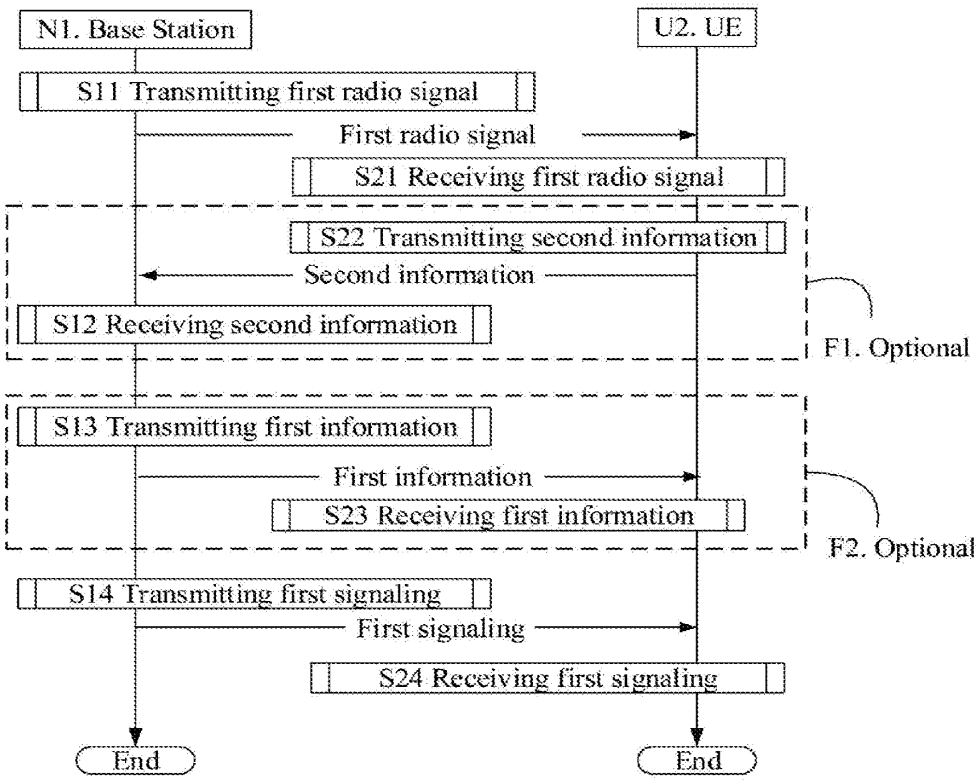

N1. Base Station
U2. UE
S11 Transmitting first radio signal
First radio signal
S21 Receiving first radio signal
S22 Transmitting second information
Second information
S12 Receiving second information
F1. Optional
S13 Transmitting first information
First information
S23 Receiving first information
F2. Optional
S14 Transmitting first signaling
First signaling
S24 Receiving first signaling
End
End

Fig. 1

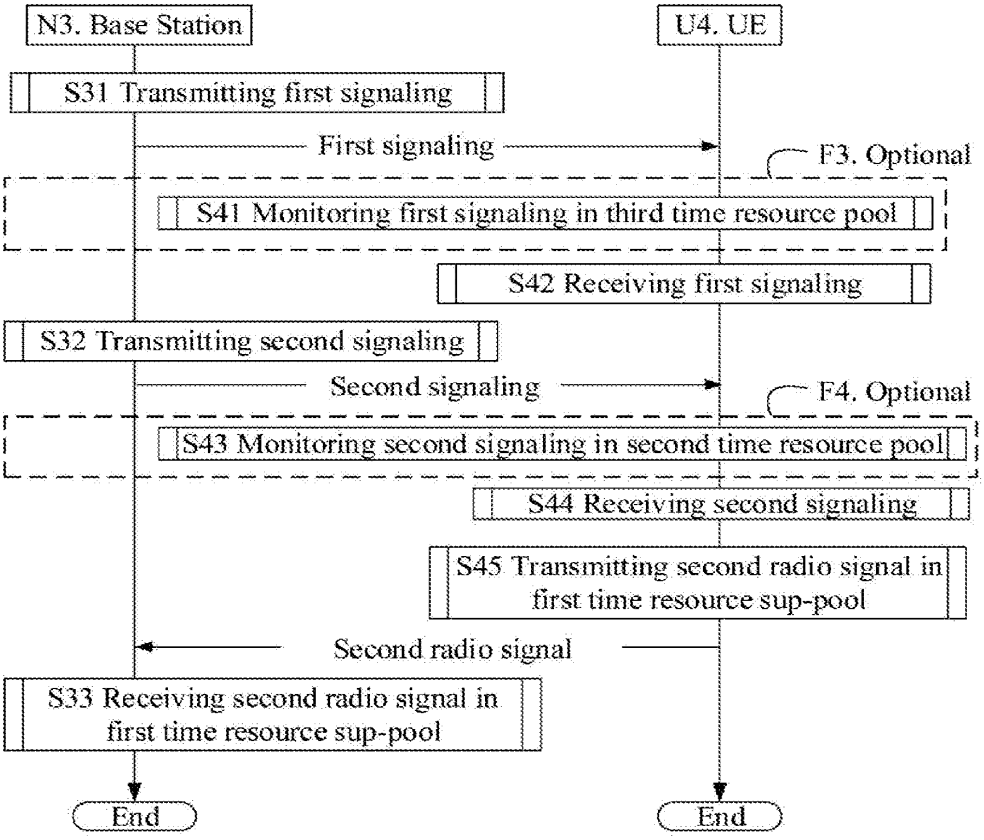

N3. Base Station
U4. UE
S31 Transmitting first signaling
First signaling
F3. Optional
S41 Monitoring first signaling in third time resource pool
S42 Receiving first signaling
S32 Transmitting second signaling
Second signaling
F4. Optional
S43 Monitoring second signaling in second time resource pool
S44 Receiving second signaling
S45 Transmitting second radio signal in first time resource sup-pool
Second radio signal
S33 Receiving second radio signal in first time resource sup-pool
End
End

Fig. 2

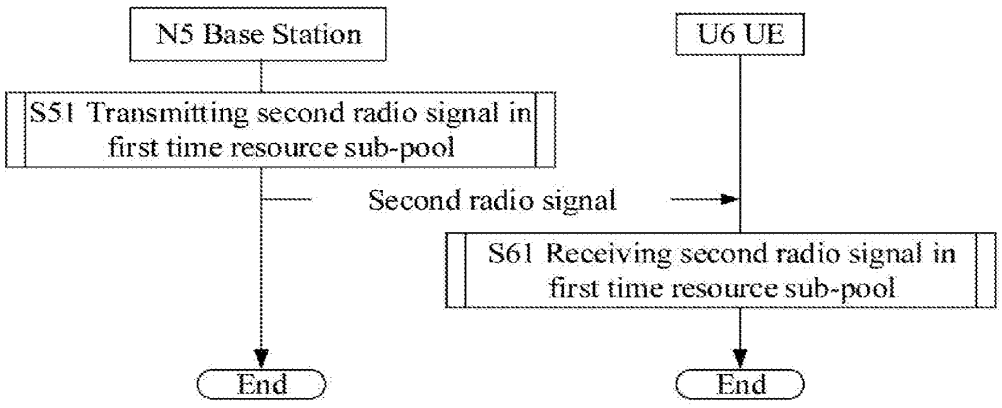

N5 Base Station
U6 UE
S51 Transmitting second radio signal in first time resource sub-pool
Second radio signal
S61 Receiving second radio signal in first time resource sub-pool
End
End

Fig. 3

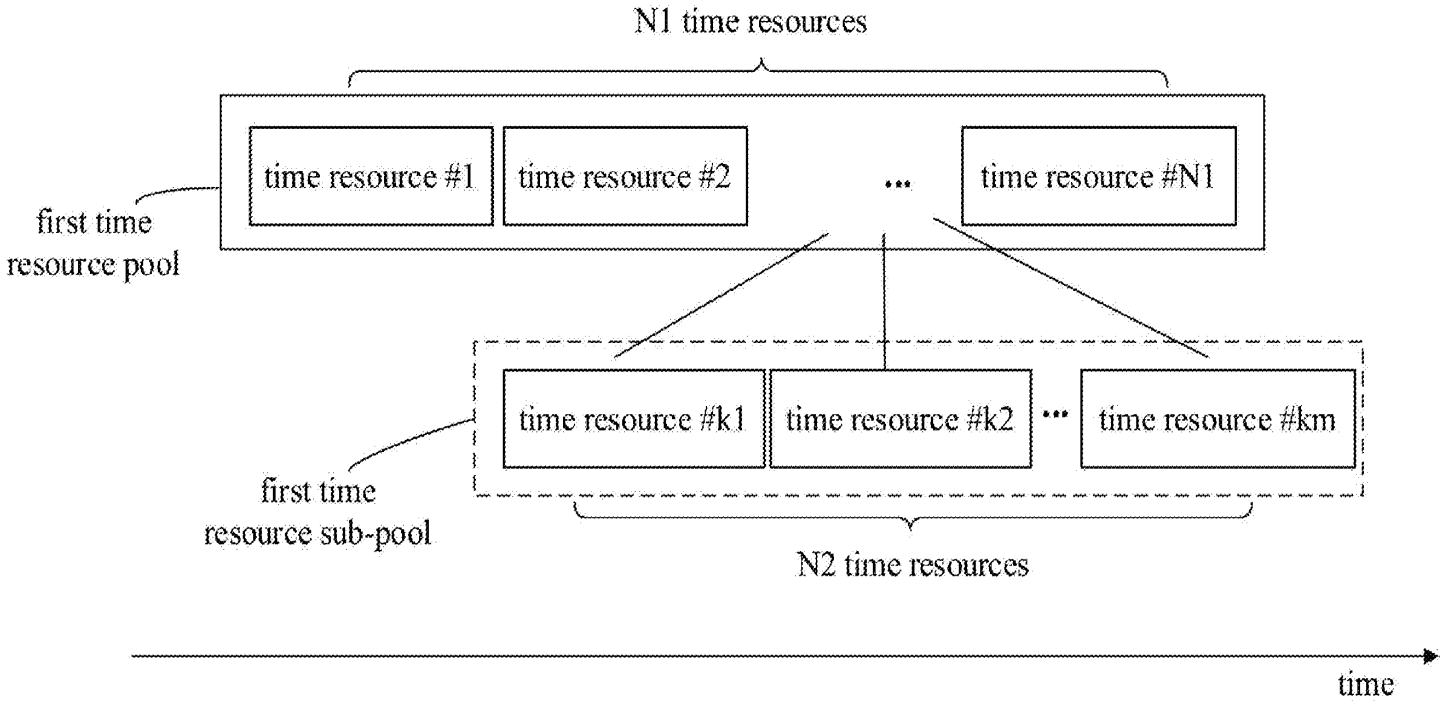


Fig. 4

Samsung Exhibit 1003, Page 4 of 438

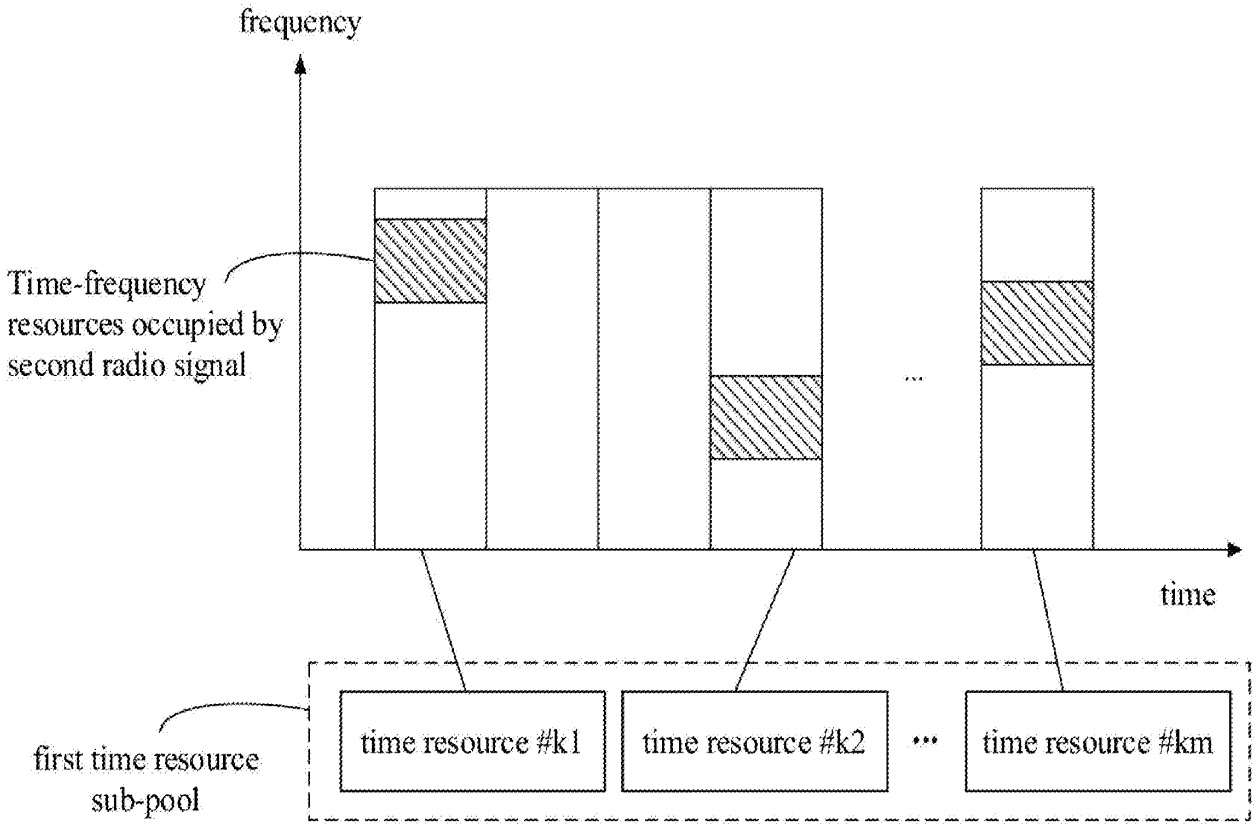


Fig. 5

Samsung Exhibit 1003, Page 5 of 438

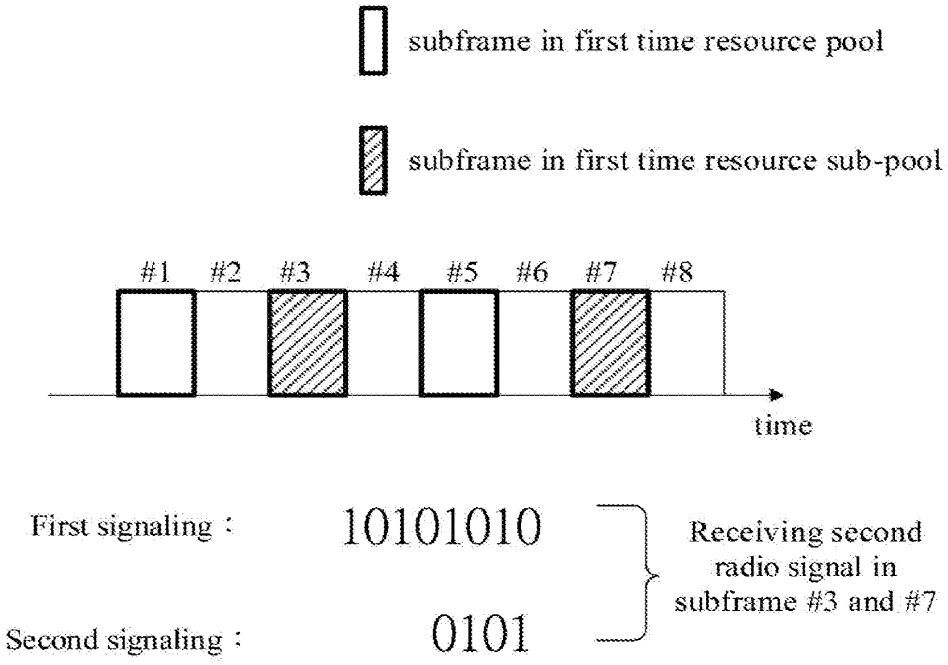

subframe in first time resource pool
subframe in first time resource sub-pool
#1
#2
#3
#4
#5
#6
#7
#8
time
First signaling：
10101010
Second signaling：
0101
Receiving second radio signal in subframe #3 and #7

Fig. 6

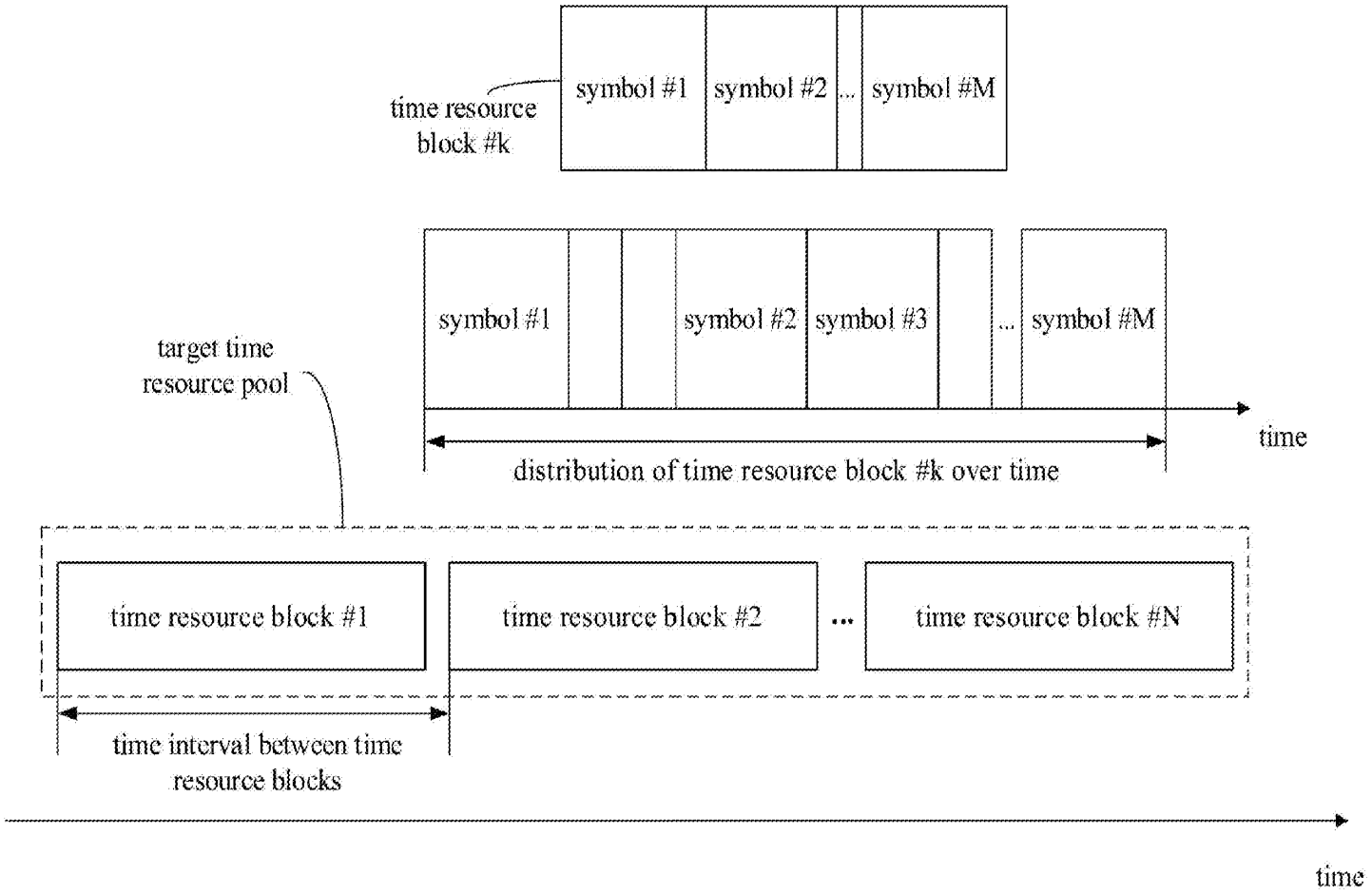


Fig. 7

Samsung Exhibit 1003, Page 7 of 438

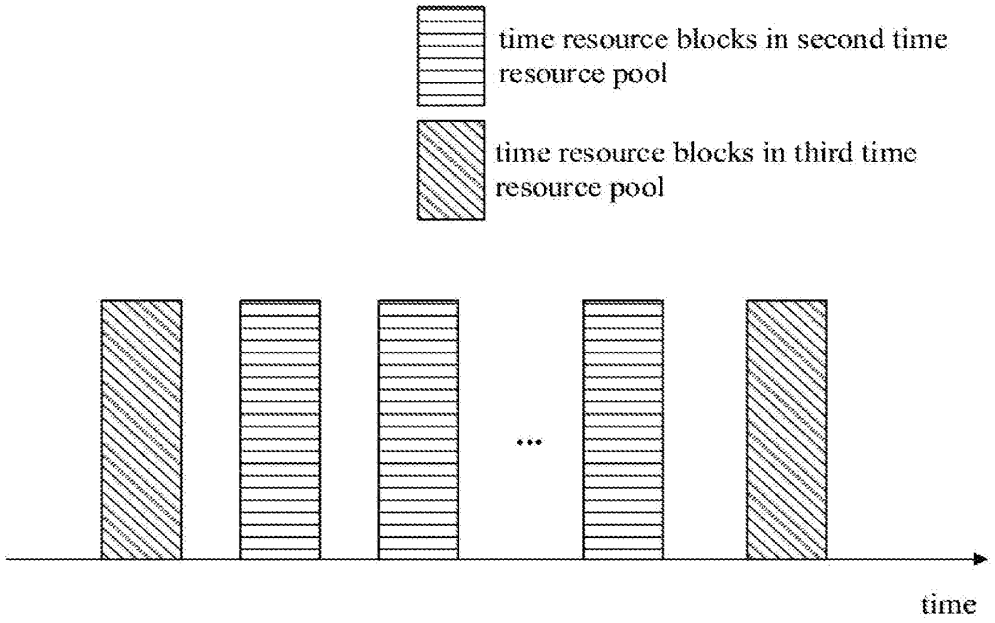

time resource blocks in second time resource pool
time resource blocks in third time resource pool
...
time

Fig. 8

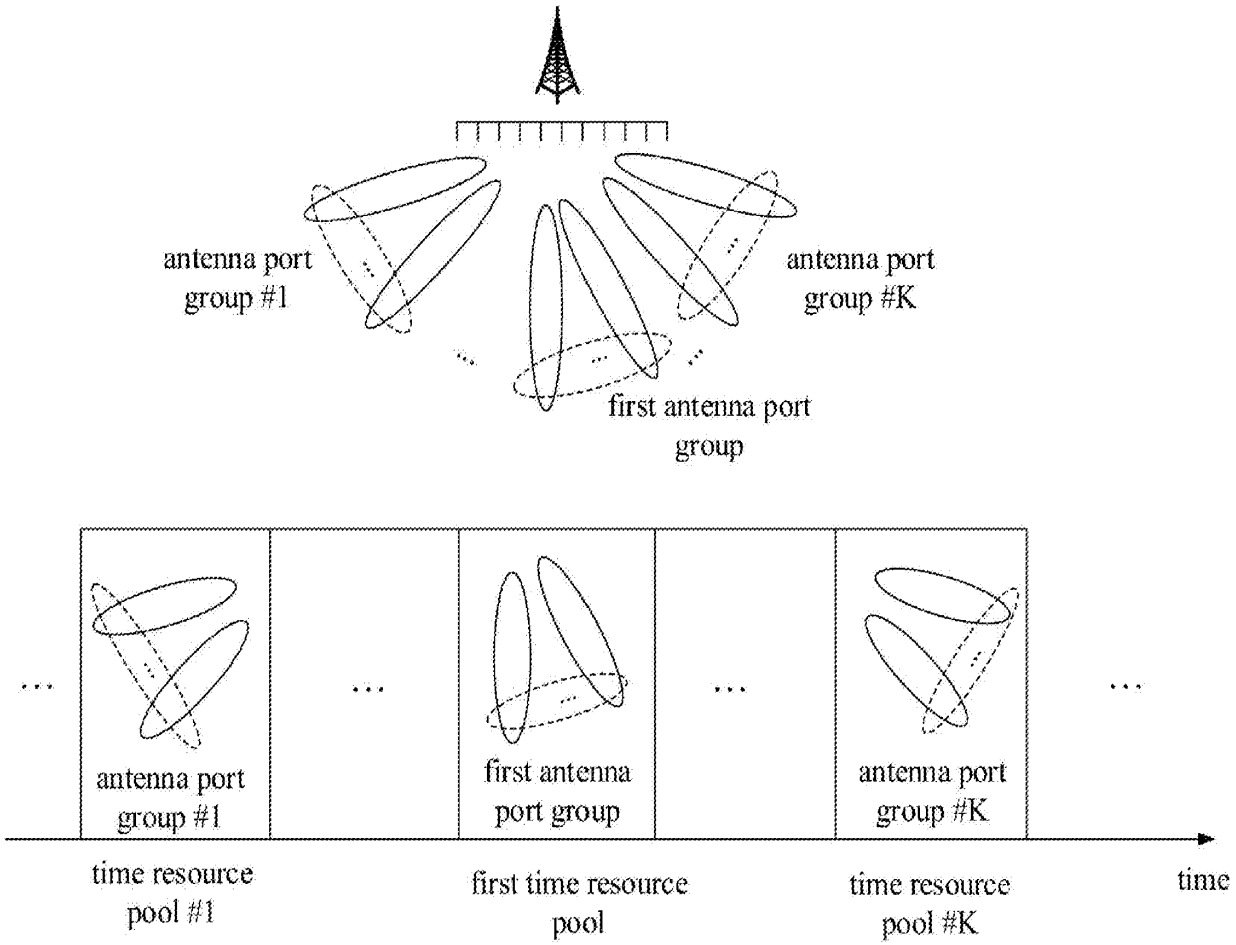


Fig. 9

Samsung Exhibit 1003, Page 9 of 438

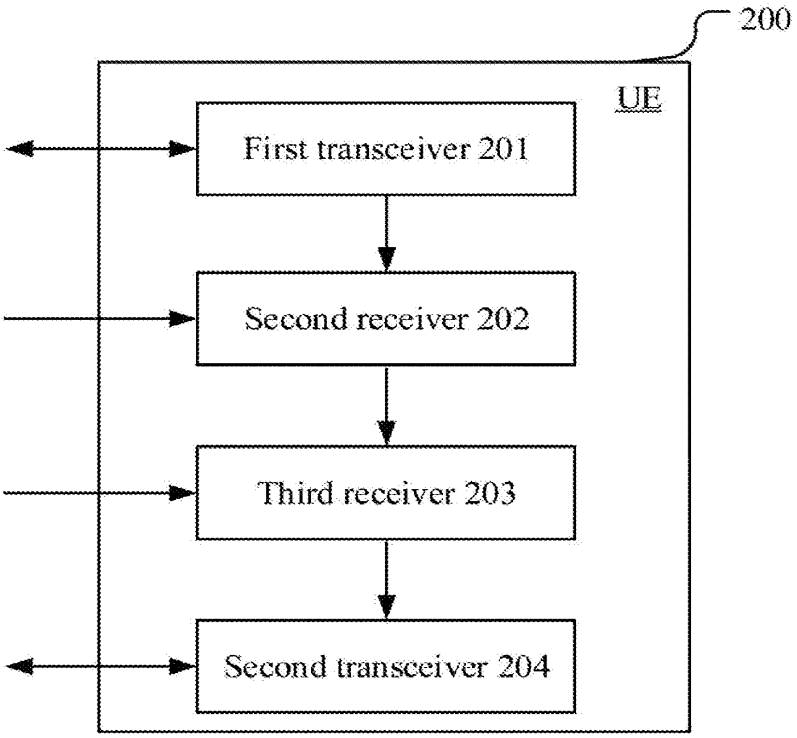

200
UE
First transceiver 201
Second receiver 202
Third receiver 203
Second transceiver 204

Fig. 10

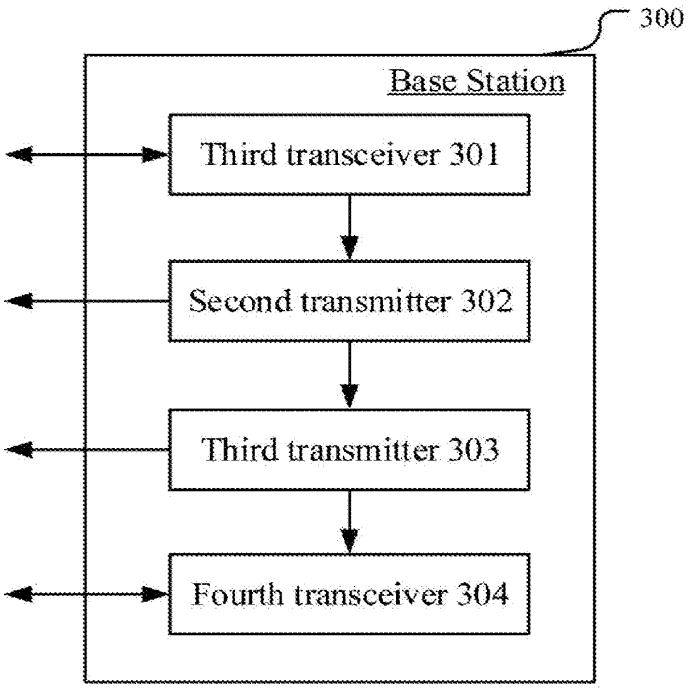

300
Base Station
Third transceiver 301
Second transmitter 302
Third transmitter 303
Fourth transceiver 304

Fig. 11

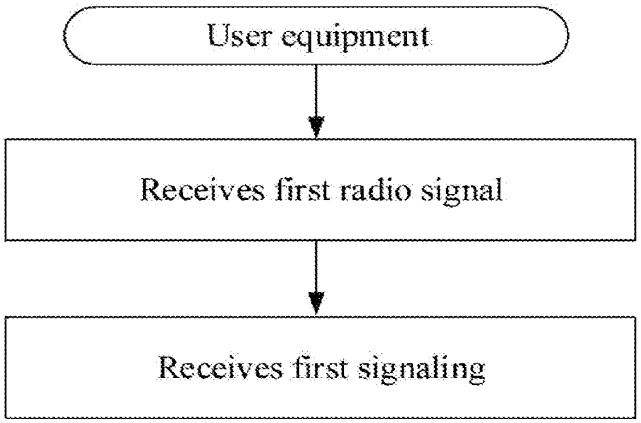

User equipment
Receives first radio signal
Receives first signaling

Fig. 12

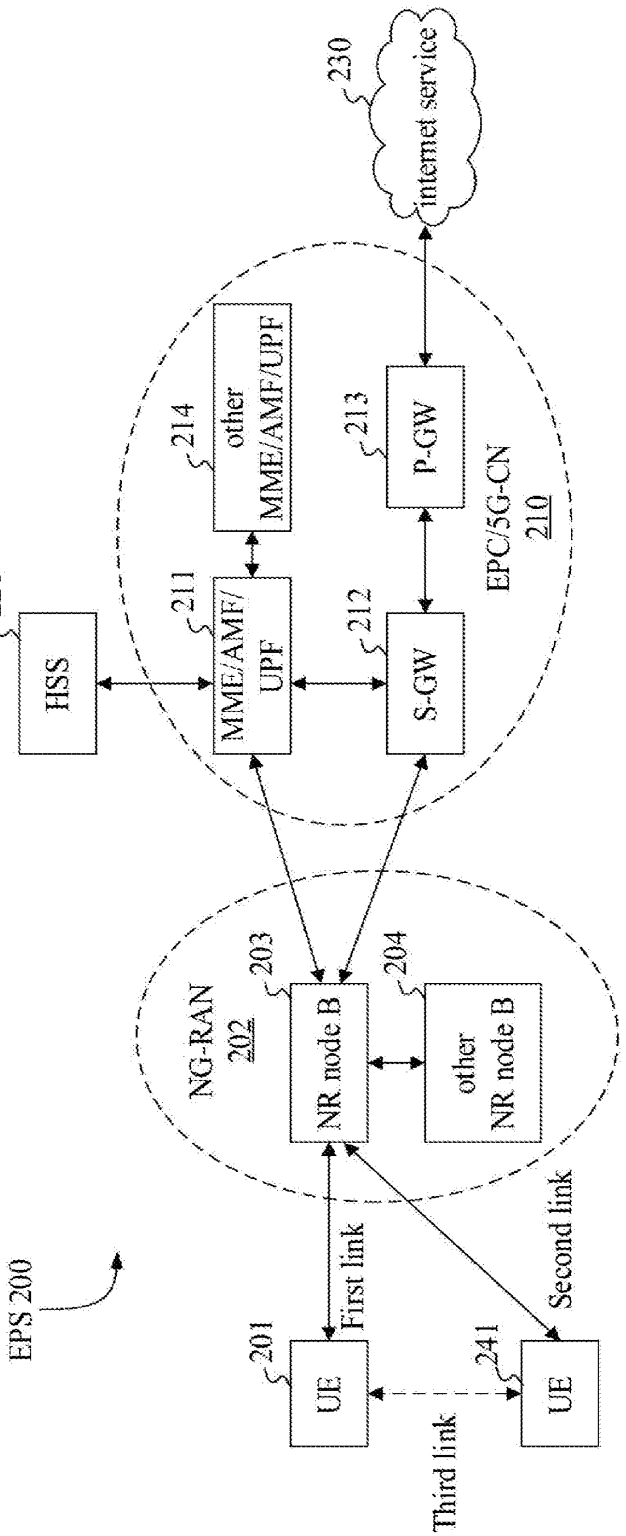

EPS 200
UE
201
First link
Second link
Third link
UE
241
NG-RAN
202
NR node B
203
other
NR node B
204
EPC/5G-CN
210
MME/AMF/
UPF
211
S-GW
212
P-GW
213
other
MME/AMF/UPF
214
HSS
220
internet service
230

Fig. 13

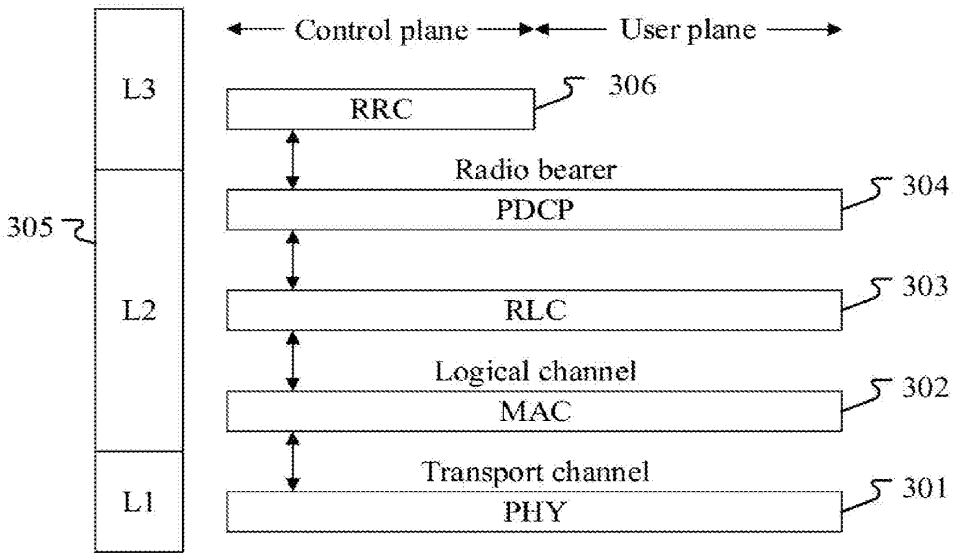

Control plane
User plane
L3
L2
L1
305
RRC
306
Radio bearer
PDCP
304
RLC
303
Logical channel
MAC
302
Transport channel
PHY
301

Fig. 14

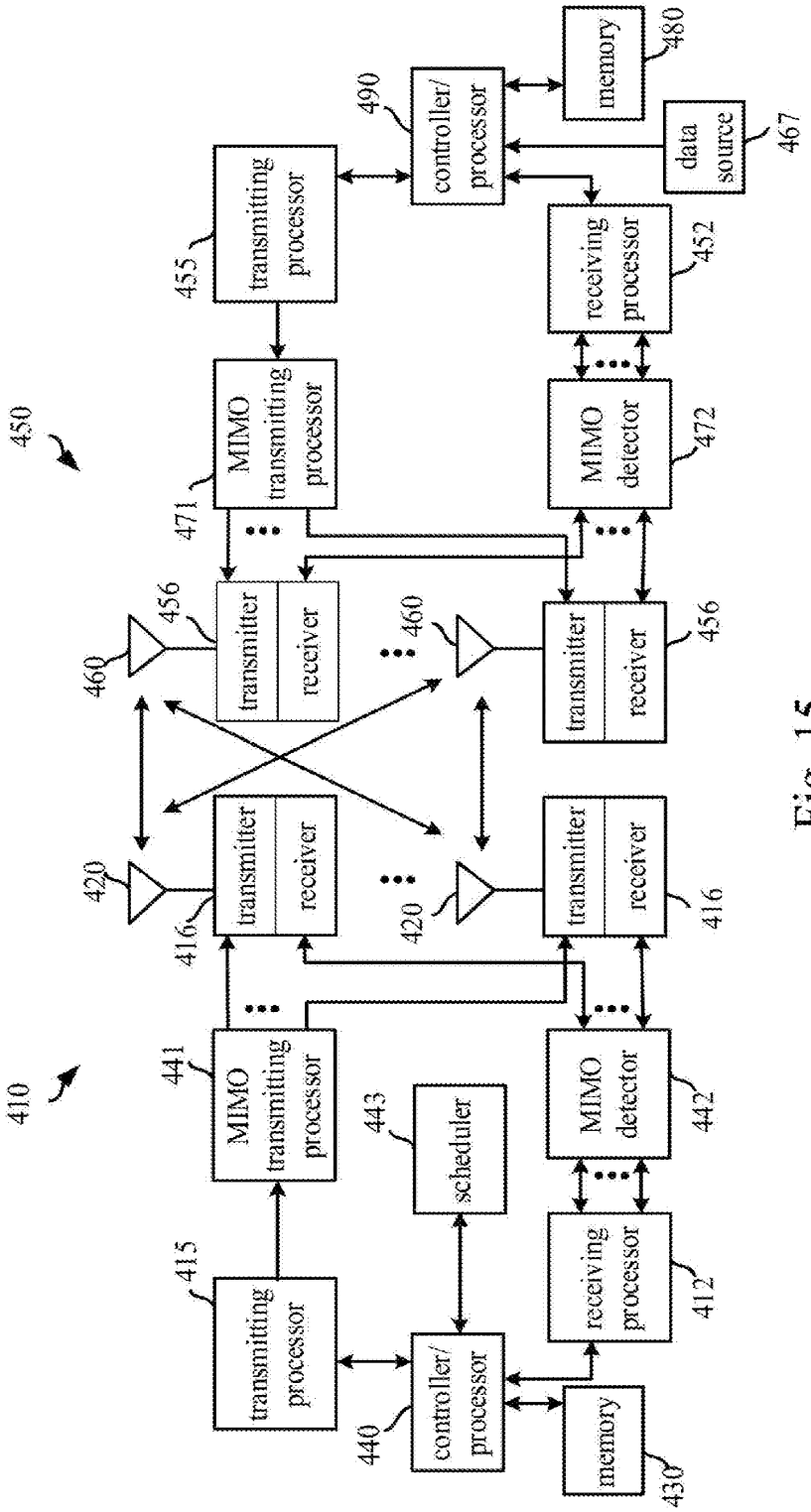

410
450
transmitting processor
415
MIMO transmitting processor
441
scheduler
443
controller/ processor
440
memory
430
receiving processor
412
MIMO detector
442
transmitter
receiver
416
420
460
456
471
transmitting processor
455
MIMO transmitting processor
transmitter
receiver
receiving processor
452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

Fig. 15

ABSTRACT

The present disclosure discloses a method and device for multi-antenna transmission in UE and base station. The user equipment first receives a first radio signal at first, then receives a first signaling. The first radio signal is transmitted by K antenna port groups, and the antenna port group includes a positive integer number of antenna port(s), and the first antenna port group is one of the K antenna port groups. The first signaling is used to determine a first time resource pool, at least one first antenna virtualization vector and the second antenna virtualization vector is associated with the first antenna port group. The invention effectively reduces signaling overhead of wireless resource dynamic scheduling of a massive MIMO system.

Samsung Exhibit 1003, Page 16 of 438

CLAIMS

WHAT IS CLAIMED IS:

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

receiving a first radio signal; and

receiving a first signaling;

wherein the first radio signal is transmitted by K antenna port groups; the antenna port group includes a positive integer number of the antenna port(s); a first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.

2. The method of claim 1, further comprising:

receiving a second signaling; and

operating a second radio signal in a first time resource sub-pool;

wherein the operating is receiving, or the operating is transmitting; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.

3. The method of claim 2, comprising;

monitoring the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s);

or,

monitoring the second signaling in a second time resource pool and monitoring the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time

resource pool includes a positive integer number of the time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

4. The method of claim 1, further comprising:

receiving first information, wherein the first information is used to determine the first antenna port group;

or,

transmitting second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

5. The method of claim 1, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

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

transmitting a first radio signal; and

transmitting a first signaling;

wherein the first radio signal is transmitted by K antenna port groups; the antenna port group includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to a target receiver of the first signaling in the first time resource pool; the K is a positive integer greater than 1.

7. The method of claim 6, further comprising:

transmitting a second signaling; and

performing a second radio signal in a first time resource sub-pool;

wherein the performing is transmitting, or the performing is receiving; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.

8. The method of claim 7, comprising:

transmitting the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s);

or,

transmitting the second signaling in a second time resource pool and transmitting the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

9. The method of claim 6, further comprising:

transmitting first information, wherein the first information is used to determine the first antenna port group;

or,

receiving second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

10. The method of claim 6, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

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

Samsung Exhibit 1003, Page 19 of 438

a first transceiver, receiving a first radio signal; and

a second receiver, receiving a first signaling;

wherein the first radio signal is transmitted by K antenna port groups; the antenna port group includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.

12. The UE of claim 11, comprising:

a third receiver, receiving a second signaling; and

a second transceiver, operating a second radio signal in a first time resource sub-pool;

wherein the operating is receiving, or the operating is transmitting; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.

13. The UE of claim 12, the third receiver further monitors the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s);

or,

the third receiver further monitors the second signaling in a second time resource pool, and the second receiver further monitors the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a

Samsung Exhibit 1003, Page 20 of 438

minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

14. The UE of claim 11, the second receiver further receives first information, wherein the first information is used to determine the first antenna port group;

or the first transceiver further transmits second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

15. The UE of claim 11, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

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

a third transceiver, transmitting a first radio signal; and

a second transmitter, transmitting a first signaling;

wherein the first radio signal is transmitted by K antenna port groups; the antenna port group includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to a target receiver of the first signaling in the first time resource pool; the K is a positive integer greater than 1.

17. The base station equipment of claim 16, further comprising:

a third transmitter, transmitting a second signaling; and

a fourth transceiver, performing a second radio signal in a first time resource sub-pool;

wherein the performing is transmitting, or the performing is receiving; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.

Samsung Exhibit 1003, Page 21 of 438

18. The base station equipment of claim 17, the third transmitter further transmits the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s);

or the third transmitter further transmits the second signaling in a second time resource pool, and the second transmitter further transmits the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

19. The base station equipment of claim 16, the second transmitter further transmits first information, wherein the first information is used to determine the first antenna port group;

or the third transceiver further receives second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

20. The base station equipment of claim 16, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

Method and Device for Multi-Antenna Transmission in UE and Base Station

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of International Application No. PCT/CN2017/112033, filed on November 21, 2017, claiming the priority benefit of Chinese Patent Application Serial Number 201611098328.7, filed on December 3, 2016. The afore-mentioned patent applications are hereby incorporated by reference in their entireties.

BACKGROUND

TECHNICAL FIELD

[0002] The present disclosure relates to a multiple antenna transmission method in a wireless communication system.

RELATED ART

[0003] 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 to a specific direction through beamforming.

[0004] According to the discussion of 3rd Generation Partner Project (3GPP) Radio Access Network (RAN), the hybrid beamforming combining analog beamforming and digital beamforming has become an important research direction of New Radio (NR) system.

SUMMARY

[0005] In a massive MIMO system, the total throughput of a cell can be greatly increased by the number of massive antennas, so the number of single-cell users can be greatly increased. However, an increase in the number of cell users will lead to a large

amount of signaling overhead for dynamic scheduling of wireless time-frequency resources. The signaling overhead of wireless resource dynamic scheduling is an urgent problem to be solved in massive MIMO system.

[0006] In view of the above problem, the present disclosure provides a solution. It should be noted that, in the case of no conflict, the features in the embodiments and embodiments in the user equipment of the present disclosure can be applied to the base station, and vice versa. The features of the embodiments and the embodiments of the present disclosure may be combined with each other arbitrarily if no conflict is incurred.

[0007] The present disclosure discloses a method for multi-antenna transmission in a user equipment (UE), comprising:

[0008] receiving first radio signal; and

[0009] receiving a first signaling;

[0010] wherein the first radio signal is transmitted by K antenna port groups; the antenna port group(s) include a positive integer number of the antenna port(s); a first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the firs antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1 .

[0011] In one embodiment, the foregoing method is advantageous in that, by associating the first time resource pool with the first antenna port group, the UE can quickly determines the location of the first time resource pool in the time domain by the index of the first antenna port group in the K antenna port groups.

[0012] In one embodiment, the foregoing method is advantageous in that, by associating the first time resource pool with the first antenna port group, the UE can quickly determine the antenna virtualization vectors which used for receiving radio signal transmitted on the first time resource pool by the location of the first time resource pool in the time domain.

[0013] In one embodiment, the first radio signal is a multi-carrier symbol.

[0014] In one embodiment, the first radio signal is a single carrier symbol.

[0015] In one embodiment, the first radio signal is an OFDM symbol.

[0016] In one embodiment, the first radio signal is an FBMC symbol.

[0017] In one embodiment, the first radio signal is an SC-FDMA symbol.

[0018] In one embodiment, the first radio signal is reference signal(s) associated with the K antenna port groups.

[0019] In one embodiment, the first radio signal is wireless resource block(s) transmitted by the K antenna port groups.

[0020] In one embodiment, the first radio signal includes one or more of Primary Synchronization Signal (PSS), Secondary Synchronization Signal (SSS), Master Information Block (MIB)/System Information Block (SIB), and Channel State Information Reference signal(s) (CSI-RS).

[0021] In one embodiment, the antenna port is formed by superposing multiple physical antennas through antenna virtualization; the mapping coefficients from the multiple physical antennas to the antenna port(s) constitute an antenna virtualization vector for the antenna virtualization.

[0022] In one embodiment, the beamforming vectors corresponding to any two different antenna ports cannot be assumed to be the same.

[0023] In one embodiment, the small-scale characteristics of a wireless channel experienced by a signal transmitted by one antenna port and cannot be used to infer the small-scale characteristics of a wireless channel experienced by a signal transmitted by another antenna port.

[0024] In one embodiment, an antenna port is associated with a reference signal.

[0025] In one embodiment, an antenna port is used to transmit a reference signal associated therewith.

[0026] In one embodiment, the pattern of the time-frequency resource occupied by the reference signal(s) in one subframe reuses the pattern of the CSI-RS in one subframe.

[0027] In one embodiment, the reference signal is a CSI-RS.

[0028] In one embodiment, the sequence corresponding to the reference signal is a Zadoff-Chu sequence.

[0029] In one embodiment, the sequence corresponding to the reference signal is a pseudo-random sequence.

[0030] In an embodiment, the time domain resources occupied by the reference signal(s) is(are) associated with at least one of time domain resources occupied by the first signaling and time domain resources occupied by the first radio signal.

[0031] In one embodiment, the frequency domain resources occupied by the reference signal(s) is associated with at least one of a frequency domain resources occupied by the first signaling and frequency domain resources occupied by the first radio signal.

[0032] In one embodiment, the frequency domain resources occupied by the reference signal(s) are configurable.

[0033] In one embodiment, the K antenna port groups are associated with K reference signal group(s), respectively.

[0034] In one embodiment, the K antenna port groups are respectively used to transmit K reference signal(s) groups.

[0035] In one embodiment, the K antenna port groups are used to transmit K CSI-RS group(s).

[0036] In one embodiment, the K antenna port groups correspond to K reference signal resources, and the first antenna port group corresponds to one of the K reference signal resources.

[0037] In one embodiment, the K reference signal groups are respectively transmitted on K reference signal resources.

[0038] In one embodiment, one reference signal resource includes a plurality of Resource Elements (REs).

[0039] In one embodiment, the K reference signal resources are pairwise orthogonal in the time-frequency domain.

[0040] In one embodiment, the antenna port group includes only one antenna port.

[0041] In one embodiment, the antenna port group includes two antenna ports. In one embodiment, the air interface resource(s) occupied by one antenna port is different from the air interface resource(s) occupied by another antenna port.

[0042] In one embodiment, the air interface resource(s) occupied by one reference signal is different from the air interface resource(s) occupied by another reference signal.

[0043] In one embodiment, the air interface resource(s) includes(include) at least one of time domain resources, frequency domain resources, and code domain resources.

[0044] In one embodiment, the pattern of the reference signal(s) transmitted by at least two antenna ports in the K antenna port groups are the same in the time-frequency resource block(s).

[0045] In one embodiment, the time-frequency resource block(s) is a Physical Resource block Pair (PRBP).

[0046] In one embodiment, the time-frequency resource block(s) occupies W subcarriers on the frequency domain and occupies a wideband symbol in the time domain, wherein the W is a positive integer greater than 1. In a sub-embodiment of this sub-embodiment, the wideband symbol is one of an OFDM symbol, an SC-FDMA symbol, and an SCMA symbol.

[0047] In one embodiment, the first radio signal is transmitted by the K antenna port groups in a manner that the first radio signal carries the K reference signal groups, and the antenna virtualization vectors corresponding to the K reference signal groups are respectively used to map the K reference signal groups to a set of physical antennas to be transmitted.

[0048] In one embodiment, the time resources respectively corresponding to the K antenna port groups are orthogonal.

[0049] In one embodiment, the first signaling is a semi-static signaling.

[0050] In one embodiment, the first signaling is a high layer signaling.

[0051] In one embodiment, the first signaling includes one or more RRC Information Elements (IEs).

[0052] In one embodiment, the first signaling is a dynamic signaling.

[0053] In one embodiment, the first signaling is a physical layer signaling.

[0054] In one embodiment, the first signaling is carried by a downlink physical layer control channel (i.e. a downlink channel that can only be used to carry physical layer signaling).

[0055] In one embodiment, the downlink physical layer control channel is a Physical Downlink Control Channel (PDCCH).

[0056] In one embodiment, the downlink physical layer control channel is a short PDCCH (sPDCCH).

[0057] In one embodiment, the first signaling carries downlink control information (DCI).

[0058] In one embodiment, the first signaling carries fast downlink control information (fast DCI).

[0059] In one embodiment, the first signaling is cell-common.

[0060] In one embodiment, the first signaling is UE-specific.

[0061] In one embodiment, the first signaling is specific to a terminal group, the terminal group includes multiple terminals, and the UE is one of the terminals of the terminal group.

[0062] In one embodiment, the first signaling is transmitted on a broadcast channel (i.e., a downlink channel that can only be used to carry broadcast signals).

[0063] In one embodiment, the broadcast channel includes a Physical Broadcast Channel (PBCH).

[0064] In one embodiment, the first signaling is transmitted by the first antenna port group.

[0065] In one embodiment, the first antenna port group includes L antenna port(s), the first signaling includes L first sub-signals, the L first sub-signals carry the same bit block, and the L first sub-signals are respectively transmitted by the L antenna port(s). The bit block includes a positive integer number of bit(s), and the L is a positive integer.

[0066] In one embodiment, the index of the first antenna port group in the K antenna port groups is a non-negative integer smaller than the K.

[0067] In one embodiment, the index of the first antenna port group in the K antenna port groups is used to generate the first signaling.

[0068] In one embodiment, a receiving beamforming vector for the first antenna port group is used to determine a receiving beamforming vector for the first signaling.

[0069] In one embodiment, the first signaling indicates the first antenna port group from the K antenna port groups.

[0070] In one embodiment, the first signaling explicitly indicates the first time resource pool.

[0071] In one embodiment, the first signaling implicitly indicates the first time resource pool.

[0072] In one embodiment, the first time resource pool is discontinuous in the time domain.

[0073] In one embodiment, a transmitter of the first signaling generates the transmitting analog beam corresponding to the first antenna port group by adopting the first antenna virtualization vector.

[0074] In one embodiment, the first antenna port group is used to transmit a first reference signal(s) group, and the first antenna virtualization vector is used to transmit the first reference signal(s) group.

[0075] In one embodiment, the UE generates the receiving analog beam corresponding to the first antenna port group(s) by adopting the second antenna virtualization vector.

[0076] In one embodiment, the second antenna virtualization vector is used to receive the first reference signal group(s).

[0077] In one embodiment, the first antenna virtualization vector is associated with the first antenna port group

[0078] In one embodiment, the second antenna virtualization vector is associated with the first antenna port group.

[0079] In one embodiment, the first antenna virtualization vector and the second antenna virtualization vector are both associated with the first antenna port group.

[0080] In one embodiment, the third radio signal is a radio signal transmitted in a time resource within the first time resource pool. The first antenna virtualization vector is used by a transmitter of the first signaling to transmit an analog beamforming of the third radio signal.

[0081] In one embodiment, the third radio signal is a radio signal transmitted in a time resource within the first time resource pool. The second antenna virtualization vector is used by the UE to receive an analog beamforming of the third radio signal.

[0082] In one embodiment, the third radio signal is a radio signal transmitted in a time resource within the first time resource pool. The first antenna virtualization vector is used by a transmitter of the first signaling to receive an analog beamforming of the third radio signal.

[0083] In one embodiment, the third radio signal is a radio signal transmitted in a time resource within the first time resource pool. The second antenna virtualization vector is used by the U E to transmit an analog beamforming of the third radio signal.

[0084] In one embodiment, the first antenna port group includes L antenna port(s), the first antenna port is one of the L antenna port(s), and the first antenna virtualization vector is associated with the first antenna port.

[0085] In one embodiment, the second antenna virtualization vector is associated with the first antenna port.

[0086] According to one aspect of the present disclosure, the method comprises:

[0087] receiving a second signaling; and

[0088] operating a second radio signal in a first time resource sub-pool;

[0089] wherein the operating is receiving; or the operating is transmitting; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, (a) transmitting antenna port(s) of the second radio signal.

[0090] In one embodiment, the advantages of the above method is that by the method of receiving the second signal to determine the first time resource sub-pool from the first

time resource pool, the UE can significantly reduce the signaling overhead for determining the frequency domain resources occupied by the second radio signal.

[0091] In one embodiment, the second signaling is dynamic signaling.

[0092] In one embodiment, the second signaling is physical layer signaling.

[0093] In one embodiment, the second signaling is carried by a downlink physical layer control channel.

[0094] In one embodiment, the second signaling is a physical layer downlink control indication.

[0095] In one embodiment, the second signaling consists of two physical layer downlink control indications.

[0096] In one embodiment, the second signaling is for the UE.

[0097] In one embodiment, the second signaling is transmitted by the first antenna port group.

[0098] In one embodiment, the first antenna virtualization vector is used to transmit the second signaling.

[0099] In one embodiment, the first time resource sub-pool is discontinuous in the time domain.

[0100] In one embodiment, the time resource included in the first time resource sub-pool is a subset of the first time resource pool.

[0101] In one embodiment, the first time resource pool includes N1 time resources, and the first time resource sub-pool includes N2 time resources in the N1 time resources.

[0102] In one embodiment, the time resource is a sub-frame.

[0103] In one embodiment, the time resource is an OFDM symbol.

[0104] In one embodiment, the time resource is an SC-FDMA symbol.

[0105] In one embodiment, the time resource is an FBMC symbol.

[0106] In one embodiment, the UE determines the time resource included in the first time resource sub-pool by the joint indication of the second signaling and the first signaling.

[0107] In an embodiment, the second signaling is used to determine a relative position of the time resource comprised in the first time resource sub-pool in the first time resource pool.

[0108] In one embodiment, the second signaling indicates that the time resource comprised in the first time resource sub-pool corresponds to a bitmap of the first time resource pool.

[0109] In an embodiment, the second signaling indicates an index of a time resource comprised in the first time resource sub-pool in the first time resource pool.

[0110] In one embodiment, the second radio signal is a radio resource block(s).

[0111] In one embodiment, the time domain resources occupied by the second radio signal are the first time resource sub-pool, and the frequency domain resources occupied by the second radio signal are indicated by the second signaling.

[0112] In one embodiment, the second signaling is divided into M fields, and the first field and the second field are respectively two fields in the M fields. The first field is used to determine the first time resource sub-pool from the first time resource pool, and the second field is used to determine frequency domain resources occupied by the second radio signal.

[0113] In one embodiment, the second signaling is divided into M fields, and the first field is one of the M fields. The first field is configured to determine the first time resource sub-pool from the first time resource pool and is used to determine frequency domain resources occupied by the second radio signal.

[0114] In one embodiment, the transmitting channel corresponding to the second radio signal is a DL-SCH, and the operation is receiving.

[0115] In one embodiment, the physical layer channel corresponding to the second radio signal is a PDSCH, and the operation is receiving.

[0116] In one embodiment, the transmitting channel corresponding to the second radio signal is a UL-SCH, and the operation is transmitting.

[0117] In one embodiment, the physical layer channel corresponding to the second radio signal is a PUSCH, and the operation is transmitting.

[0118] In one embodiment, the operation is receiving, and the first antenna virtualization vector is used to transmit an analog beamforming of the second radio signal.

[0119] In one embodiment, the operation is receiving, and the second antenna virtualization vector is used to receive an analog beamforming of the second radio signal.

[0120] In one embodiment, the operation is transmitting, and the first antenna virtualization vector is used to receive an analog beamforming of the second radio signal.

[0121] In one embodiment, the operation is transmitting, and the second antenna virtualization vector is used to transmit an analog beamforming of the second radio signal.

[0122] In one embodiment, the second signaling explicitly indicates at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, (a) transmitting antenna port(s).

[0123] In one embodiment, the second signaling implicitly indicates at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, (a) transmitting antenna port(s).

[0124] In one embodiment, the first antenna port group is used to transmit first reference signal group, and the second radio signal and the first reference signal group are spatially Quasi Co-Located (QCL).

[0125] In one embodiment, the first antenna virtualization vector is used to transmit the second radio signal.

[0126] In one embodiment, the second antenna virtualization vector is used to receive the second radio signal.

[0127] According to another embodiment of the present disclosure, the method comprises:

[0128] receiving first information;

[0129] wherein the first information is used to determine the first antenna port group.

[0130] In one embodiment, the first information is used to determine the first antenna port group from the K antenna port groups.

[0131] In one embodiment, the first information explicitly indicates the first antenna port group.

[0132] In one embodiment, the first information implicitly indicates the first antenna port group.

[0133] In one embodiment, the first signaling includes the first information.

[0134] In one embodiment, a field in the first signaling indicates an index of the first antenna port group in the K antenna port groups.

[0135] In one embodiment, the first information is transmitted before the first signaling.

[0136] In one embodiment, the first information is used to determine a time resource pool in which the first signaling is located.

[0137] In one embodiment, the first information is used to determine a search space in which the first signaling is located.

[0138] According to another embodiment of the present disclosure, the method comprises:

[0139] transmitting second information;

[0140] wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

[0141] In one embodiment, the second information is used to determine the first antenna port group from the K antenna port groups.

[0142] In one embodiment, the second information explicitly indicates the K1 antenna port group(s).

[0143] In one embodiment, the second information implicitly indicates the K1 antenna port group(s).

[0144] In an embodiment, the second information is time domain information corresponding to the K1 antenna port group(s).

[0145] In one embodiment, the second information includes a CSI-RS Resource Indicator (CRI) (), and the CRI indicates the CSI-RS resources corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups.

[0146] In one embodiment, the physical layer channel corresponding to the second information includes an uplink physical layer control channel (i.e., an uplink channel that can only be used to carry physical layer signaling). In a sub-embodiment, the uplink physical layer control channel is a Physical Uplink Control Channel (PUCCH).

[0147] In one embodiment, the second information is a RACH preamble, and at least one of the sequences of the RACH preamble, and the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

[0148] In one embodiment, the physical layer channel corresponding to the second information includes a PRACH (Physical Random Access Channel).

[0149] In one embodiment, the K1 is equal to one.

[0150] In one embodiment, the K1 is greater than 1.

[0151] According to one aspect of the present disclosure, the method comprises:

[0152] monitoring the second signaling in a second time resource pool;

[0153] wherein the second signaling occupies at most one time resource block in the second time resource pool; the second time resource pool includes a positive integer number of the time resource block(s).

[0154] In one embodiment, the second time resource pool is discontinuous in the time domain.

[0155] In one embodiment, the time resource block is discontinuous in the time domain.

[0156] In one embodiment, the time resource block is continuous in the time domain.

[0157] In an embodiment, the second time resource pool is a UE-specific time resource pool.

[0158] In an embodiment, the second time resource pool is a specific time resource pool of the first antenna port group.

[0159] In one embodiment, the first antenna port group is used to determine the second time resource pool.

[0160] In one embodiment, the first antenna virtualization vector is used for transmitting analog beamforming of the second signaling.

[0161] In one embodiment, the second antenna virtualization vector is used for receiving analog beamforming of the second signaling.

[0162] In one embodiment, the second signaling is on the UE-specific search space.

[0163] In one embodiment, the second signaling is dynamic.

[0164] In one embodiment, the second signaling is carried by a downlink physical layer control channel.

[0165] In one embodiment, the downlink physical layer control channel is a PDCCH.

[0166] In one embodiment, the downlink physical layer control channel is an sPDCCH.

[0167] In one embodiment, the second signaling carries a DCI.

[0168] In one embodiment, the second signaling carries a fast DCI.

[0169] In one embodiment, the UE performs blind detection in the second time resource pool to determine a time-frequency resource occupied by the second signaling.

[0170] In one embodiment, the UE determines whether the second signaling is transmitted in the second time resource pool by using a blind detection method.

[0171] In one embodiment, the blind detection refers to that the UE receives a signal on multiple candidate time-frequency resources and performs a decoding operation, and if the decoding is determined correct according to the check bit, the receiving is judged as successful, otherwise the receiving is judged as a failure.

[0172] In one embodiment, the frequency resource pool corresponding to the blind detection is configurable.

[0173] According to another embodiment of the present disclosure, the method comprises:

[0174] monitoring the first signaling in a third time resource pool;

[0175] wherein the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

[0176] In one embodiment, the advantages of the foregoing method are that reducing the signaling overhead of notifying the UE to perform the time resource of the operation, and increasing the dynamicity of the time resource scheduling.

[0177] In one embodiment, the third time resource pool is discontinuous in the time domain.

[0178] In one embodiment, the time resource block is discontinuous in the time domain.

[0179] In one embodiment, the time resource block is continuous in the time domain.

[0180] In one embodiment, the third time resource pool is a time resource pool common to the cell.

[0181] In one embodiment, the third time resource pool is a UE-specific time resource pool.

[0182] In one embodiment, the third time resource pool is a specific time resource pool of the first antenna port group.

[0183] In one embodiment, the first antenna port group is used to determine the third time resource pool.

[0184] In one embodiment, the first antenna virtualization vector is used for transmitting analog beamforming of the first signaling.

[0185] In one embodiment, the second antenna virtualization vector is used for receiving analog beamforming of the first signaling.

[0186] In one embodiment, the UE performs blind detection in the third time resource pool to determine a time-frequency resource occupied by the first signaling.

[0187] In one embodiment, the UE determines whether the first signaling is transmitted in the third time resource pool by using a blind detection method.

[0188] In one embodiment, the first signaling is on a common search space.

[0189] In one embodiment, the first signaling is in a specific search space of the first antenna port group.

[0190] In one embodiment, the first signaling is on the UE-specific search space.

[0191] In one embodiment, the third time resource pool is a subset of the second time resource pool.

[0192] The present disclosure discloses a method for multi-antenna transmission in a base station, comprising:

[0193] transmitting first radio signal; and

[0194] transmitting a first signaling;

[0195] wherein the first radio signal is transmitted by K antenna port groups; the antenna port group(s) includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector, and second antenna virtualization vector is associated with the first antenna port group; the firs antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.

[0196] In one embodiment, the first signaling is transmitted by the first antenna port group.

[0197] In one embodiment, the reference signal(s) transmitted by the first antenna port group with at least two different antenna port(s) has the same pattern in the time-frequency resource block(s).

[0198] In one embodiment, the first time resource pool is discontinuous in the time domain.

[0199] According to one aspect of the present disclosure, the method comprises:

[0200] transmitting a second signaling;

[0201] performing second radio signal in a first time resource sub-pool;

[0202] wherein the performing is transmitting; or the performing is receiving; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; the second signaling is used to determine at least one of occupied

frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, (a) transmitting antenna port(s) of the second radio signal.

[0203] In one embodiment, the second signaling is transmitted by the first antenna port group.

[0204] In one embodiment, the second signaling is transmitted by one antenna port in the first antenna port group.

[0205] In one embodiment, the first time resource sub-pool is discontinuous in the time domain.

[0206] According to one aspect of the present disclosure, the method comprises:

[0207] transmitting first information;

[0208] wherein the first information is used to determine the first antenna port group.

[0209] In one embodiment, the first information is a domain of the first signaling.

[0210] In one embodiment, the first information is transmitted before the first signaling

[0211] According to one aspect of the present disclosure, the method comprises:

[0212] receiving second information;

[0213] wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

[0214] In one embodiment, the K1 is equal to 1.

[0215] In one embodiment, the K1 is greater than 1.

[0216] In one embodiment, the second information is a CRI.

[0217] According to another embodiment of the present disclosure, the method comprises:

[0218] transmitting the second signaling in a second time resource pool;

[0219] wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s).

[0220] In one embodiment, the second time resource pool is discontinuous in the time domain.

[0221] According to one aspect of the present disclosure, the method comprises:

[0222] transmitting the first signaling in a third time resource pool;

[0223] wherein the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

[0224] In one embodiment, the third time resource pool discontinuous in the time domain.

[0225] The present disclosure discloses a user equipment for multi-antenna transmission, comprising:

[0226] a first transceiver, receiving first radio signal; and

[0227] a second receiver, receiving a first signaling;

[0228] wherein the first radio signal is transmitted by K antenna port groups; the antenna port group(s) includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector, and second antenna virtualization vector is associated with the first antenna port group; the firs antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.

[0229] According to one aspect of the present disclosure, the method comprises:

[0230] a third receiver, receiving a second signaling; and

[0231] a second transceiver, operating a second radio signal in a first time resource sub-pool;

[0232] wherein the operating is receiving; or the operating is transmitting; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, (a) transmitting antenna port(s) of the second radio signal.

[0233] In one embodiment, the second receiver receives the first information. The first information is used to determine the first antenna port group.

[0234] In one embodiment, the first transceiver transmits the second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

[0235] In one embodiment, the third receiver further monitors the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s).

[0236] In one embodiment, the first signaling is a dynamic signaling, and the second receiver monitors the first signaling in a third time resource pool. Wherein the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

[0237] In one embodiment, the first time resource pool is discontinuous in the time domain.

[0238] In one embodiment, the first signaling is a semi-static signaling.

[0239] The present disclosure discloses a base station device for multi-antenna transmission, comprising:

[0240] a third transceiver, transmitting first radio signal;

[0241] a second transmitter, transmitting a first signaling;

[0242] wherein the first radio signal is transmitted by K antenna port groups; the antenna port group(s) includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector, and second antenna virtualization vector is associated with the first antenna port group; the firs antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to a target receiver of the first signaling in the first time resource pool; the K is a positive integer greater than 1.

[0243] According to one aspect of the present disclosure, the method comprises:

[0244] third transmitter, transmitting a second signaling; and

[0245] a fourth transceiver, performing a second radio signal in a first time resource sub-pool;

[0246] wherein the performing is transmitting; or the performing is receiving; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, (a) transmitting antenna port(s) of the second radio signal.

[0247] In one embodiment, the second transmitter transmits a first information. The first information is used to determine the first antenna port group.

[0248] In one embodiment, the third transceiver receives second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

[0249] In one embodiment, the third transmitter transmits the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of the time resource block(s).

[0250] In one embodiment, the first signaling is a dynamic signaling, and the second transmitter transmits the first signaling in a third time resource pool. Wherein the first

signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of the time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

[0251] In one embodiment, the first time resource pool is discontinuous in the time domain.

[0252] In one embodiment, the first signaling is a semi-static signaling.

[0253] Compared with traditional schemes, the present disclosure has the following advantages:

[0254] The overhead of wireless resource scheduling signaling is reduced by using beam information.

[0255] The joint indication of the time resources by the first signaling and the second signaling not only saves the signaling overhead, but also ensures the dynamic and timeliness of the signaling.

[0256] The gain of multiple antennas is utilized by using the first antenna virtualization vector and the second antenna virtualization vector.

[0257] The RF costs for multi-antenna systems is reduced by applying the first antenna virtualization vector and the second antenna virtualization vector to analog beamforming.

BRIEF DESCRIPTION OF THE DRAWINGS

[0258] Other features, objects, and advantages of the present disclosure will become more apparent from the detailed description of the accompanying drawings.

[0259] FIG. 1 shows a flowchart of wireless transmission according to one embodiment of the present disclosure;

[0260] FIG. 2 shows a flowchart of wireless transmission according to another one embodiment of the present disclosure;

[0261] FIG. 3 shows a flowchart of wireless transmission in accordance with yet another embodiment of the present disclosure;

[0262] FIG. 4 shows a schematic diagram of a first time resource pool and a first time resource sub-pool according to one embodiment of the present disclosure;

[0263] FIG. 5 shows a schematic diagram of a time-frequency resources occupied by a second radio signal according to one embodiment of the present disclosure;

[0264] FIG. 6 shows a schematic diagram of the first time resource sub-pool jointly determined by the first signaling and the second signaling according to one embodiment of the present disclosure;

[0265] FIG. 7 shows a schematic diagram of a time resource pool and a time resource block according to one embodiment of the present disclosure;

[0266] FIG. 8 shows a schematic diagram of the distribution of a second time resource pool and a third time resource pool in a time domain according to one embodiment of the present disclosure;

[0267] FIG. 9 shows schematic diagram of an antenna port group(s) corresponding to a time resource pool according to one embodiment of the present disclosure;

[0268] FIG. 10 shows a structural block diagram of a processing device for a UE according to one embodiment of the present disclosure;

[0269] FIG. 11 shows a structural block diagram of a processing device for a base station according to one embodiment of the present disclosure;

[0270] FIG. 12 shows flow chart of a first radio signal and first signaling according to one embodiment of the present disclosure;

[0271] FIG. 13 shows a schematic diagram of a network architecture according to one embodiment of the present disclosure;

[0272] FIG. 14 shows a schematic diagram of a wireless protocol architecture of a user plane and a control plane according to one embodiment of the present disclosure;

[0273] FIG. 15 shows a schematic diagram of a base station device and a given user equipment according to one embodiment of the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0274] Embodiment 1

[0275] Embodiment 1 illustrates a flow chart of wireless transmission according to one embodiment of the present disclosure, as shown in FIG.1. In FIG.1, the base station N1 is a maintenance base station of the serving cell of the UE U2. In the figure, the step in the box identified as F1 and F 2 are optional, respectively.

[0276] The base station N1 transmits the first radio signal in step S11; receives the second information in step S12; transmits the first information in step S13,; and transmits the first signaling in step S14.

[0277] The UE U2 receives the first radio signal in step S21; transmits the second information in step S22; receives the first information in step S23; and receives the first signaling in step S24.

[0278] In Embodiment 1, the first radio signal is transmitted by K antenna port groups, the antenna port group(s) includes a positive integer number of the antenna port(s); a first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector, and second antenna virtualization vector is associated with the first antenna port group; the firs antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1. The first information is used to determine the first antenna port group. The second information is used to determine K1 antenna port group(s), the K1 antenna port group(s) belong to the K antenna port groups. The first antenna port group is one of the K1 antenna port group(s). The K1 is a positive integer.

[0279] In n a sub-embodiment 1 of Embodiment 1, the first antenna virtualization vector and the second antenna virtualization vector are both associated with the first antenna port group.

[0280] In a sub-embodiment 2 of embodiment 1, the second information includes a CRI.

[0281] In a sub-embodiment 3 of Embodiment 1, the first information is carried by RRC signaling.

[0282] In a sub-embodiment 4 of Embodiment 1, the first information is DCI.

[0283] In a sub-embodiment 5 of Embodiment 1, the K antenna port groups respectively correspond to K reference signal group(s).

[0284] In a sub-embodiment 6 of Embodiment 1, the first radio signal includes the K reference signal groups.

[0285] Embodiment 2

[0286] Embodiment 2 illustrates a flowchart of wireless transmission according to another one embodiment of the present disclosure, as shown in FIG.2. In FIG.2, the base station N3 is a maintenance base station of the serving cell of the user equipment U4.In Embodiment II, the N3 can reuse steps S11-S13 in FIG. 1 before step 31; the U4 can reuse steps S21-S23 in FIG.1 before step S41. In FIG. 2, the step in the box identified as F3 and F 4 are optional, respectively.

[0287] The base station N3 transmits a first signaling in step S31; transmits a second signaling in step S32; receives second radio signal in the first time resource sub-pool in step S33.

[0288] The UE U4 monitors a first signaling in the third time resource pool in step S41; receives the first signaling in step S42; monitors a second signaling in the second time resource pool in step S43; receives the second signaling in step S44; transmits the second radio signal in the first time resource sub-pool in step S45.

[0289] In a sub-embodiment 1 of Embodiment 2, the first signaling is a semi-static RRC signaling, including one or more RRC IEs (Information Element).

[0290] In a sub-embodiment 2 of Embodiment 2, the first signaling is a DCI carried by a PDCCH.

[0291] In a sub-embodiment 3 of Embodiment 2, the first signaling is for a terminal group, the terminal group includes a plurality of terminals, and the UE is one terminal in the terminal group.

[0292] In a sub-embodiment 4 of Embodiment 2, the first signaling is transmitted by the first antenna port group.

[0293] n a sub-embodiment 5 of Embodiment 2, the second signaling is a DCI carried by a PDCCH. The second signaling is for a terminal group, the terminal group includes a plurality of terminals, and the UE is one terminal in the terminal group. The second signaling is transmitted by the first antenna port group.

[0294] In a sub-embodiment 6 of Embodiment 2, the transmission period of the first signaling is greater than the transmission period of the second signaling.

[0295] Embodiment 3

[0296] Embodiment 3 illustrates a flowchart of wireless transmission in accordance with yet another embodiment of the present disclosure, as shown in FIG.3. In FIG.3, a base station N5 is a maintenance base station for a serving cell of the UE U6. In Embodiment 3, the N5 can reuse steps S11-S13 in FIG. 1 and steps S31-S32 in FIG. 2 prior to step 51; the U4 can reuse steps S21-S23 in FIG.1 and steps S41-S44 before in FIG.2 prior to step S61.

[0297] The base station N5 transmits the second radio signal in the first time resource sub-pool in step S51.

[0298] The UE U6 receives the second radio signal in the first time resource sup-pool in step S61.

[0299] Embodiment 4

[0300] Embodiment 4 illustrates a schematic diagram of a first time resource pool and a first time resource sub-pool, as shown in FIG. 4.

[0301] In Embodiment 4, the first time resource pool includes N1 time resources; the first signaling indicates the distribution of the first time resource pool in the time domain. The second radio signal is transmitted on the first time resource sub-pool. The first time resource sub-pool includes N2 time resources #k1-#km in the N1 time resources. The second signaling indicates the number #k1-#km of the N2 time resources in the N1 time resources.

[0302] In a sub-embodiment 1 of Embodiment 4, the time resource is a subframe.

[0303] In a sub-embodiment 2 of Embodiment 4, the time resource is an OFDM symbol.

[0304] Embodiment 5

[0305] Embodiment 5 illustrates a schematic diagram of a time-frequency resources occupied by second radio signal, as shown in FIG.5. In FIG.5, the slash-filled block is the time-frequency resource occupied by the second radio signal.

[0306] In Embodiment 5, the second radio signal is transmitted on the time resource #k1-#km of the first time resource sub-pool. By the second signaling, the UE determines a first time resource sub-pool from the first time resource pool and determines the frequency domain resources occupied by the second radio signal, thereby determining the second time-frequency resource occupied by the second radio signal.

[0307] In a sub-embodiment 1 of Embodiment 5, the time resource is a subframe.

[0308] In a sub-embodiment 2 of embodiment 5, the time resource is an OFDM symbol.

[0309] In a sub-embodiment 3 of the embodiment 5, the time-frequency resource is a wireless resource block(s).

[0310] Embodiment 6

[0311] Embodiment 6 illustrates a schematic diagram of the first time resource sub-pool jointly determined by the first signaling and the second signaling, as shown in FIG.6. In FIG.6, the bold block is a subframe in the first time resource pool, and the slash-filled bold block is a subframe in the first time resource sub-pool.

[0312] In Embodiment 6, subframes #1-#8 are candidate subframes for transmitting a second radio signal, and the first signaling, by the form of bitmap, uses 10101010 to indicate that the first time resource pool is consisted of subframes # 1, # 3, # 5 and # 7, the second signaling, by the form of bitmap, uses 0101 to indicate that the subframe # 3 and # 7 in the first time resource pool {#1, #3, #5, #7} consiste of the first time sub-pool , which means the UE receives the second radio signal on the subframes # 3 and # 7.

[0313] In a sub-embodiment 1 of Embodiment 6, the first signaling is high layer signaling, and the second signaling is UE-specific DCI.

[0314] In a sub-embodiment 2 of Embodiment 6, the first signaling is a terminal group specific DCI, and the second signaling is UE-specific DCI.

[0315] Embodiment 7

[0316] Embodiment 7 illustrates a schematic diagram of a time resource pool and a time resource block, as shown in FIG. 7.

[0317] In Embodiment 7, one target time resource pool includes N time resource block(s), and the N time resource block(s) are discontinuous in the time domain. The time resource block #k is one of the N time resource block(s). The time resource block(s) #k includes M symbols in the target time resource pool. The M symbols in the target time resource pool are discontinuous in the time domain. The time interval between two time resource blocks is the time interval between the first symbols of the respective two time resource blocks.

[0318] In a sub-embodiment 1 of Embodiment 7, the target time resource pool is a second time resource pool, and the second signaling occupies one time resource block in the second time resource pool at most.

[0319] In a sub-embodiment 2 of Embodiment 7, the target time resource pool is a third time resource pool, and the first signaling occupies one time resource block in the third time resource pool at most.

[0320] In a sub-embodiment 3 of embodiment 7, the symbol is an OFDM symbol.

[0321] Embodiment 8

[0322] Embodiment 8 illustrates a schematic diagram of the distribution of the second time resource pool and the third time resource in the time domain, as shown in FIG.8. In FIG. 8, the horizontally filled blocks are time resource blocks in the second time resource pool, and the diagonally filled blocks are time resource blocks in the third time resource pool.

[0323] In Embodiment 8, the second signaling is transmitted on one time resource block in the second time resource pool, and the first signaling is transmitted on one time resource block in the third time resource pool. Between two time resource blocks of the third time resource pool may exist a plurality of time resource blocks of the second time resource pool.

[0324] In a sub-embodiment 1 in Embodiment 8, the second time resource pool and the third time resource pool are discontinuous in the time domain.

[0325] Embodiment 9

[0326] Embodiment 9 illustrates a schematic diagram of an antenna port group(s) corresponding to a time resource pool; as shown in FIG. 9.

[0327] In Embodiment 9, the first antenna port group is one of the K antenna port groups. The K antenna port groups respectively correspond to K different beam groups. The K antenna port groups respectively correspond to K time resource pools, and the first time resource pool is a time resource pool corresponding to the first antenna port group.

[0328] Embodiment 10

[0329] Embodiment 10 illustrates a structural block diagram of a processing device in a UE, as shown in FIG. 10.

[0330] In FIG.10, the UE 1000 is mainly composed of a first transceiver 1001, a second receiver 1002, a third receiver 1003, and a second transceiver 1004.

[0331] The first transceiver 1001 receives the first radio signal; the second receiver 1002 receives the first signaling; the third receiver 1003 receives the second signaling; and the second transceiver 1004 operates the second radio signal in the first time resource pool.

[0332] In the embodiment 10, the first radio signal is transmitted by K antenna port groups, and the antenna port group(s) includes a positive integer number of the antenna port(s). The K is a positive integer greater than 1. The first antenna port group is one of the K antenna port groups. The first signaling is used by the UE to determine the first time the resource pool. At least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group. The first antenna virtualization vector is an available antenna virtualization vector of the base station in the first time resource pool. The second antenna virtualization vector is an available antenna virtualization vector of the UE in the first time resource pool. The operation is receiving; or the operation is transmitting. The second signaling is used by the UE to determine the first time resource sub-pool from the first time resource pool, and the second signaling is further used by the UE to determine at least one of the occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, (a) transmit antenna port of the second radio signal.

[0333] In a sub-embodiment 1 of the embodiment 10, the second receiver 1002 is further used by the UE to receive the first information. The first information is used to determine the first antenna port group.

[0334] In a sub-embodiment 2 of the embodiment 10, the first transceiver 1001 is further used by the UE to transmit the second information. The second information is used by the base station to determine K1 antenna port group(s), the K1 antenna port group(s) belong to the K antenna port groups, and the first antenna port group is one of the K1 antenna port group(s). The K1 is a positive integer.

[0335] In a sub-embodiment 3 of embodiment 10, the third receiver 1003 is further used by the UE to monitor the second signaling in a second time resource pool.

[0336] In a sub-embodiment 4 of embodiment 10, the first signaling is a dynamic signaling, and the second receiver 1002 is further used by the UE to monitor the first signaling in a third time resource pool. The minimum time interval between time resource blocks in the third time resource pool is greater than the minimum time interval between time resource blocks in the second time resource pool.

[0337] In a sub-embodiment 5 of embodiment 10, the first time resource pool is discontinuous in the time domain.

[0338] In a sub-embodiment 6 of embodiment 10, the first signaling is a semi-static signaling.

[0339] In one embodiment, the second transceiver 1001 includes a transmitter/receiver 460, a MIMO detector 472, a receiving processor 452, an antenna 460, a controller/processor 490, and a memory 480 in Embodiment 15.

[0340] In one embodiment, the first transceiver 1001 includes a transmitting processor 455, a MIMO transmitting processor 471, a transmitter/receiver 460, and an antenna 460 in Embodiment 15.

[0341] In one embodiment, the second receiver 1002 includes a transmitter/receiver 460, a MIMO detector 472, a receiving processor 452, and an antenna 460 in Embodiment XV.

[0342] In one embodiment, the second receiver 1002 includes the controller/processor 490 in Embodiment 15.

[0343] In one embodiment, the third receiver 1003 includes the transmitter/receiver 460, the MIMO detector 472, the receiving processor 452, and the antenna 460 in Embodiment 15.

[0344] In one embodiment, the second transceiver 1004 includes the transmitter/receiver 460, the MIMO detector 472, the receiving processor 452, the antenna 460, the controller/processor 490, and the memory 480 in Embodiment 15.

[0345] In one embodiment, the second transceiver 1004 includes a transmitting processor 455, a MIMO transmitting processor 471, a transmitter/receiver 460, a controller/processor 490, a data source 467, and an antenna 460 in Embodiment 15.

[0346] Embodiment 11

[0347] Embodiment 11 illustrates a structural block diagram of a processing device in the base station equipment; as shown in FIG. 11.

[0348] FIG.11, the base station 1100 is mainly composed of a third transceiver 1101, a second transmitter 1102, a third transmitter 1103, and a fourth transceiver 1104.

[0349] The third transceiver 1101 transmits first radio signal; the second transmitter 1102 transmits a first signaling; the third transmitter 1103 transmits a second signaling; and the fourth transceiver 1104 performs second radio signal in a first time resource sub-pool.

[0350] In Embodiment 11, the first radio signal is transmitted by K antenna port groups, and the antenna port group(s) includes a positive integer number of the antenna port(s). The K is a positive integer greater than 1. The first antenna port group is one of the K antenna port groups. The first signaling is used by the UE to determine the first time the resource pool. At least one first antenna virtualization vector, and the second antenna virtualization vector is associated with the first antenna port group. The first antenna virtualization vector is an available antenna virtualization vector of the base station in the first time resource pool. The second antenna virtualization vector is an available antenna virtualization vector of a target receiver of the first signaling in the first time resource pool. The K is a positive integer greater than 1. The performing is receiving; or the performing is transmitting. The second signaling is used by the UE to determine the first time resource sub-pool from the first time resource pool, and the second signaling is

further used by the UE to determine at least one of the occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI, (a) transmit antenna port of the second radio signal.

[0351] In a sub-embodiment 1 of Embodiment 11, the second transmitter 1102 is further used by the base station to transmit first information. Herein, the first information is used by the UE to determine the first antenna port group.

[0352] In a sub-embodiment 2 of the embodiment 11, the third transceiver 1101 is further used by the base station to receive the second information. Herein, the second information is used by the base station to determine K1 antenna port group(s), the K1 antenna port group(s) belong to the K antenna port groups, and the first antenna port group is one of the K1 antenna port group(s). The K1 is a positive integer.

[0353] In a sub-embodiment 3 of Embodiment 11, the third transmitter 1103 is further used by the base station to transmit the second signaling in a second time resource pool.

[0354] In a sub-embodiment 4 of Embodiment 11, the first signaling is a dynamic signaling, and the second transmitter 1102 is further used by the base station to transmit the first signaling in a third time resource pool. The minimum time interval between time resource blocks in the third time resource pool is greater than the minimum time interval between time resource blocks in the second time resource pool.

[0355] In a sub-embodiment 5 of embodiment 11, the first time resource pool is discontinuous in the time domain.

[0356] In a sub-embodiment 6 of Embodiment 11, the first signaling is a semi-static signaling.

[0357] In one embodiment, the third transceiver 1101 includes a transmitting processor 415, a MIMO transmitting processor 441, a transmitter/receiver 416, and an antenna 420 in Embodiment 15.

[0358] In one embodiment, the third transceiver 1101 includes an antenna 420, a transmitter/receiver 416, a MIMO detector 442, and a receiving processor 412 in Embodiment 15.

[0359] In one embodiment, the second transmitter 1102 includes a transmitting processor 415, a MIMO transmitting processor 441, a transmitter/receiver 416, and an antenna 420 in Embodiment 15.

[0360] In one embodiment, the second transmitter 1102 includes the controller/processor 440 of Embodiment 15.

[0361] In one embodiment, the third transmitter 1103 includes a transmitting processor 415, a MIMO transmitting processor 441, a transmitter/receiver 416, and an antenna 420 in Embodiment 15.

[0362] In one embodiment, the fourth transceiver 1104 includes the controller/processor 440, the transmitting processor 415, the MIMO transmitting processor 441, the transmitter/receiver 416, and the antenna 420 in Embodiment 15.

[0363] In one embodiment, the fourth transceiver 1104 includes an antenna 420, a transmitter/receiver 416, a MIMO detector 442, a receiving processor 412, a controller/processor 440, and a memory 430 in Embodiment 15.

[0364] Embodiment 12

[0365] Embodiment 12 illustrates a flow chart of the first radio signal and the first signaling, as shown in FIG.12. In FIG.12, each box represents a step. In Embodiment 12, the user equipment (UE) in the present disclosure sequentially receives a first radio signal and a first signaling; wherein the first radio signal is transmitted by the K antenna port groups; the antenna port group(s) includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool. At least one first antenna virtualization vector, and the second antenna virtualization vector is associated with the first antenna port group. The first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to a target receiver of the first signaling in the first time resource pool; the K is a positive integer greater than 1.

[0366] In one embodiment, the first radio signal is K reference signal(s) groups respectively transmitted by the K antenna port groups. The first reference signal group(s) is(are) reference signal group(s) transmitted by the first antenna port group in the K

reference signal group(s). The first antenna virtualization vector is used to form an analog transmitting beam for transmitting the first reference signal group, and the second antenna virtualization vector is used to form an analog receiving beam for receiving the first reference signal group(s).

[0367] In one embodiment, the first signaling is a semi-static signaling.

[0368] In one embodiment, the first time resource pool is used to transmit physical layer control signaling.

[0369] In one embodiment, the first signaling is a dynamic signaling.

[0370] In one embodiment, the first time resource pool is used to transmit high layer signaling or data.

[0371] In one embodiment, the first antenna virtualization vector is used to form a wireless channel corresponding to the first antenna port group.

[0372] In one embodiment, the second antenna virtualization vector is used to form a wireless channel corresponding to the first antenna port group.

[0373] In one embodiment, the second antenna virtualization vector is a spatial Receive(Rx) parameter used by the UE to receive a radio signal in the first time resource pool.

[0374] Embodiment 13

[0375] Embodiment 13 illustrates a schematic diagram of network architecture, as shown in FIG. 13.

[0376] FIG. 13 describes a system network structure 200 of NR 5G, long-term evolution (LTE) and long-term evolution advanced (LTE-A). 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, NG- radio access network (RAN) 202, 5G- core network (CN)/ evolved packet core (EPC) 210, Home Subscriber Server (HSS)220 and the internet service 230. EPS may be interconnected with other access networks, but for the sake of simplicity, these entities/interfaces are not shown. As shown in figure, the EPS provides the 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 switched services. The NG-RAN includes an NR Node B (gNB) 203 and other gNBs 204.The gNB 203 provides user and control plane protocol termination for the UE 201.The gNB 203 can be connected to other gNBs 204 via an Xn interface (eg, a backhaul).The gNB 203 may also be referred to as a base station, a base transceiver station, a wireless base station, a wireless 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 UE201 with an access point to the 5G-CN/EPC 210. In the embodiment, the UE201 includes cellular telephones, smart phones, Session Initiation Protocol (SIP) phones, laptop computers, personal digital assistants (PDAs), satellite wirelesses, non-terrestrial 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 wireless unit, a remote unit, a mobile device, a wireless device, a wireless communication device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, remote terminal, handset, user agent, mobile client, client or some other suitable term. The gNB 203 is connected to the 5G-CN/EPC 210 through an S1/NG interface. 5G-CN/EPC 210 includes MME/AMF/UPF 211, other Mobility Management Entity (MME)/ Authentication Management Field (AMF) / User Plane Function (UPF) 214 An 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 signaling between the UE 201 and the 5G-CN/EPC 210. In general, MME/AMF/UPF 211 provides bearer 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).

[0377] In one embodiment, the UE 201 corresponds to the UE in this disclosure.

[0378] In one embodiment, the gNB203 corresponds to the base station in this disclosure.

[0379] In one embodiment, the UE 201 supports multi-antenna transmission.

[0380] In one embodiment, the gNB 203 supports multi-antenna transmission.

[0381] Embodiment 14

[0382] Embodiment 14 illustrates a schematic diagram of a radio protocol architecture of a user plane and a control plane, as shown in FIG.14.

[0383] FIG. 14 is a schematic diagram illustrating a radio protocol architecture of a user plane and a control plane. In FIG. 3, the radio protocol architecture for a UE and a gNB is represented by three layers, which are a layer 1, a layer 2 and a layer 3, respectively. The layer 1 (L1) is the lowest layer and performs signal processing functions of various PHY layers. The L1 is called PHY 301 in the present disclosure. The layer 2 (L2) 305 is above the PHY 301, and is in charge of the link between the UE and the gNB via the PHY 301. In the user plane, L2 305 comprises a Medium Access Control (MAC) sublayer 302, a Radio Link Control (RLC) sublayer 303 and a Packet Data Convergence Protocol (PDCP) sublayer 304. All the three sublayers terminate at the gNBs of the network side. Although not described in FIG. 3, the UE may comprise several protocol layers above the L2 305, such as a network layer (i.e., IP layer) terminated at a P-GW 213 of the network side and an application layer terminated at the other side of the connection (i.e., a peer UE, a server, etc.). The PDCP sublayer 304 provides multiplexing among variable radio bearers and logical channels. The PDCP sublayer 304 also provides a header compression for a higher-layer packet so as to reduce a radio transmission overhead. The PDCP sublayer 304 provides security by encrypting a packet and provides support for UE handover between gNBs. The RLC sublayer 303 provides segmentation and reassembling of a higher-layer packet, retransmission of a lost packet, and reordering of a packet so as to compensate the disordered receiving caused by 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 between UEs various radio resources (i.e., resource block) in a cell. The MAC sublayer 302 is also in charge of HARQ operation. In the control plane, the radio protocol architecture of the UE

and the gNB is almost the same as the radio protocol architecture in the user plane on the PHY 301 and the L2 305, but there is no header compression for the control plane. The control plane also comprises a Radio Resource Control (RRC) sublayer 306 in the layer 3 (L3). The RRC sublayer 306 is responsible for acquiring radio resources (i.e., radio bearer) and configuring the lower layer using an RRC signaling between the gNB and the UE.

[0384] In one embodiment, the radio protocol architecture of FIG. 14 is applicable to the user equipment in this disclosure.

[0385] In one embodiment, the radio protocol architecture of FIG. 14 is applicable to the base station in this disclosure.

[0386] In one embodiment, the first radio signal in the present disclosure is generated by the PHY 301.

[0387] In one embodiment, the first control signal in the present disclosure is generated by the PHY 301.

[0388] In one embodiment, the second radio signal in the present disclosure is generated by the PHY 301.

[0389] In one embodiment, the first reference signal in the present disclosure is generated by the PHY 301.

[0390] In one embodiment, the second reference signal in the present disclosure is generated by the PHY 301.

[0391] In one embodiment, the first signaling in the present disclosure is generated by the PHY 301.

[0392] Embodiment 15

[0393] Embodiment 15 illustrates a base station device and a given UE, as shown in FIG.15. The FIG.15 is a block diagram of a gNB 410 in communication with a UE 450 in an access network.

[0394] A base station device (410) comprises 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, and a transmitter/receiver 416, and an antenna 420.

[0395] A user equipment (UE 450) comprises 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 456, and an antenna 460.

[0396] In the downlink transmission (DL), the processing related to the base station (410) comprises:

[0397] A higher layer packet is provided to the controller/processor 440, the controller/processor440 provides header compression, encryption, packet segmentation and reordering, and multiplexing and demultiplexing between logical and transport channels so as to implement L2 layer protocols used for the user plane and the control plane, the higher layer packet may include data or control information, such as a downlink shared channel (DL-SCH);

[0398] the controller/processor440 may be connected with a memory 430 that stores program codes and data, the memory 430 may be a computer-readable medium;

[0399] the controller/processor 440, which notifies the scheduler 443 of transmission requests, the scheduler 443 is configured for scheduling the air interface resource(s) corresponding to the transmission requests, and notifying the controller/processor 440 of the scheduling result;

[0400] the controller/processor 440transmits to the transmitting processor 415 control information for uplink transmission acquired from operation on uplink reception by the receiving processor 412;

[0401] the transmitting processor 415, which receives the output bit stream from the controller/processor 440, and implements various signal transmission processing functions for the L1 layer (i.e. physical layer), including encoding, interleaving, scrambling, modulation, power control/allocation and physical layer control signaling (i.e., PBCH, PDCCH,PHICH,PCFICH, a reference signal) generation, etc.;

[0402] the MIMO transmitting processor 441, which performs spatial processing on data symbols, control symbols or reference signal symbols (such as multi-antenna pre-coding, digital beamforming) and outputs a baseband signal to the transmitter 416;

[0403] the MIMO transmitting processor 441, which outputs an analog transmitting beamforming vector to the transmitter 416;

[0404] the transmitter 416, which is configured for converting a baseband signals provided by the MIMO transmitting processor 441 into a radio frequency signal to be transmitted via the antenna 420; each transmitter 416 performs sampling processing on respective input symbol streams (e.g. digital to analog conversion, amplification, filtering, upconversion, etc.) to get respective sampled signal streams; each transmitter 416 further processes respective sampled stream to obtain a downlink signal; the analog transmitting beamforming is processed in the transmitter 416.

[0405] In the DL transmission, the processing related to the user equipment (450) comprises:

[0406] the receiver 456 is configured for converting the radio frequency signal received through the antenna 460 into a baseband signal and providing it to the MIMO detector 472; the analog receiving beamforming is processed in the receiver 456;

[0407] the MIMO detector 472 is configured to perform MIMO detection on a signal received from the receiver 456, and provide the baseband signal subjected to the MIMO detection to the receiving processor 452;

[0408] the receiving processor 452 extracts parameter relevant to the analog receiving beamforming to be output to the MIMO detector 472, and the MIMO detector 472 outputs the analog receive beamforming vector to the receiver 456;

[0409] the receiving processor 452, which implements various signal receiving processing functions for the L1 layer (i.e. physical layer) , including decoding, deinterleaving, descrambling, demodulation and physical layer control signaling extraction, etc.;

[0410] the controller/processor 490 receives the bit stream output by the receive processor 452, provides header decompression, decryption, packet segmentation and

reordering, and multiplexing and demultiplexing between a logical channel and a transport channel to implement L2 layer protocol for user plane and control plane;

[0411] the controller/processor 490 is associated with a memory 480 that stores program codes and data, and the memory 480 may be a computer-readable medium;

[0412] the controller/processor 490 transmits to the receiving processor 452 the control information for downlink reception obtained from uplink transmission processing by the transmitting processor 455.

[0413] The first control signal in the present disclosure is generated by the transmitting processor 415.The MIMO transmitting processor 441 performs multi-antenna precoding on a baseband signal associated with the first control signal output by the transmitting processor 415. The transmitter 416 converts a baseband signal provided by the MIMO transmitting processor 441 into a radio frequency signal, performs analog transmit beamforming, and transmits the radio frequency signal via antenna 420.The receiver 456 then receives the radio frequency signal through the antenna 460, perform analog receive beamforming, obtain a radio frequency signal related to the first control signal, and convert the radio frequency signal into a baseband signal to be supplied 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 control signal.

[0414] The first radio signal in the present disclosure is generated by the transmitting processor 415.The MIMO transmitting processor 441 performs multi-antenna precoding on a baseband signal associated with the first radio signal output by the transmitting processor 415.The transmitter 416 converts the baseband signal provided by MIMO transmit processor 441 into a radio frequency signal, performs analog transmitting beamforming, and transmits the radio frequency signal via antenna 420.The receiver 456 will receive the radio frequency signal through the antenna 460, perform analog receive beamforming, obtain a radio frequency signal related to the first radio signal, and convert the radio frequency signal into a baseband signal to be supplied 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 detection on the baseband signal output from the MIMO detector 472.

[0415] The first signaling in the present disclosure is generated by the transmitting processor 415 and output to the controller/processor 440 or is directly generated by the transmitting processor 415.The MIMO transmitting processor 441 performs multi-antenna precoding on a baseband signal relevant to the first signaling output by the transmitting processor 415. The transmitter 416 converts the baseband signal provided by MIMO transmitting processor 441 into a radio frequency signal, performs analog transmit beamforming, and transmits the radio frequency signal via antenna 420.The receiver 456 will receive the radio frequency signal through the antenna 460, perform analog receive beamforming, obtain a radio frequency signal related to the first signaling, and convert the radio frequency signal into a baseband signal to be provided 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.

[0416] The second signaling in this disclosure is generated by the transmitting processor 415.The MIMO transmitting processor 441 performs multi-antenna precoding on a baseband signal relevant to the first signaling output by the transmission processor 415. The transmitter 416 converts the baseband signal provided by MIMO transmitting processor 441 into a radio frequency signal, performs analog transmit beamforming, and transmits the radio frequency signal via antenna 420.The receiver 456 will receive the radio frequency signal through the antenna 460, perform analog receive beamforming, obtain a radio frequency signal related to the first signaling, and convert the radio frequency signal into a baseband signal to be supplied 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 outputted by the MIMO detector 472 to obtain the first signaling.

[0417] The first information in the present disclosure is generated by the controller/processor 440 and output to the transmit processor 415 or is directly generated by the transmit processor 415. The MIMO transmitting processor 441 performs multi-antenna precoding on a baseband signal relevant to the first signaling output by the transmitting processor 415. The transmitter 416 converts the baseband signal provided by MIMO transmitting processor 441 into a radio frequency signal, performs analog transmit beamforming, and transmits the radio frequency signal via antenna 420.The receiver 456

will receive the radio frequency signal through the antenna 460, perform analog receive beamforming, obtain a radio frequency signal related to the first signaling, and convert the radio frequency signal into a baseband signal to be provided 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 outputted by the MIMO detector 472 to obtain the first information.

[0418] In uplink (UL) transmission, the processing related to the user equipment (UE450) comprises:

[0419] the data source 467 provides a higher layer packet to controller/processor 490. The controller/processor 490 implements header compression, encryption, packet segmentation and reordering, and multiplexing and demultiplexing between the logical and transport channels, and implements an L2 layer protocol for the user plane and the control plane; the higher layer packet includes data or control information, such as an Uplink Shared Channel (UL-SCH);

[0420] 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;

[0421] the controller/processor 490 transmits to the transmitting processor 455 the control information for uplink transmission obtained from processing on downlink reception by the receiving processor 452;

[0422] the transmitting processor 455 receives the output bit stream of controller/processor 490 and implements various signal reception processing functions for the L1 layer (i.e. physical layer) , including encoding, interleaving, scrambling, modulation, power control/allocation and physical layer signaling （ i.e., PUCCH, Sounding Reference Signal generation (SRS), a detection reference signal ） , etc.;

[0423] the MIMO transmitting processor 471 performs spatial processing on data symbols, control symbols or reference signal symbols (such as multi-antenna pre-coding, digital beamforming) and outputs a baseband signal to the transmitter 456;

[0424] the MIMO transmitting processor 471 outputs an analog transmitting beamforming vector to the transmitter 457;

[0425] The transmitter 456 is configured to convert a baseband signals provided by MIMO transmitting processor 471 into a radio frequency signal and transmit the radio frequency signal via the antenna 460; each transmitter 456 samples respective input symbol stream to obtain respective sampled signal stream. Each transmitter 456 further processes the respective sampled streams (such as digital-to-analog conversion, amplification, filtering, up-conversion, etc.) to obtain an uplink signal. The analog transmitting beamforming is processed in the transmitter 456.

[0426] In the uplink (UL) transmission, the processing related to the base station device (410) comprises:

[0427] 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 analog receiving beamforming is processed in the receiver 416;

[0428] the MIMO detector 442 is configured to perform MIMO detection on the signal received from the receiver 416, and provide the receiving processor 442 with the MIMO-detected symbol;

[0429] the MIMO detector 442 outputs an analog receiving beamforming vector to the receiver 416;

[0430] 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, and the like;

[0431] the controller/processor 440 receives the bit stream outputted by the receiving processor 412, and provides header decompression, decryption, packet segmentation, reordering, and multiplexing and demultiplexing between the logical and transport channels so as to implement L2 layer protocol of user plane and control plane;

[0432] the controller/processor 440 can be associated with memory 430 that stores program codes and data .The memory 430 can be a computer readable medium;

[0433] the controller/processor 440 transmits the control information of the uplink transmission obtained from processing the downlink transmission by the transmission processor 415 to the receiving processor 412;

[0434] The second information in the present disclosure is generated by the transmit processor 455.The MIMO transmitting processor 471 performs multi-antenna precoding on a baseband signal relevant to the second information output by the transmitting processor 455. The transmitter 456 converts the baseband signal provided by the MIMO transmitting processor 471 into a radio frequency signal, performs analog transmitting beamforming, and transmits the radio frequency signal via antenna 460.The receiver 416 will receive the radio frequency signal through the antenna 420, perform analog receive beamforming, obtain a radio frequency signal related to the second information, and convert the radio frequency signal into a baseband signal for supply 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 outputted by the MIMO detector 442 to obtain the second information.

[0435] In one embodiment, the UE 450 comprises: at least one processor and at least one memory, the at least one memory further comprising computer program codes; the at least one memory and the computer program code are configured to work in collaboration with the processor, the UE 450 at least: receives a first radio signal and a first signaling. The first radio signal is transmitted by K antenna port groups; the antenna port group(s) includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector, and second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.

[0436] In one embodiment, the UE 450 comprises a memory storing a computer readable instruction program, which generates an action when executed by at least one processor, and the action comprises: receiving first radio signal and a first signaling. The first radio signal is transmitted by K antenna port groups; the antenna port group(s) includes a positive integer number of the antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one of first antenna virtualization vector, and second antenna

virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.

[0437] In one embodiment, the gNB 410 device comprises: at least one processor and at least one memory, the at least one memory comprises computer program codes; the at least one memory and the computer program code are configured to work in collaboration with at least one processor. The gNB410 at least: transmits a first radio signal; and transmits a first signaling. The first radio signal is transmitted by K antenna port groups, the antenna port group(s) includes a positive integer number of the antenna port(s); and the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector, and second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to a target receiver of the first signaling in the first time resource pool; the K is a positive integer greater than 1.

[0438] In one embodiment, the gNB 410 comprises: a memory storing a computer readable instruction program, which generates an action when executed by at least one processor, and the action comprises: transmitting first radio signal, transmitting the first signaling. The first radio signal is transmitted by K antenna port groups, the antenna port group(s) includes a positive integer number of the antenna port(s); and the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one first antenna virtualization vector, and second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.

[0439] In one embodiment, the UE 450 corresponds to the UE in the present disclosure.

[0440] In one embodiment, the gNB 410 corresponds to the base station in the present disclosure.

[0441] In one embodiment, the transmitting processor 415, the MIMO transmitter 441 and the transmitter/receiver 416 are used to transmit the first radio signal in the present disclosure.

[0442] In one embodiment, the receiver 456, the MIMO detector 472, and the receiving processor 452 are configured to receive the first radio signal in the present disclosure.

[0443] In one embodiment, the transmitting processor 415, the MIMO transmitter 441 and the transmitter/receiver 416 are used to transmit the first signaling in the present disclosure.

[0444] In one embodiment, the controller/processor 440 is configured to transmit the first signaling in the present disclosure.

[0445] In one embodiment, the transmitter/receiver 456, the MIMO detector 472, and the receiving processor 452 are configured to receive the first signaling in the present disclosure.

[0446] In one embodiment, the controller/processor 490 is configured to receive the first signaling in the present disclosure.

[0447] In one embodiment, the transmitting processor 415, the MIMO transmitter 441 and the transmitter/receiver 416 are used to transmit the second signaling in the present disclosure.

[0448] In one embodiment, the transmitter/receiver 456, the MIMO detector 472, and the receiving processor 452 are configured to receive the second signaling in the present disclosure.

[0449] In one embodiment, the transmitting processor 415, the MIMO transmitter 441 and the transmitter/receiver 416 are used to transmit the first information in the present disclosure.

[0450] In one embodiment, the controller/processor 440 is configured to transmit the first information in the present disclosure.

[0451] In one embodiment, the transmitter/receiver 456, the MIMO detector 472, and the receiving processor 452 are used to receive the first information in the present disclosure.

[0452] In one embodiment, the controller/processor 490 is configured to receive the first information in the present disclosure.

[0453] In one embodiment, the transmitting processor 455, the MIMO transmitter 471, and the transmitter 456 are used to transmit the second information in the present disclosure.

[0454] In one embodiment, the receiver 416, the MIMO detector 442, and the receiving processor 412 are configured to receive the second information in the present disclosure.

[0455] 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, wireless 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.

[0456] 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.

Samsung Exhibit 1003, Page 69 of 438

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xiaobo		ZHANG	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Shanghai	Country of Residence i	CN

Mailing Address of Inventor:

Address 1	Room 210, 2nd Floor, No. 2088, Xietu Road		
Address 2	Xuhui District		
City	Shanghai	**State/Province**	OT
Postal Code	200032	**Country** i	CN

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	157297		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station		
Attorney Docket Number	20160089-PCT-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	15	**Suggested Figure for Publication (if any)**	12

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	157297		

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					
Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/CN2017/112033	2017-11-21

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country	Filing Date (YYYY-MM-DD)	Access Code (if applicable)
201611098328.7	CN	2016-12-03	0727

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◯ Assignee	◯ Legal Representative under 35 U.S.C. 117	◯ Joint Inventor
◯ Person to whom the inventor is obligated to assign.	◯ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	
If the Applicant is an Organization check here. ☐	

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Applicant:

Address 1			
Address 2			
City		**State/Province**	
Country[i]		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	Shanghai Langbo Communication Technology Company Limited

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	Room 210, 2nd Floor, No. 2088, Xietu Road		
Address 2	Xuhui District		
City	Shanghai	**State/Province**	OT
Country i	CN	Postal Code	200032
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e. g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Xiaobo ZHANG/			Date (YYYY-MM-DD)	
First Name	Xiaobo	Last Name	ZHANG	Registration Number	

Additional Signature may be generated within this form by selecting the Add button.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Filer:	Qi Zhou
Attorney Docket Number:	20160089-PCT-US

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
INDEPENDENT CLAIMS IN EXCESS OF 3	2201	1	230	230
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1015**

Electronic Acknowledgement Receipt	
EFS ID:	36176611
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	157297
Filer:	Qi Zhou
Filer Authorized By:	
Attorney Docket Number:	20160089-PCT-US
Receipt Date:	03-JUN-2019
Filing Date:	
Time Stamp:	04:54:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1015
RAM confirmation Number	060319INTEFSW04574600
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Drawings-only black and white line drawings	20160089-PCT-US_APP_FIG_VF.pdf	1705978 e073c061f86135aa580d4756ee060f10b6955e6b	no	15
Warnings:					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73	20160089-PCT-US_APP_Assignment_VF.pdf	324959 d56c523e44639095df2be1ffe25f55daad21fdc6	no	2
Warnings:					
Information:					
3	Oath or Declaration filed	20160089-PCT-US_APP_Declaration_VF.pdf	526342 59617923a649cd8bc364a233b361dcd202983289	no	2
Warnings:					
Information:					
4		20160089-PCT-US_APP_SPEC_VF.pdf	702704 c687a18d85229774a8e6f76608812aa1f710d7f2	yes	54

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Abstract	54	54
	Claims	48	53
	Specification	1	47

Warnings:					
Information:					
5	Application Data Sheet	WebADS.pdf	114399 fdecdc8b66b98d510c4d2d0e71f428f788a27224	no	7

Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	36961 f1c26bbd8ce7812f56cf38a2c5263981138f2aa0	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3411343		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☑ United States application or PCT international application number PCT/CN2017/112033 filed on November 21, 2017.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: XiaoBo ZHANG Date (Optional): May.30 2019

Signature: XiaoBo ZHANG

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ASSIGNMENT

THIS ASSIGNMENT is by **(1)XiaoBo ZHANG**, a citizen of the **People's Republic of China** (the "Assignor"). I Assignor(s) have invented one or more certain inventions (the "Invention(s)") described in a United States Patent Application entitled Method and Device for Multi-Antenna Transmission in UE and Base Station, executed herewith (the "Application").

Shanghai Langbo Communication Technology Company Limited, a legal entity existing under the laws of the People's Republic of China, having an address at **Room 210, 2nd Floor, No. 2088, Xietu Road, Xuhui District, Shanghai 200032 China** ("Assignee"), desires to acquire the entire right, title and interest in and to the Invention(s) and the Application, and in and to any patents (collectively, "Patents") that may be granted for the Invention(s) in the United States or in any foreign countries or regions.

For valuable consideration, the receipt and sufficiency of which I/we acknowledge, Assignor(s) hereby sells, assigns, and transfers to Assignee, its successors, legal representatives and assigns, any and all of our right, title and interest in and to: the Invention(s), the Application, and any Patents; any divisions, continuations, and continuations-in-part of the Application and any other application claiming priority rights from the Application; any reissues, reexaminations, or extensions of any and all Patents; the right to file foreign applications directly in the name of Assignee; and the right to claim priority rights deriving from the Application (collectively, the "Rights"), whether now existing or hereafter arising. Assignor(s) warrants that the Rights are unencumbered. Assignor(s) also agrees to not sign any writing or do any act conflicting with this assignment, and, without further compensation, sign all documents and do such additional acts as Assignee deems necessary or desirable to: perfect Assignee's enjoyment of the Rights; prepare and prosecute the Application or any other applications for Patents; conduct proceedings regarding the Rights, including any litigation or interference proceedings; or perfect or defend title to the Rights. Assignor(s) requests the Commissioner of Patents to issue any Patent of the United States that may be issued on the Invention(s) to Assignee.

Inventor:

XiaoBo ZHANG

XiaoBo ZHANG

Date: May. 30 2019

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/429,077

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*	x 50 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1	x 230 =	230			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	1015		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/429,077	06/03/2019	2845	1015	20160089-PCT-US	20	4

CONFIRMATION NO. 2560

157297
Langbo Communication Technology Co. LTD
11422 Turtleback Ln
San Diego, CA 92127

FILING RECEIPT

OC000000108797522

Date Mailed: 06/11/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)
Xiaobo ZHANG, Shanghai, CHINA;

Applicant(s)
Xiaobo ZHANG, Shanghai, CHINA;

Assignment For Published Patent Application
Shanghai Langbo Communication Technology Company Limited, Shanghai, CHINA

Power of Attorney: None

Domestic Priority data as claimed by applicant
This application is a CON of PCT/CN2017/112033 11/21/2017

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
CHINA 201611098328.7 12/03/2016 Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to Retrieve Electronic Priority Application(s)** (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 06/10/2019
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/429,077**
Projected Publication Date: 09/19/2019
Non-Publication Request: No
Early Publication Request: No
**** SMALL ENTITY ****
Title

Method and Device for Multi-Antenna Transmission in UE and Base Station

Preliminary Class

343

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Digital Access Service
(DAS)

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

CERTIFICATE OF AVAILABILITY OF A CERTIFIED PATENT DOCUMENT IN A DIGITAL LIBRARY

The International Bureau certifies that a copy of the patent application indicated below has been available to the WIPO Digital Access Service since the date of availability indicated, and that the patent application has been available to the indicated Office(s) as of the date specified following the relevant Office code:

Document details: Country/Office: CN
Filing date: 03 Dec 2016 (03.12.2016)
Application number: 2016110983287

Date of availability of document: 09 Apr 2019 (09.04.2019)

The following Offices can retrieve this document by using the access code:
JP, US, GE, SE, NZ, KR, IL, EA, IN, BR, GB, AU, CA, EP, ES, NL, IB, EE, CN, MA, FI, DK, CL

Date of issue of this certificate: 16 Jul 2019 (16.07.2019)

34, chemin des Colombettes
1211 Geneva 20, Switzerland
www.wipo.int

国家知识产权局

NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION, PRC

证　　明

本证明之附件是向本局提交的下列专利申请文件副本。

申　　请　　号：201611098328.7

申　请　类　型：发明专利

发明 创造 名称：一种被用于多天线传输的 UE、基站中的方法和装置

申　　请　　日：2016 年 12 月 03 日

申　　请　　人：上海朗帛通信技术有限公司

发明人或设计人：张晓博

局长

申长雨

2019 年 04 月 09 日

2016110983287

权 利 要 求 书

1. 一种用于多天线传输的UE中的方法，其中，包括如下步骤：

- 步骤A. 接收第一无线信号；

- 步骤B. 接收第一信令。

其中，所述第一无线信号被K个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述K个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述UE在所述第一时间资源池中的可用的天线虚拟化向量。所述K是大于1的正整数。

2. 根据权利要求1所述的方法，其特征在于，还包括如下步骤：

- 步骤C. 接收第二信令；

- 步骤D. 在第一时间资源子池中操作第二无线信号。

其中，所述操作是接收；或者所述操作是发送。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ进程号，RV，NDI，发送天线端口}中的至少之一。

3. 根据权利要求1，2所述的方法，其特征在于，所述步骤B还包括步骤B0：

- 步骤B0：接收第一信息。

其中，所述第一信息被用于确定所述第一天线端口组。

4. 根据权利要求1-3所述的方法，其特征在于，所述步骤A还包括步骤A0：

- 步骤A0：发送第二信息。

其中，所述第二信息被用于确定K1个天线端口组，所述K1个天线端口组属于所述K个天线端口组，所述第一天线端口组是所述K1个天线端口组中的一个所述天线端口组。所述K1是正整数。

5. 根据权利要求1-4所述的方法，其特征在于，所述步骤C还包括步骤C0：

- 步骤C0：在第二时间资源池中监测所述第二信令。

Samsung Exhibit 1003, Page 93 of 438

权 利 要 求 书

其中，所述第二信令最多占用所述第二时间资源池中的一个时间资源块，所述第二时间资源池中包括正整数个所述时间资源块。

6. 根据权利要求 1-5 所述的方法，其特征在于，所述第一信令是动态信令，并且所述步骤 B 包括步骤 B1：

- 步骤 B1：在第三时间资源池中监测所述第一信令。

其中，所述第一信令最多占用所述第三时间资源池中的一个时间资源块，所述第三时间资源池中包括正整数个所述时间资源块。所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资源池中的时间资源块之间最小的时间间隔。

7. 一种用于多天线传输的基站中的方法，其中，包括如下步骤：

- 步骤 A. 发送第一无线信号；

- 步骤 B. 发送第一信令。

其中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。

8. 根据权利要求 7 所述的方法，其特征在于，还包括如下步骤：

- 步骤 C. 发送第二信令；

- 步骤 D. 在第一时间资源子池中执行第二无线信号。

其中，所述执行是发送；或者所述执行是接收。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

9. 根据权利要求 7，8 所述的方法，其特征在于，所述步骤 B 还包括步骤 B0：

- 步骤 B0：发送第一信息。

其中，所述第一信息被用于确定所述第一天线端口组。

权 利 要 求 书

10. 根据权利要求 7-9 所述的方法，其特征在于，所述步骤 A 还包括步骤 A0：

- 步骤 A0：接收第二信息。

其中，所述第二信息被用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

11. 根据权利要求 7-10 所述的方法，其特征在于，所述步骤 C 还包括步骤 C0：

- 步骤 C0：在第二时间资源池中发送所述第二信令。

其中，所述第二信令最多占用所述第二时间资源池中的一个时间资源块，所述第二时间资源池中包括正整数个所述时间资源块。

12. 根据权利要求 7-11 所述的方法，其特征在于，所述第一信令是动态信令，并且所述步骤 B 包括步骤 B1：

- 步骤 B1：在第三时间资源池中发送所述第一信令。

其中，所述第一信令最多占用所述第三时间资源池中的一个时间资源块，所述第三时间资源池中包括正整数个所述时间资源块。所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资源池中的时间资源块之间最小的时间间隔。

13. 一种用于多天线传输的用户设备，其中，包括如下模块：

- 第一模块：用于接收第一无线信号；

- 第二接收模块：用于接收第一信令。

其中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。

14. 根据权利要求 13 所述的用户设备，其特征在于，还包括如下模块：

权 利 要 求 书

- 第三接收模块：用于接收第二信令；

- 第二模块：用于在第一时间资源子池中操作第二无线信号。

其中，所述操作是接收；或者所述操作是发送。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

15. 一种用于多天线传输的基站设备，其中，包括如下模块：

- 第三模块：用于发送第一无线信号；

- 第二发送模块：用于发送第一信令。

其中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。

16. 根据权利要求 15 所述的基站设备，其特征在于，还包括如下模块：

- 第三发送模块：用于发送第二信令；

- 第四模块：用于在第一时间资源子池中执行第二无线信号。

其中，所述执行是发送；或者所述执行是接收。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

2016110983287

说 明 书

一种被用于多天线传输的UE、基站中的方法和装置

技术领域

本发明涉及无线通信系统中的多天线传输的方案。

背景技术

大规模（Massive）MIMO 成为下一代移动通信的一个研究热点。大规模 MIMO 中，多个天线通过波束赋型，形成较窄的波束指向一个特定方向来提高通信质量。

根据 3GPP（3rd Generation Partner Project，第三代合作伙伴项目）RAN1（Radio Access Network，无线接入网）的讨论，结合了模拟波束赋型（analog beamforming）和数字预编码（digital precoding）的 hybrid 波束赋型（hybrid beamforming）成为 NR（New Radio technology，新型无线技术）系统的一个重要研究方向。

在大规模 MIMO 系统中，通过大规模天线数量，小区的总吞吐量可以大幅增加，因此单小区用户数量可以大量增加。但是，小区用户数量的增加会带来无线时频资源动态调度的大量信令开销。无线资源动态调度的信令开销是大规模 MIMO 系统中一个亟待解决的问题。

发明内容

本发明针对上述问题公开了一种方案。需要说明的是，在不冲突的情况下，本申请的 UE 中的实施例和实施例中的特征可以应用到基站中，反之亦然。进一步的，在不冲突的情况下，本申请的实施例和实施例中的特征可以任意相互组合。

本发明公开了一种用于多天线传输的 UE 中的方法，其中，包括如下步骤：

- 步骤 A. 接收第一无线信号；
- 步骤 B. 接收第一信令。

其中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天

线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。

作为一个实施例，上述方法的好处在于通过把所述第一时间资源池和所述第一天线端口组相关联，所述 UE 可以通过所述第一天线端口组在所述 K 个天线端口组中的索引快速确定所述第一时间资源池在时域上的位置。

作为一个实施例，所述第一无线信号是多载波符号。

作为一个实施例，所述第一无线信号是单载波符号。

作为一个实施例，所述第一无线信号是 OFDM 符号。

作为一个实施例，所述第一无线信号是 FBMC 符号。

作为一个实施例，所述第一无线信号是 SC-FDMA 符号。

作为一个实施例，所述第一无线信号是所述 K 个天线端口组所关联的参考信号。

作为一个实施例，所述第一无线信号是被所述 K 个天线端口组发送的无线资源块。

作为一个实施例，所述第一无线信号包括{PSS (Primary Synchronization Signal，主同步信号)，SSS (Secondary Synchronization Signal,辅同步信号),MIB(Master Information Block,主信息块)/SIB (System Information Block，系统信息块)，CSI-RS (Channel State Information Reference Signal，信道状态信息参考信号)}中的一种或多种。

作为一个实施例，所述天线端口是由多根物理天线通过天线虚拟化(Virtualization)叠加而成，所述多根物理天线到所述天线端口的映射系数组成天线虚拟化向量用于所述天线虚拟化。作为一个实施例，任意两个不同的天线端口所对应的波束赋型向量不能被假定是相同的。

作为一个实施例，一个天线端口发送的信号所经历的无线信道的小尺度特性不能用于推断另一个天线端口发送的信号所经历的无线信道的小尺度特性。

作为一个实施例，一个天线端口与一个参考信号相关联。

作为一个实施例，所述参考信号所占的时频资源在一个子帧内的图案重用 CSI-RS 在一个子帧内的图案。

作为一个实施例，所述参考信号是 CSI-RS。

作为一个实施例，所述参考信号所对应的序列是 Zadoff-Chu 序列。

作为一个实施例，所述参考信号所对应的序列是伪随机序列。

作为一个实施例，所述参考信号所占用的时域资源和{所述第一信息所占用的时域资源，所述第一无线信号所占用的时域资源}中的至少之一相关联。

作为一个实施例，所述参考信号所占用的频域资源和{所述第一信息所占用的频域资源，所述第一无线信号所占用的频域资源}中的至少之一相关联。

作为一个实施例，所述参考信号所占用的频域资源是可配置的。

作为一个实施例，所述 K 个天线端口组分别和 K 个参考信号组相关联。

作为一个实施例，一个天线端口所占用的空口资源不同于另一个天线端口所占用的空口资源。

作为一个实施例，一个参考信号所占用的空口资源不同于另一个参考信号所占用的空口资源。

作为一个实施例，所述空口资源包括{时域资源，频域资源，码域资源}中至少之一。

作为一个实施例，所述 K 个天线端口组中存在至少两个天线端口发送的参考信号在时频资源块内的图案（Pattern）是相同的。

作为一个实施例，所述时频资源块是 PRBP（Physical Resource Block Pair，物理资源块）。

作为一个实施例，所述时频资源块在频域上占用 W 个子载波，在时域上占用一个宽带符号。其中所述 W 是大于 1 的正整数。作为该子实施例的一个子实施例，所述宽带符号是{OFDM 符号，SC-FDMA 符号，SCMA 符号}中的一种。

作为一个实施例，所述第一无线信号被所述 K 个天线端口组发送的方式是：所述第一无线信号承载所述 K 个参考信号组，所述 K 个参考信号组对应的天线虚拟化向量被用于分别将所述 K 个参考信号组映射到一

组物理天线上发送。

作为一个实施例，所述 K 个天线端口组分别对应的时间资源正交。

作为一个实施例，所述第一信令是半静态信令。

作为一个实施例，所述第一信令是高层信令。

作为一个实施例，所述第一信令包括一个或者多个 RRC IE（Information Element，信息单元）。

作为一个实施例，所述第一信令是动态信令。

作为一个实施例，所述第一信令是物理层信令。

作为一个实施例，所述第一信令由下行物理层控制信道（即仅能用于承载物理层信令的下行信道）承载。

作为一个实施例，所述下行物理层控制信道是 PDCCH（Physical Downlink Control Channel，物理下行控制信道）。

作为一个实施例， 所述下行物理层控制信道是 sPDCCH（short PDCCH）。

作为一个实施例，所述第一信令承载 DCI（下行控制信息，Downlink Control Information）。

作为一个实施例，所述第一信令承载 fast DCI（快速下行控制信息，fast Downlink Control Information）。

作为一个实施例，所述第一信令是小区公共的。

作为一个实施例，所述第一信令是针对所述 UE 的。

作为一个实施例，所述第一信令是针对终端组的，所述终端组中包括多个终端，所述 UE 是所述终端组中的一个所述终端。

作为一个实施例，所述第一信令在广播信道（即仅能用于承载广播信号的下行信道）上传输。

作为一个实施例，所述广播信道包括 PBCH（Physical Broadcast CHannel，物理广播信道）。

作为一个实施例，所述第一信令被所述第一天线端口组发送。

作为一个实施例，所述第一天线端口组包括 L 个天线端口，所述第一信令包括 L 个第一子信令，所述 L 个第一子信令携带相同的比特块，所述 L 个第一子信令分别被所述 L 个天线端口发送。所述比特块包括正整数个比特，所述 L 是正整数。

作为一个实施例，所述第一天线端口组在所述 K 个天线端口组中的索引是小于所述 K 的非负整数。

作为一个实施例，所述第一天线端口组在所述 K 个天线端口组中的索引被用于生成所述第一信令。

作为一个实施例，针对所述第一天线端口组的接收波束赋型向量被用于确定针对所述第一信令的接收波束赋型向量。

作为一个实施例，所述第一信令从所述 K 个天线端口组中指示所述第一天线端口组。

作为一个实施例，所述第一信令显示的指示所述第一时间资源池。

作为一个实施例，所述第一信令隐式的指示所述第一时间资源池。

作为一个实施例，所述第一时间资源池在时域上是非连续的。

作为一个实施例，所述第一信令的发送者采用所述第一天线虚拟化向量生成所述第一天线端口组对应的发送模拟波束。

作为一个实施例，所述 UE 使用所述第二天线虚拟化向量生成模拟波束所述第一天线端口组对应的接收模拟波束。

作为一个实施例，所述第一天线虚拟化向量与所述第一天线端口组关联。

作为一个实施例，所述第二天线虚拟化向量与所述第一天线端口组关联。

作为一个实施例，所述第一天线虚拟化向量和所述第二天线虚拟化向量都与所述第一天线端口组关联。

作为一个实施例，第三无线信号是在所述第一时间资源池内的时间资源上发送的一个无线信号。所述第一天线虚拟化向量被所述第一信令的发送者用于发送所述第三无线信号的模拟波束赋型。

作为一个实施例，第三无线信号是在所述第一时间资源池内的时间资源上发送的一个无线信号。所述第二天线虚拟化向量被所述 UE 用于接收所述第三无线信号的模拟波束赋型。

作为一个实施例，第三无线信号是在所述第一时间资源池内的时间资源上发送的一个无线信号。所述第一天线虚拟化向量被所述第一信令的发送者用于接收所述第三无线信号的模拟波束赋型。

作为一个实施例，第三无线信号是在所述第一时间资源池内的时间

资源上发送的一个无线信号。所述第二天线虚拟化向量被所述 UE 用于发送所述第三无线信号的模拟波束赋型。

作为一个实施例，所述第一天线端口组包括 L 个天线端口，第一天线端口是所述 L 个天线端口中的一个端口，所述第一天线虚拟化向量与所述第一天线端口关联。

作为一个实施例，所述第二天线虚拟化向量与所述第一天线端口关联。

具体的，根据本发明的一个方面，其特征在于，还包括如下步骤：

- 步骤 C. 接收第二信令；

- 步骤 D. 在第一时间资源子池中操作第二无线信号。

其中，所述操作是接收；或者所述操作是发送。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

作为一个实施例，上述方法的好处在于，所述 UE 通过接收所述第二信令从所述第一时间资源池中确定所述第一时间资源子池的方法可以显著降低用于确定第二无线信号所占用的频域资源的信令开销。

作为一个实施例，所述第二信令是动态信令。

作为一个实施例，所述第二信令是物理层信令。

作为一个实施例，所述第二信令由下行物理层控制信道承载。

作为一个实施例，所述第二信令是物理层下行控制指示。

作为一个实施例，所述第二信令由两个物理层下行控制指示组成。

作为一个实施例，所述第二信令是针对所述 UE 的。

作为一个实施例，所述第二信令被所述第一天线端口组发送。

作为一个实施例，所述第一天线虚拟化向量被用于发送所述第二信令。

作为一个实施例，所述第一时间资源子池在时域上是非连续性的。

作为一个实施例，所述第一时间资源子池所包括的时间资源是所述第一时间资源池的一个子集。

作为一个实施例，所述第一时间资源池包括 N1 个时间资源，所述第一时间资源子池包括所述 N1 个时间资源中的 N2 个时间资源。

作为一个实施例，所述时间资源是子帧。

作为一个实施例，所述时间资源是 OFDM 符号。

作为一个实施例，所述时间资源是 SC-FDMA 符号。

作为一个实施例，所述时间资源是 FBMC 符号。

作为一个实施例，所述 UE 通过所述第二信令与所述第一信令的联合指示确定所述第一时间资源子池所包括的时间资源。

作为一个实施例，所述第二信令被用于确定所述第一时间资源子池所包括的时间资源在所述第一时间资源池的相对位置。

作为一个实施例，所述第二信令指示所述第一时间资源子池所包括的时间资源对应所述第一时间资源池的比特映射（bitmap）。

作为一个实施例，所述第二信令指示所述第一时间资源子池所包括的时间资源在所述第一时间资源池中的索引。

作为一个实施例，所述第二无线信号是无线资源块。

作为一个实施例，所述第二无线信号所占用的时域资源是所述第一时间资源子池，所述第二无线信号所占用的频域资源由所述第二信令指示。

作为一个实施例，所述第二信令被划分为 M 个域，第一域和第二域分别是所述 M 个域中的两个域。所述第一域被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二域被用于确定所述第二无线信号所占用的频域资源。

作为一个实施例，所述第二信令被划分为 M 个域，第一域是所述 M 域中的一个域。第一域被用于从所述第一时间资源池中确定所述第一时间资源子池，且被用于确定所述第二无线信号所占用的频域资源。

作为一个实施例，所述第二无线信号对应的传输信道是 DL-SCH，所述操作是接收。

作为一个实施例，所述第二无线信号对应的物理层信道是 PDSCH，所述操作是接收。

作为一个实施例，所述第二无线信号对应的传输信道是 UL-SCH，所述操作是发送。

作为一个实施例，所述第二无线信号对应的物理层信道是 PUSCH，所述操作是发送。

作为一个实施例，所述操作是接收，所述第一天线虚拟化向量被用于发送所述第二无线信号的模拟波束赋型。

作为一个实施例，所述操作是接收，所述第二天线虚拟化向量被用于接收所述第二无线信号的模拟波束赋型。

作为一个实施例，所述操作是发送，所述第一天线虚拟化向量被用于接收所述第二无线信号的模拟波束赋型。

作为一个实施例，所述操作是发送，所述第二天线虚拟化向量被用于发送所述第二无线信号的模拟波束赋型。

作为一个实施例，所述第二信令显示的指示{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

作为一个实施例，所述第二信令隐式的指示{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

具体的，根据本发明的一个方面，其特征在于，所述步骤 B 还包括如下步骤：

- 步骤 B0：接收第一信息。

其中，所述第一信息被用于确定所述第一天线端口组。

作为一个实施例，所述第一信息被用于从所述 K 个天线端口组中确定所述第一天线端口组。

作为一个实施例，所述第一信息显示的指示第一天线端口组。

作为一个实施例，所述第一信息隐式的指示第一天线端口组。

作为一个实施例，所述第一信令包括所述第一信息。

作为一个实施例，所述第一信令中的一个域（field）指示所述第一天线端口组在所述 K 个天线端口组中的索引。

作为一个实施例，所述第一信息在所述第一信令之前发送。

作为一个实施例，所述第一信息被用于确定所述第一信令所在的时间资源池。

作为一个实施例，所述第一信息被用于确定所述第一信令所在的搜索空间。

具体的，根据本发明的一个方面，其特征在于，所述步骤 A 还包括如下步骤 A0：

- 步骤 A0：发送第二信息。

其中，所述第二信息被用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

作为一个实施例，所述第二信息被用于从所述 K 个天线端口组中确定所述第一天线端口组。

作为一个实施例，所述第二信息显示的指示所述 K1 个天线端口组。

作为一个实施例，所述第二信息隐式的指示所述 K1 个天线端口组。

作为一个实施例，所述第二信息是所述 K1 个天线端口组对应的时域信息。

作为一个实施例，所述第二信息包括 CRI（CSI-RS Resource Indicator，CSI-RS 资源指示），所述 CRI 从所述 K 个天线端口组对应的 CSI-RS 资源中指示所述 K1 个天线端口组对应的 CSI-RS 资源。

作为一个实施例，所述第二信息对应的物理层信道包括上行物理层控制信道（即仅能用于承载物理层信令的上行信道）。作为一个子实施例，所述上行物理层控制信道是 PUCCH（Physical Uplink Control Channel，物理上行控制信道）。

作为一个实施例，所述第二信息是 RACH 前导（Preamble），{所述 RACH 前导的序列，所述 RACH 前导所占用的时频资源}中的至少之一被用于确定所述第一天线端口组。

作为一个实施例，所述第二信息对应的物理层信道包括 PRACH(Physical Random Access CHannel，物理随机接入信道)。

作为一个实施例，所述 K1 等于 1。

作为一个实施例，所述 K1 大于 1。

具体的，根据本发明的一个方面，其特征在于，所述步骤 C 还包括如下步骤：

- 步骤 C0：在第二时间资源池中监测所述第二信令。

其中，所述第二信令最多占用所述第二时间资源池中的一个时间资源块，所述第二时间资源池中包括正整数个所述时间资源块。

作为一个实施例，所述第二时间资源池在时域上是非连续性的

作为一个实施例，所述时间资源块在时域上是非连续性的。

作为一个实施例，所述时间资源块在时域上是连续性的。

作为一个实施例，所述第二时间资源池是所述 UE 特定的一个时间资源池。

作为一个实施例，所述第二时间资源池是所述第一天线端口组特定的一个时间资源池。

作为一个实施例，所述第一天线端口组被用于确定所述第二时间资源池。

作为一个实施例，所述第一天线虚拟化向量被用于所述第二信令的发送模拟波束赋型。

作为一个实施例，所述第二天线虚拟化向量被用于所述第二信令的接收模拟波束赋型。

作为一个实施例，所述第二信令在所述 UE 特定的搜索空间上。

作为一个实施例，所述第二信令是动态的。

作为一个实施例，所述第二信令由下行物理层控制信道承载。

作为一个实施例，所述下行物理层控制信道是 PDCCH。

作为一个实施例， 所述下行物理层控制信道是 sPDCCH。

作为一个实施例，所述第二信令承载 DCI。

作为一个实施例，所述第二信令承载 fast DCI。

作为一个实施例，所述 UE 在所述第二时间资源池内进行盲检测（Blind Detection）确定所述第二信令所占用的时频资源。

作为一个实施例，所述 UE 通过盲检测的方法确定所述第二信令在所述第二时间资源池中是否发送。

作为一个实施例，所述盲检测是指:所述 UE 在多个候选时频资源上接收信号并执行译码操作，如果根据校验比特确定译码正确则判断接收成功，否则判断接收失败。

作为一个实施例，所述盲检测对应的频率资源池是可配置的。

具体的，根据本发明的一个方面，其特征在于，所述第一信令是动态信令，并且所述步骤 B 包括步骤 B1：

- 步骤 B1：在第三时间资源池中监测所述第一信令。

其中，所述第一信令最多占用所述第三时间资源池中的一个时间资源块，所述第三时间资源池中包括正整数个所述时间资源块。所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资

源池中的时间资源块之间最小的时间间隔。

作为一个实施例，上述方法的好处，可以减少通知所述 UE 进行所述操作的时间资源的信令开销，可以增加时间资源调度的动态性。

作为一个实施例，所述第三时间资源池在时域上是非连续性的

作为一个实施例，所述时间资源块在时域上是非连续性的。

作为一个实施例，所述时间资源块在时域上是连续性的。

作为一个实施例，所述第三时间资源池是小区公共的一个时间资源池。

作为一个实施例，所述第三时间资源池是所述 UE 特定的一个时间资源池。

作为一个实施例，所述第三时间资源池是所述第一天线端口组特定的一个时间资源池。

作为一个实施例，所述第一天线端口组被用于确定所述第三时间资源池。

作为一个实施例，所述第一天线虚拟化向量被用于所述第一信令的发送模拟波束赋型。

作为一个实施例，所述第二天线虚拟化向量被用于所述第一信令的接收模拟波束赋型。

作为一个实施例，所述 UE 在所述第三时间资源池内进行盲检测确定所述第一信令所占用的时频资源。

作为一个实施例，所述 UE 通过盲检测的方法确定所述第一信令在所述第三时间资源池中是否发送。

作为一个实施例，所述第一信令在公共搜索空间上。

作为一个实施例，所述第一信令在第一天线端口组特定的搜索空间上。

作为一个实施例，所述第一信令在所述 UE 特定的搜索空间上。

作为一个实施例，所述第三时间资源池是所述第二时间资源池的一个子集。

本发明公开了一种用于多天线传输的基站中的方法，其中，包括如下步骤：

- 步骤 A. 发送第一无线信号；

- 步骤 B. 发送第一信令。

其中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。

作为一个实施例，所述第一信令被所述第一天线端口组发送。

作为一个实施例，所述第一天线端口组至少有两个不同的天线端口发送的参考信号在时频资源块内的图案是相同的。

作为一个实施例，所述第一时间资源池在时域上是非连续的。

具体的，根据本发明的一个方面，其特征在于，还包括如下步骤：

- 步骤 C. 发送第二信令；

- 步骤 D. 在第一时间资源子池中执行第二无线信号。

其中，所述执行是发送；或者所述执行是接收。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

作为一个实施例，所述第二信令被所述第一天线端口组发送。

作为一个实施例，所述第二信令被所述第一天线端口组中的一个天线端口发送。

作为一个实施例，所述第一时间资源子池在时域上是非连续的。

具体的，根据本发明的一个方面，其特征在于，所述步骤 B 还包括步骤 B0：

- 步骤 B0：发送第一信息。

其中，所述第一信息被用于确定所述第一天线端口组。

作为一个实施例，所述第一信息是所述第一信令的一个域。

作为一个实施例，所述第一信息在所述第一信令之前发送。

具体的，根据本发明的一个方面，其特征在于，所述步骤 A 还包括

步骤 A0：

- 步骤 A0：接收第二信息。

其中，所述第二信息被用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

作为一个实施例，所述 K1 等于 1。

作为一个实施例，所述 K1 大于 1。

作为一个实施例，所述第二信息是 CRI。

具体的，根据本发明的一个方面，其特征在于，所述步骤 C 还包括步骤 C0：

- 步骤 C0：在第二时间资源池中发送所述第二信令。

其中，所述第二信令最多占用所述第二时间资源池中的一个时间资源块，所述第二时间资源池中包括正整数个所述时间资源块。

作为一个实施例，所述第二时间资源池在时间域上非连续。

具体的，根据本发明的一个方面，其特征在于，所述第一信令是动态信令，并且所述步骤 B 包括步骤 B1：

- 步骤 B1：在第三时间资源池中发送所述第一信令。

其中，所述第一信令最多占用所述第三时间资源池中的一个时间资源块，所述第三时间资源池中包括正整数个所述时间资源块。所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资源池中的时间资源块之间最小的时间间隔。

作为一个实施例，所述第三时间资源池在时间域上是非连续的。

本发明公开了一种用于多天线传输的用户设备，其中，包括如下模块：

- 第一模块：用于接收第一无线信号；

- 第二接收模块：用于接收第一信令。

其中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天

线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。

具体的，根据本发明的一个方面，其特征在于，还包括如下模块：

- 第三接收模块：用于接收第二信令；
- 第二模块：用于在第一时间资源子池中操作第二无线信号。

其中，所述操作是接收；或者所述操作是发送。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

作为一个实施例，上述用户设备的特征在于，所述第二接收模块还被用于接收第一信息。其中，所述第一信息被用于确定所述第一天线端口组。

作为一个实施例，上述用户设备的特征在于，所述第一模块还被用于发送第二信息。其中，所述第二信息被用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

作为一个实施例，上述用户设备的特征在于，所述第三接收模块还被用于在第二时间资源池中监测所述第二信令。其中，所述第二信令最多占用所述第二时间资源池中的一个时间资源块，所述第二时间资源池中包括正整数个所述时间资源块。

作为一个实施例，上述用户设备的特征在于，所述第一信令是动态信令，并且所述第二接收模块还被用于在第三时间资源池中监测所述第一信令。其中，所述第一信令最多占用所述第三时间资源池中的一个时间资源块，所述第三时间资源池中包括正整数个所述时间资源块。所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资源池中的时间资源块之间最小的时间间隔。

本发明公开了一种用于多天线传输的基站设备，其中，包括如下模块：

- 第三模块：用于发送第一无线信号；
- 第二发送模块：用于发送第一信令。

其中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。所述第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。

具体的，根据本发明的一个方面，其特征在于，还包括如下模块：

- 第三发送模块：用于发送第二信令；
- 第四模块：用于在第一时间资源子池中执行第二无线信号。

其中，所述执行是发送；或者所述执行是接收。所述第二信令被用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

作为一个实施例，上述基站设备的特征在于，所述第二发送模块还被用于发送第一信息。其中，所述第一信息被用于确定所述第一天线端口组。

作为一个实施例，上述基站设备的特征在于，所述第三模块还被用于接收第二信息。其中，所述第二信息被用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

作为一个实施例，上述基站设备的特征在于，所述第三发送模块还被用于在第二时间资源池中发送所述第二信令。其中，所述第二信令最多占用所述第二时间资源池中的一个时间资源块，所述第二时间资源池中包括正整数个所述时间资源块。

作为一个实施例，上述基站设备的特征在于，所述第一信令是动态信令，并且所述第二发送模块还被用于在第三时间资源池中发送所述第一信令。其中，所述第一信令最多占用所述第三时间资源池中的一个时

间资源块，所述第三时间资源池中包括正整数个所述时间资源块。所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资源池中的时间资源块之间最小的时间间隔。

和传统方案相比，本发明具备如下优势：

- 通过利用波束信息降低了无线资源调度信令的开销。
- 通过第一信令和第二信令对时间资源的联合指示，既节省了信令开销，又保证了信令的动态性和及时性。
- 通过使用第一天线虚拟化向量和第二天线虚拟化向量，利用了多天线的增益。
- 通过将第一天线虚拟化向量和第二天线虚拟化向量应用于模拟波束赋型，降低了多天线系统的射频成本。

附图说明

通过阅读参照以下附图中的对非限制性实施例所作的详细描述，本发明的其它特征、目的和优点将会变得更加明显：

图 1 示出了根据本发明的一个实施例的无线传输的流程图；

图 2 示出了根据本发明的另一个实施例的无线传输的流程图；

图 3 示出了根据本发明的又一个实施例的无线传输的流程图；

图 4 示出了根据本发明的一个实施例的第一时间资源池和第一时间资源子池的示意图；

图 5 示出了根据本发明的一个实施例的第二无线信号所占用的时频资源的示意图。

图 6 示出了根据本发明的一个实施例的第一信令和第二信令联合确定第一时间资源子池的示意图。

图 7 示出了根据本发明的一个实施例的时间资源池和时间资源块的示意图。

图 8 示出了根据本发明的一个实施例的第二时间资源池和第三时间资源池在时域上的分布的示意图。

图 9 示出了根据本发明的一个实施例的天线端口组与时间资源池对应的示意图；

图 10 示出了根据本发明的一个实施例的用于 UE 中的处理装置的结构框图；

图 11 示出了根据本发明的一个实施例的用于基站中的处理装置的结构框图。

实施例 1

实施例 1 示例了根据本发明的一个实施例的无线传输的流程图，如附图 1 所示。附图 1 中，基站 N1 是 UE U2 的服务小区维持基站。附图 1 中，方框 F1 和方框 F2 中的步骤是分别可选的。

对于 N1，在步骤 S11 中发送第一无线信号；在步骤 S12 中接收第二信息；在步骤 S13 中发送第一信息；在步骤 S14 中发送第一信令。

对于 U2，在步骤 S21 中接收第一无线信号；在步骤 S22 中发送第二信息；在步骤 S23 中接收第一信息；在步骤 S24 中接收第一信令。

在实施例 1 中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。第一天线虚拟化向量是所述第一信令的发送者在所述第一时间资源池中的可用的天线虚拟化向量。第二天线虚拟化向量是所述 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。所述第一信息被用于确定所述第一天线端口组。所述第二信息被用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

作为实施例 1 的子实施例 1，所述第一天线虚拟化向量和所述第二天线虚拟化向量都与所述第一天线端口组关联。

作为实施例 1 的子实施例 2，所述第二信息包括 CRI。

作为实施例 1 的子实施例 3，所述第一信息由 RRC 信令承载。

作为实施例 1 的子实施例 4，所述第一信息是 DCI。

作为实施例 1 的子实施例 5，所述 K 个天线端口组分别对应 K 个参考信号组。

作为实施例 1 的子实施例 6，所述第一无线信号包括所述 K 个参考信号组。

实施例 2

实施例 2 示例了根据本发明的另一个实施例的无线传输的流程图，如附图 2 所示。附图 2 中，基站 N3 是 UE U4 的服务小区维持基站。在实施例 2 中，N3 在步骤 S31 之前重用附图 1 中的步骤 S11-S13；U4 在步骤 S41 之前重用附图 1 中的步骤 S21-S23。附图 2 中，方框 F3 和方框 F4 中的步骤是分别可选的。

对于 N3，在步骤 S31 中发送第一信令；在步骤 S32 中发送第二信令；在步骤 S33 中在第一时间资源子池中接收第二无线信号。

对于 U4，在步骤 S41 中在第三时间资源池中监测第一信令；在步骤 S42 中接收第一信令；在步骤 S43 中在第二时间资源池中监测第二信令；在步骤 S44 中接收第二信令；在步骤 S45 中在第一时间资源子池中发送第二无线信号。

作为实施例 2 的子实施例 1，所述第一信令是半静态的 RRC 信令，包括一个或者多个 RRC IE（Information Element，信息单元）。

作为实施例 2 的子实施例 2，所述第一信令是由 PDCCH 承载的 DCI。

作为实施例 2 的子实施例 3，所述第一信令是针对终端组的，所述终端组中包括多个终端，所述 UE 是所述终端组中的一个所述终端。

作为实施例 2 的子实施例 4，所述第一信令被所述第一天线端口组发送。

作为实施例 2 的子实施例 5，所述第二信令是由 PDCCH 承载的 DCI。所述第二信令是针对终端组的，所述终端组中包括多个终端，所述 UE 是所述终端组中的一个所述终端。所述第二信令被所述第一天线端口组发送。

作为实施例 2 的子实施例 6，所述第一信令的发送周期要大于所述第二信令的发送周期。

实施例 3

实施例 3 示例了根据本发明的又一个实施例的无线传输的流程图。

如附图 3 所示。附图 3 中，基站 N5 是 UE U6 的服务小区维持基站。在实施例 3 中，N5 在步骤 S51 之前重用附图 1 中的步骤 S11-S13 和附图 2 中的步骤 S31-S32；U4 在步骤 S61 之前重用附图 1 中的步骤 S21-S23 和附图 2 中的步骤 S41-S44。

对于 N5，在步骤 S51 中在第一时间资源子池中发送第二无线信号。

对于 U6，在步骤 S61 中在第一时间资源子池中接收第二无线信号。

实施例 4

实施例 4 示例了根据本发明的一个实施例的第一时间资源池和第一时间资源子池的示意图，如附图 4 所示。

在实施例 4 中，第一时间资源池包括了 N1 个时间资源，所述第一时间资源池在时域中的分布由第一信令指示。第二无线信号在第一时间资源子池上发送。所述第一时间资源子池包括了所述 N1 个时间资源中的 N2 个时间资源#k1-#km。第二信令指示所述 N2 个时间资源在所述 N1 个时间资源中的编号#k1-#km。

作为实施例 4 的子实施例 1，所述时间资源是子帧。

作为实施例 4 的子实施例 2，所述时间资源是 OFDM 符号。

实施例 5

实施例 5 示例了根据本发明的一个实施例的第二无线信号所占用的时频资源的示意图，如附图 5 所示。在附图 5 中，斜线填充的方格是第二无线信号所占用的时频资源。

在实施例 5 中，第二无线信号在第一时间资源子池的时间资源#k1-#km 上发送。UE 通过第二信令从第一时间资源池中确定所述第一时间资源子池，并通过所述第二信令确定所述第二无线信号所占用的频域资源，从而确定所述第二无线信号所占用的时频资源。

作为实施例 5 的子实施例 1，所述时间资源是子帧。

作为实施例 5 的子实施例 2，所述时间资源是 OFDM 符号。

作为实施例 5 的子实施例 3，所述时频资源是无线资源块(Resource Block)。

实施例 6

实施例 6 示出了根据本发明的一个实施例的第一信令和第二信令联合确定第一时间资源子池的示意图，如附图 6 所示。在附图 6 中，加粗的方块是第一时间资源池中的子帧，斜线填充的加粗方块是第一时间资源子池中的子帧。

在实施例 6 中，子帧#1-#8 是发送第二无线信号的候选子帧，第一信令通过比特映射（bitmap）的形式用 10101010 指示第一时间资源池由子帧#1，#3，#5 和#7 组成，第二信令通过比特映射的形式用 0101 指示第一时间资源池{#1，#3，#5，#7}中的子帧#3 和#7 组成第一时间子池，即 UE 在子帧#3 和#7 上接收所述第二无线信号。

作为实施例 6 的子实施例 1，所述第一信令是高层信令，所述第二信令是 UE 特定的 DCI。

作为实施例 6 的子实施例 2，所述第一信令是终端组特定的 DCI，所述第二信令是 UE 特定的 DCI。

实施例 7

实施例 7 示出了根据本发明的一个实施例的时间资源池和时间资源块的示意图，如附图 7 所示。

在实施例 7 中，一个目标时间资源池包括了 N 个时间资源块，所述 N 个时间资源块在时域上是不连续的。时间资源块#k 是所述 N 个时间资源块中的一个时间资源块。所述时间资源块#k 包括了 M 个在所述目标时间资源池中的符号。所述 M 个在所述目标时间资源池中的符号在时域上是不连续的。两个时间资源块之间的时间间隔是所述两个时间资源块各自的第一个符号之间的时间间隔。

作为实施例 7 的子实施例 1，所述目标时间资源池是第二时间资源池，第二信令最多占用所述第二时间资源池中的一个时间资源块。

作为实施例 7 的子实施例 2，所述目标时间资源池是第三时间资源池，第一信令最多占用所述第三时间资源池中的一个时间资源块。

作为实施例 7 的子实施例 3，所述符号是 OFDM 符号。

实施例 8

实施例 8 示出了根据本发明的一个实施例的第二时间资源池和第三时间资源在时域上的分布的示意图，如附图 8 所示。在附图 8 中，横线填充的方块是第二时间资源池中的时间资源块，斜线填充的方块是第三时间资源池中的时间资源块。

在实施例 8 中，第二信令在第二时间资源池中的一个时间资源块上发送，第一信令在第三时间资源池中的一个时间资源块上发送。所述第三时间资源池的两个时间资源块之间可能存在多个所述第二时间资源池的时间资源块。

作为实施例 8 中的子实施例 1，所述第二时间资源池和所述第三时间资源池在时域上是非连续性的

实施例 9

实施例 9 示例了根据本发明的一个实施例的天线端口组与时间资源池对应的示意图，如附图 9 所示。

在实施例 9 中，第一天线端口组是 K 个天线端口组中的一个天线端口组。所述 K 个天线端口组分别对应 K 个不同的波束组。所述 K 个天线端口组分别对应 K 个时间资源池，所述第一时间资源池是所述第一天线端口组对应的时间资源池。

实施例 10

实施例 10 示例了根据本发明的一个实施例的用于 UE 中的处理装置的结构框图，如附图 10 所示。

附图 10 中，UE 装置 200 主要由第一模块 201，第二接收模块 202，第三接收模块 203 和第二模块 204 组成。

第一模块 201 用于接收第一无线信号；第二接收模块 202 用于接收第一信令；第三接收模块 203 用于接收第二信令；第二模块 204 用于在第一时间资源子池中操作第二无线信号。

在实施例 10 中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。所述 K 是大于 1 的正整数。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信令被 UE 用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚

拟化向量}中的至少之一与所述第一天线端口组关联。第一天线虚拟化向量是基站在所述第一时间资源池中的可用的天线虚拟化向量。第二天线虚拟化向量是UE在所述第一时间资源池中的可用的天线虚拟化向量。所述操作是接收；或者所述操作是发送。所述第二信令被所述 UE 用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令还被所述UE用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ进程号，RV，NDI，发送天线端口}中的至少之一。

作为实施例 10 的子实施例 1，所述第二接收模块 202 还被 UE 用于接收第一信息。其中，所述第一信息被用于确定所述第一天线端口组。

作为实施例 10 的子实施例 2，所述第一模块 201 还被 UE 用于发送第二信息。其中，所述第二信息被基站用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

作为实施例 10 的子实施例 3，所述第三接收模块 203 还被 UE 用于在第二时间资源池中监测所述第二信令。

作为实施例 10 的子实施例 4，所述第一信令是动态信令，并且所述第二接收模块 202 还被 UE 用于在第三时间资源池中监测所述第一信令。其中，所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资源池中的时间资源块之间最小的时间间隔。

实施例 11

实施例 11 示例了根据本发明的一个实施例的用于基站中的处理装置的结构框图，如附图 11 所示。

附图 11 中，基站装置 300 主要由第三模块 301，第二发送模块 302，第三发送模块 303 和第四模块 304 组成。

第三模块 301 用于发送第一无线信号；第二发送模块 302 用于发送第一信令；第三发送模块 303 用于发送第二信令；第四模块 304 用于在第一时间资源子池中执行第二无线信号。

在实施例 11 中，所述第一无线信号被 K 个天线端口组发送，所述天线端口组中包括正整数个所述天线端口。所述 K 是大于 1 的正整数。第一天线端口组是所述 K 个天线端口组中的一个天线端口组。所述第一信

令被 UE 用于确定第一时间资源池。{第一天线虚拟化向量，第二天线虚拟化向量}中的至少之一与所述第一天线端口组关联。所述第一天线虚拟化向量是基站在所述第一时间资源池中的可用的天线虚拟化向量。所述第二天线虚拟化向量是 UE 在所述第一时间资源池中的可用的天线虚拟化向量。所述 K 是大于 1 的正整数。所述执行是发送；或者所述执行是接收。所述第二信令被 UE 用于从所述第一时间资源池中确定所述第一时间资源子池，所述第二信令被所述 UE 用于确定所述第二无线信号的{所占用的频域资源，MCS，HARQ 进程号，RV，NDI，发送天线端口}中的至少之一。

作为实施例 11 的子实施例 1，所述第二发送模块 302 还被基站用于发送第一信息。其中，所述第一信息被所述 UE 用于确定所述第一天线端口组。

作为实施例 11 的子实施例 2，所述第三模块 301 还被所述基站用于接收第二信息。其中，所述第二信息被所述基站用于确定 K1 个天线端口组，所述 K1 个天线端口组属于所述 K 个天线端口组，所述第一天线端口组是所述 K1 个天线端口组中的一个所述天线端口组。所述 K1 是正整数。

作为实施例 11 的子实施例 3，所述第三发送模块 303 还被所述基站用于在第二时间资源池中发送所述第二信令。

作为实施例 11 的子实施例 4，所述第一信令是动态信令，并且所述第二发送模块 302 还被所述基站用于在第三时间资源池中发送所述第一信令。其中，所述第三时间资源池中的时间资源块之间最小的时间间隔大于所述第二时间资源池中的时间资源块之间最小的时间间隔。

本领域普通技术人员可以理解上述方法中的全部或部分步骤可以通过程序来指令相关硬件完成，所述程序可以存储于计算机可读存储介质中，如只读存储器，硬盘或者光盘等。可选的，上述实施例的全部或部分步骤也可以使用一个或者多个集成电路来实现。相应的，上述实施例中的各模块单元，可以采用硬件形式实现，也可以由软件功能模块的形式实现，本申请不限于任何特定形式的软件和硬件的结合。本发明中的 UE 或者终端包括但不限于手机，平板电脑，笔记本，上网卡，NB-IOT

终端，eMTC 终端等无线通信设备。本发明中的基站或者系统设备包括但不限于宏蜂窝基站，微蜂窝基站，家庭基站，中继基站等无线通信设备。

以上所述，仅为本发明的较佳实施例而已，并非用于限定本发明的保护范围。凡在本发明的精神和原则之内，所做的任何修改，等同替换，改进等，均应包含在本发明的保护范围之内。

说 明 书 附 图

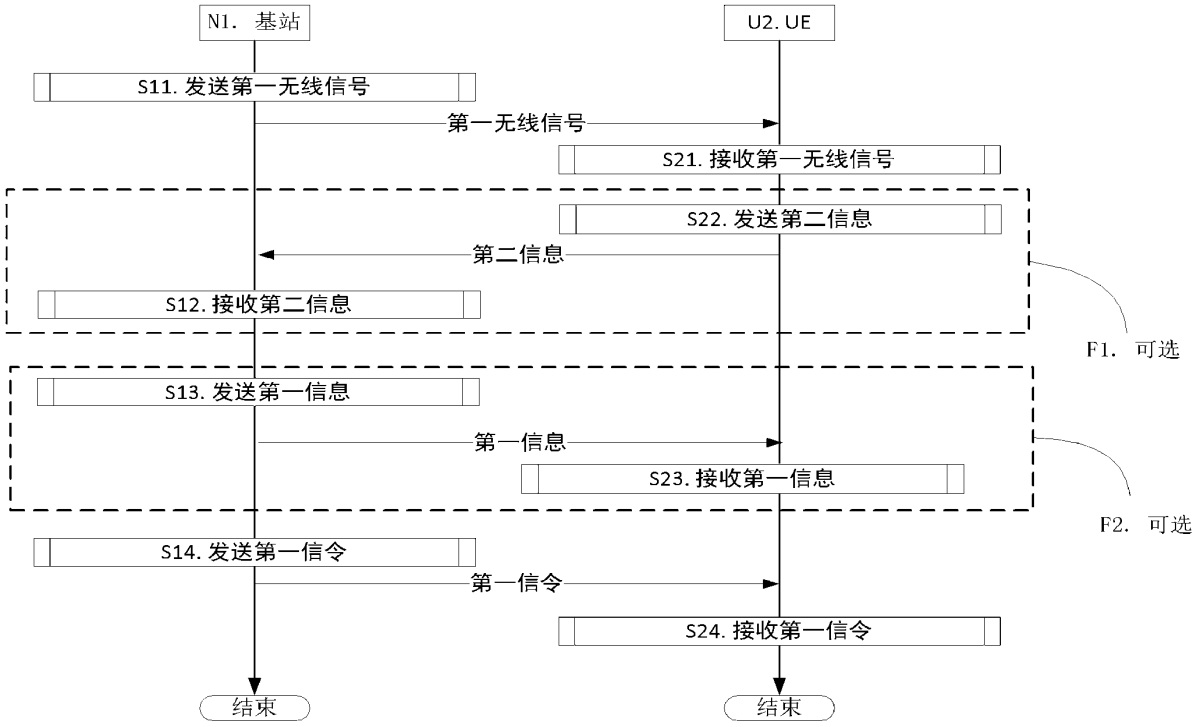

N1. 基站
U2. UE
S11. 发送第一无线信号
第一无线信号
S21. 接收第一无线信号
S22. 发送第二信息
第二信息
S12. 接收第二信息
F1. 可选
S13. 发送第一信息
第一信息
S23. 接收第一信息
F2. 可选
S14. 发送第一信令
第一信令
S24. 接收第一信令
结束
结束

图 1

说 明 书 附 图

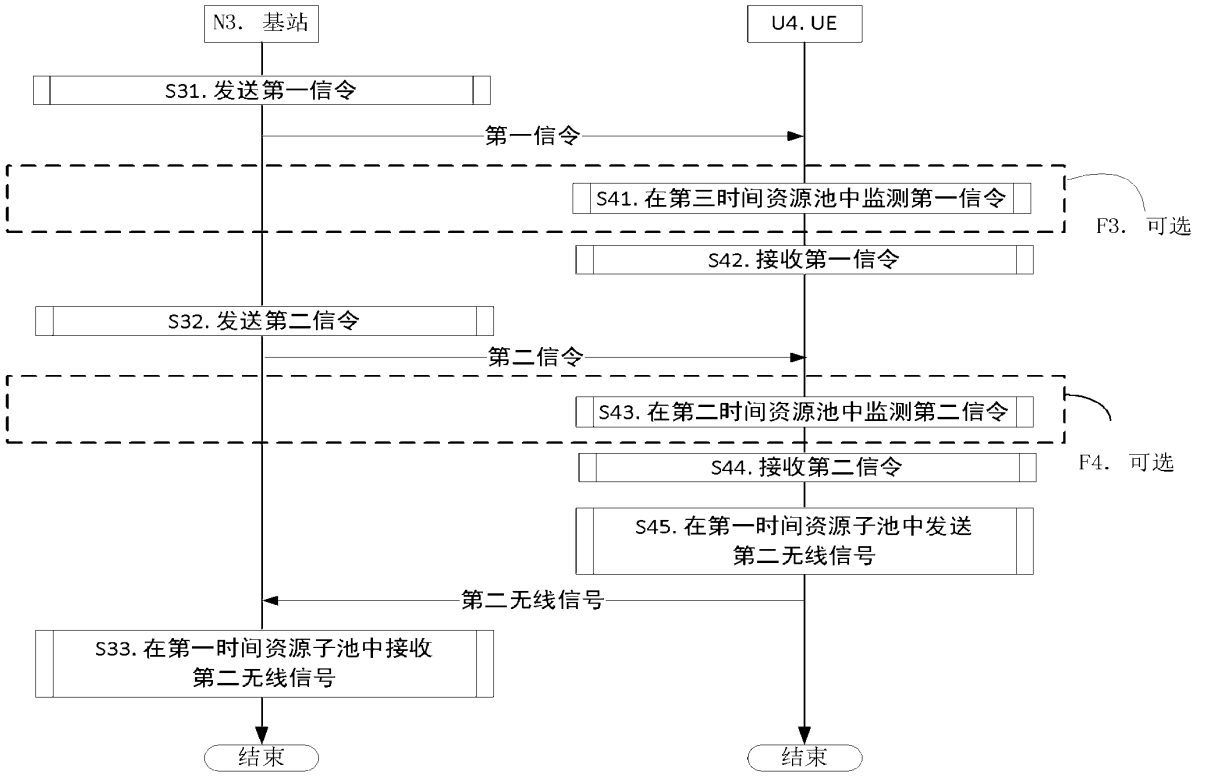

N3. 基站
U4. UE
S31. 发送第一信令
第一信令
S41. 在第三时间资源池中监测第一信令
F3. 可选
S42. 接收第一信令
S32. 发送第二信令
第二信令
S43. 在第二时间资源池中监测第二信令
F4. 可选
S44. 接收第二信令
S45. 在第一时间资源子池中发送第二无线信号
第二无线信号
S33. 在第一时间资源子池中接收第二无线信号
结束
结束

图 2

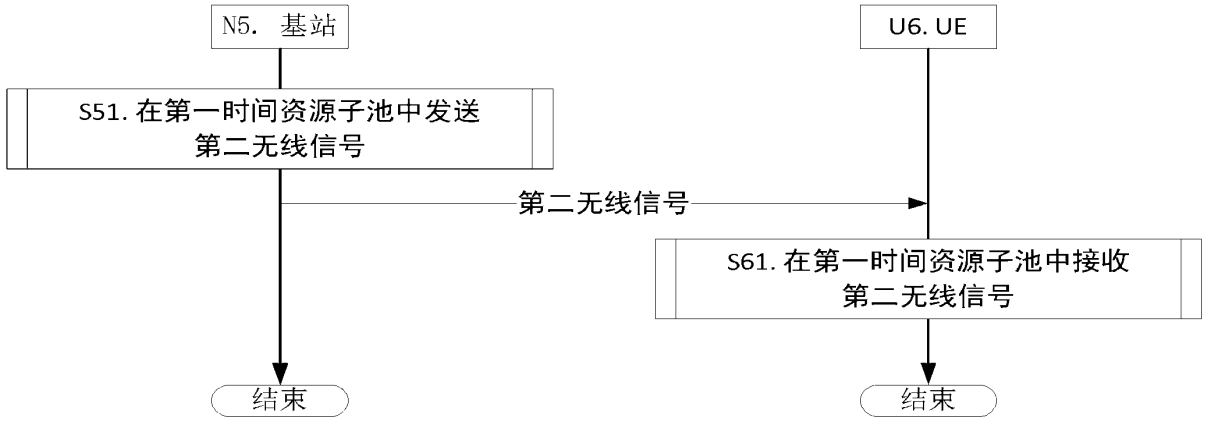

N5. 基站
U6. UE
S51. 在第一时间资源子池中发送第二无线信号
第二无线信号
S61. 在第一时间资源子池中接收第二无线信号
结束
结束

图 3

说 明 书 附 图

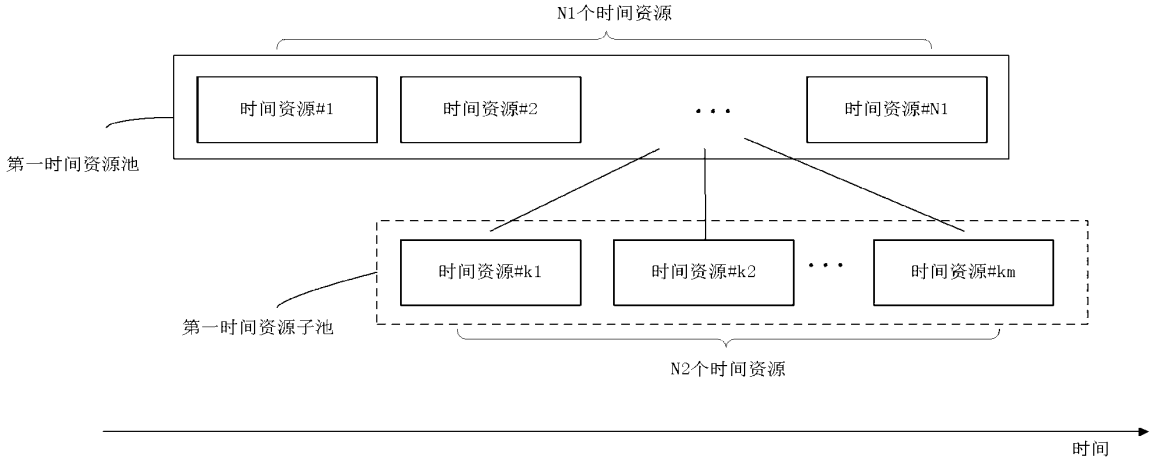

N1个时间资源
时间资源#1
时间资源#2
时间资源#N1
第一时间资源池
时间资源#k1
时间资源#k2
时间资源#km
第一时间资源子池
N2个时间资源
时间

图 4

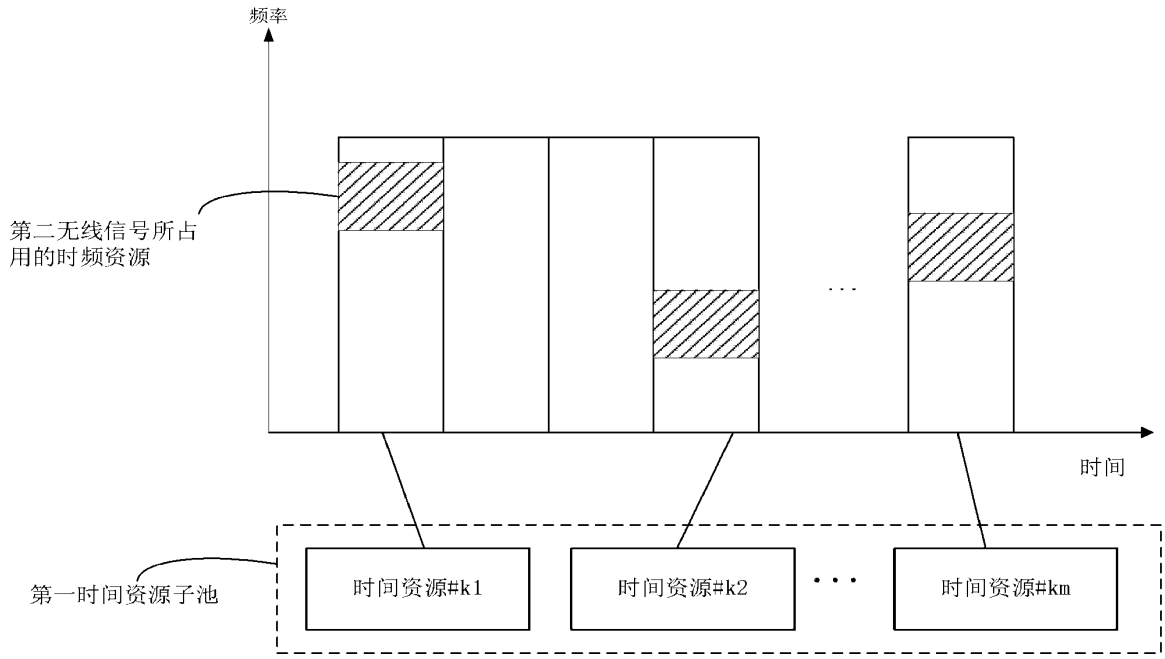

频率
第二无线信号所占用的时频资源
时间
第一时间资源子池
时间资源#k1
时间资源#k2
时间资源#km

图 5

说 明 书 附 图

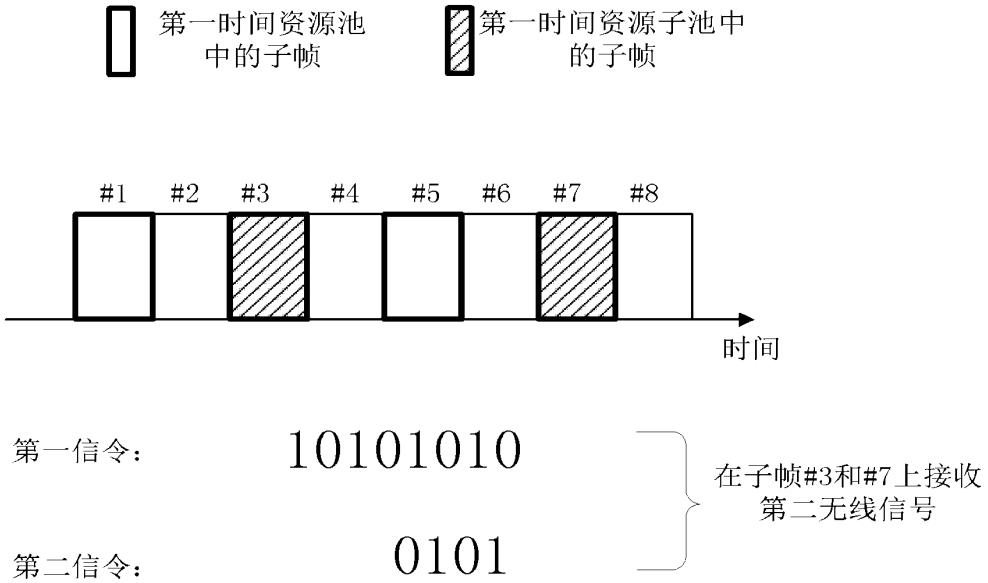

第一时间资源池中的子帧
第一时间资源子池中的子帧
#1
#2
#3
#4
#5
#6
#7
#8
时间
第一信令：
10101010
第二信令：
0101
在子帧#3和#7上接收第二无线信号

图 6

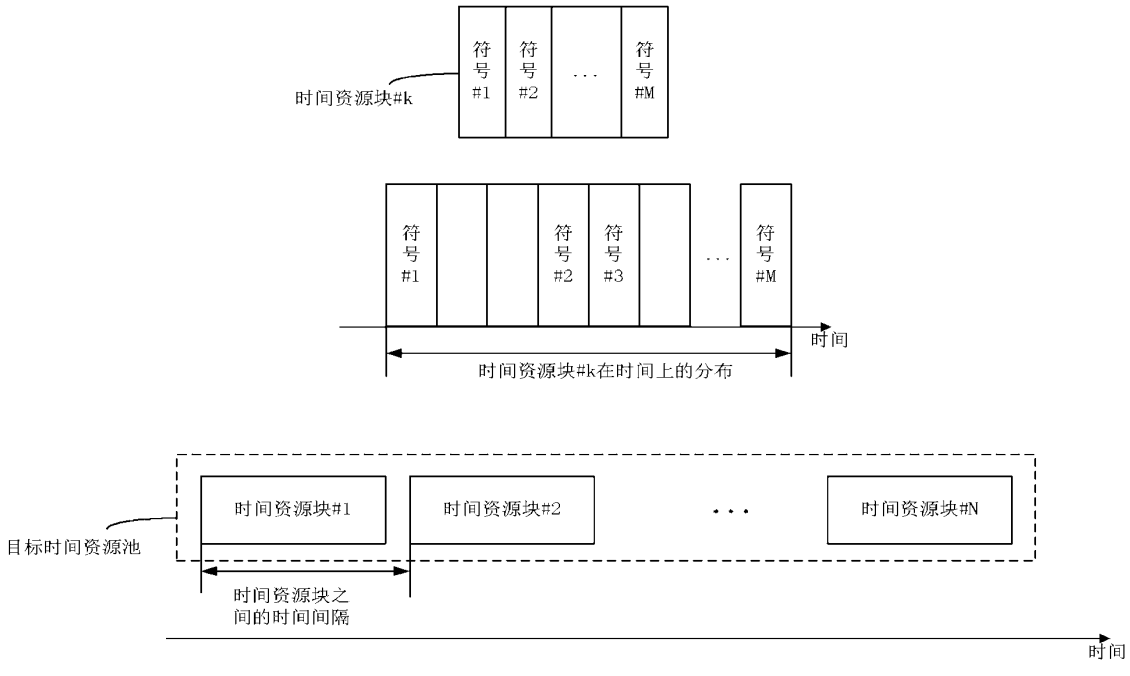

时间资源块#k
符号#1
符号#2
...
符号#M
符号#1
符号#2
符号#3
...
符号#M
时间
时间资源块#k在时间上的分布
目标时间资源池
时间资源块#1
时间资源块#2
...
时间资源块#N
时间资源块之间的时间间隔
时间

图 7

说 明 书 附 图

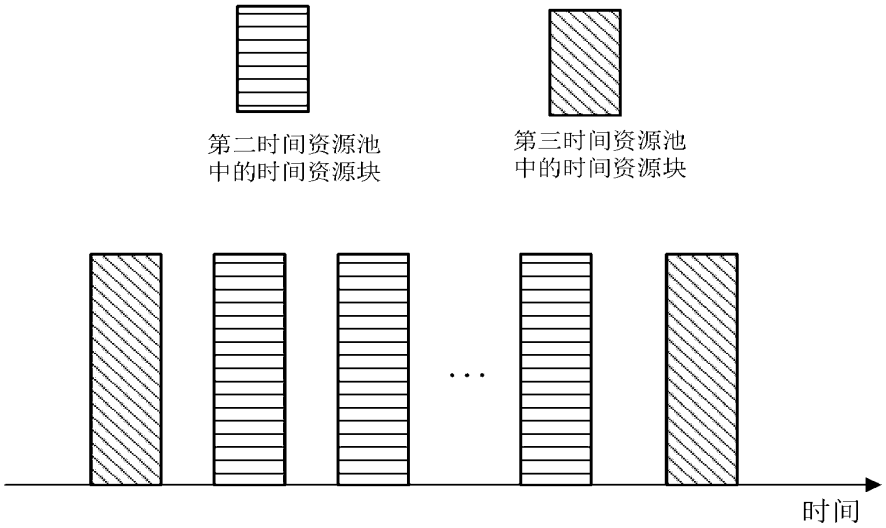
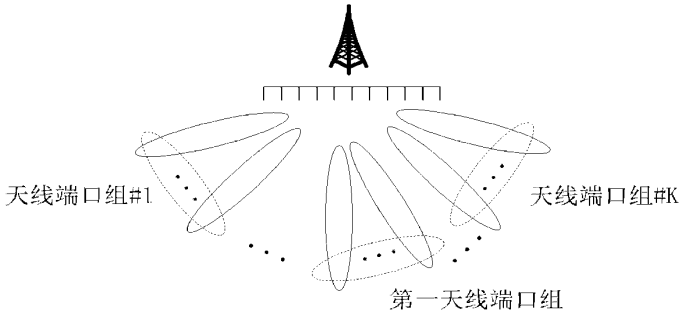

第二时间资源池
中的时间资源块
第三时间资源池
中的时间资源块
时间

图 8


天线端口组#1
天线端口组#K
第一天线端口组

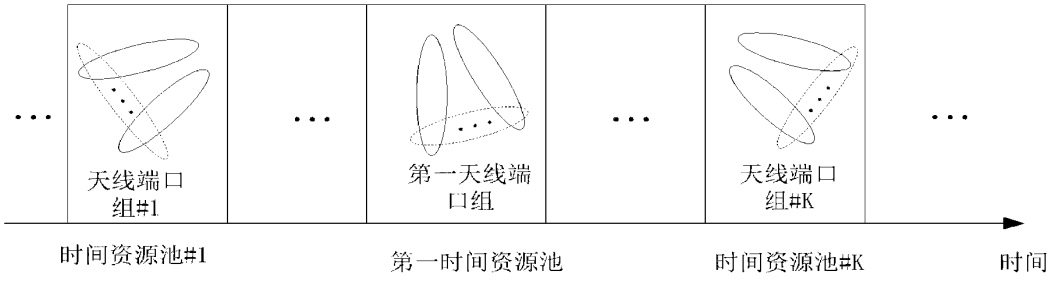

天线端口
组#1
第一天线端
口组
天线端口
组#K
时间资源池#1
第一时间资源池
时间资源池#K
时间

图 9

说 明 书 附 图

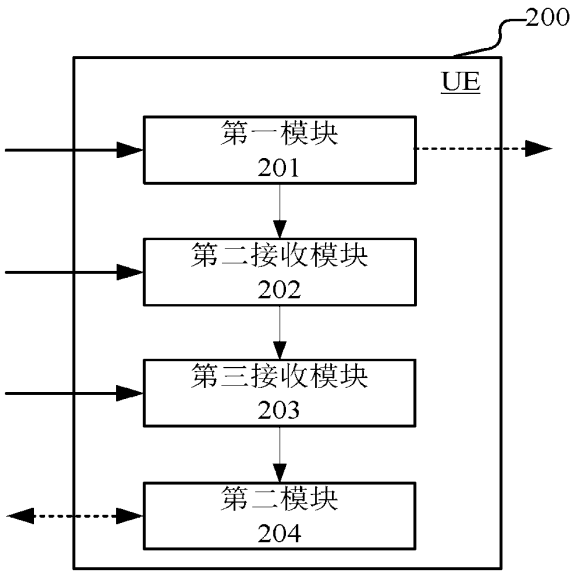


图 10

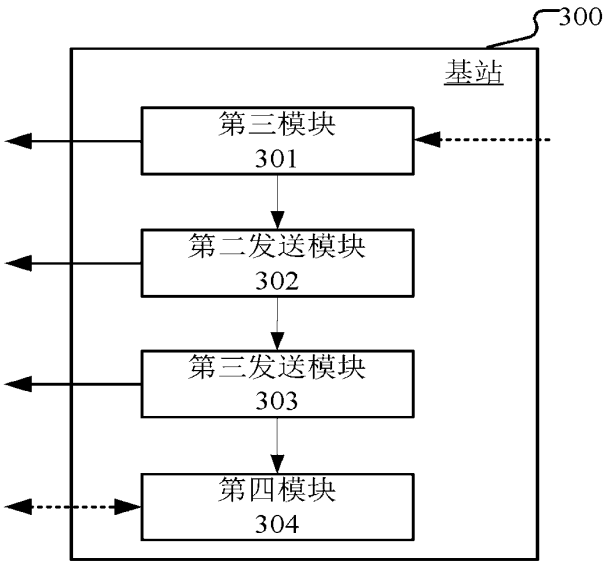


图 11

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16429077
Filing Date	2019-06-03
First Named Inventor	XiaoBo ZHANG
Art Unit	2464
Examiner Name	NGO, RICKY QUOC
Attorney Docket Number	20160089-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20160094326	A1	2016-03-31	KOREA ELECTRONICS TELECOMM	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	105577318	CN	A	2016-05-11	LONGBO COMMUNICATION TECHNICAL CO., LTD	English Abstract	☒
	2	103687010	CN	A	2014-03-26	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY	English Abstract	☒
	3	2016018100	WO	A1	2016-02-04	LG ELECTRONICS INC		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	XiaoBo ZHANG
	Art Unit	2464
	Examiner Name	NGO, RICKY QUOC
	Attorney Docket Number	20160089-PCT-US

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ISR received in application no. PCT/CN2017/112033 dated February 7, 2018	
	2	RS design enhancements for supporting EB and FD-MIMO, LG Electronics, 3GPP TSG RAN WG1 Meeting #78bis , R1-144047, October 5, 2014	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	XiaoBo ZHANG
	Art Unit	2464
	Examiner Name	NGO, RICKY QUOC
	Attorney Docket Number	20160089-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/XiaoBo ZHANG/	Date (YYYY-MM-DD)	2019-08-19
Name/Print	XiaoBo ZHANG	Registration Number	

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	36918905
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	157297
Filer:	Qi Zhou
Filer Authorized By:	
Attorney Docket Number:	20160089-PCT-US
Receipt Date:	19-AUG-2019
Filing Date:	03-JUN-2019
Time Stamp:	23:58:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	IDS_R1_CN105577318A.pdf	947892 ef53df383f8166f53a6389b1cf263e1fbdd1b0ec	no	15

Warnings:

Information:					
2	Foreign Reference	IDS_R2_CN103687010A.pdf	2138723 10c1bb404ef919afe2617b3d36ce2db44c79a641	no	30
Warnings:					
Information:					
3	Foreign Reference	IDS_R3_WO2016018100A1.pdf	2801495 5a2166930e7d7c3b58a332933deaedd6aaaecbad	no	60
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	20160089-PCT-US_APP_Official_Info_PCTCN2017112033_ISR.pdf	166997 0bee6e4775d0b714b6f6bcd28c0da8f2ecd96ba2	no	5
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	20160089-PCT-US_LtO_IDS.pdf	612495 af06d270c6f18cf1f2cc64e0a90e3a2328434 9b0	no	4
Warnings:					
Information:					
6	Non Patent Literature	IDS_R4_RS_design_enhancements_for_supporting_EB_and_FD-MIMO.pdf	488831 d4d9fc48dd07305da46b6587996ef35ff9817bcb	no	5
Warnings:					
Information:					
		Total Files Size (in bytes):	7156433		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Espacenet

Bibliographic data: CN105577318 (A) — 2016-05-11

CSI feedback method and apparatus in FD-MIMO transmission

Inventor(s): ZHANG XIAOBO ± (ZHANG XIAOBO, ; 张晓博)

Applicant(s): LONGBO COMMUNICATION TECHNICAL CO LTD ± (LONGBO COMMUNICATION TECHNICAL CO., LTD, ; 上海朗帛通信技术有限公司)

Classification: - international: ***H04L1/00; H04L1/16***
- cooperative:

Application number: CN201410545497 20141015 Global Dossier

Priority number(s): CN201410545497 20141015

Also published as: CN105577318 (B)

Abstract of CN105577318 (A)

The invention provides a channel status information (CSI) feedback method and apparatus in full-dimension multiple-input-multiple-output (FD-MIMO) transmission. User equipment (UE) receives a downlink reference signal at a first reference signal (RS) resource at a step one and receives a downlink signalling at the step one to obtain a first precoding vector index (PVI). The first RS resource includes N RS ports and the vector of the first PVI index includes M elements; each RS port of the first RS resource in a target sub-frame set is generated by M antenna unit groups based on an antenna virtualization scheme; and the corresponding antenna virtualization vector is indicated by the first PVI, wherein the N is a positive integer lager than 1, the M is a positive integer larger than 1. The sub-frame set includes F subframes, wherein the F is a positive integer. According to the method provided by the invention, the US utilizes limited air interface resources to measure and feed back the CSI effectively, so that the costs of the air interface resources are saved.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 105577318 A
(43)申请公布日 2016.05.11

(21)申请号 201410545497.5

(22)申请日 2014.10.15

(71)申请人 上海朗帛通信技术有限公司
地址 200240 上海市闵行区东川路555号乙楼A2117室

(72)发明人 张晓博

(51)Int.Cl.
H04L 1/00(2006.01)
H04L 1/16(2006.01)

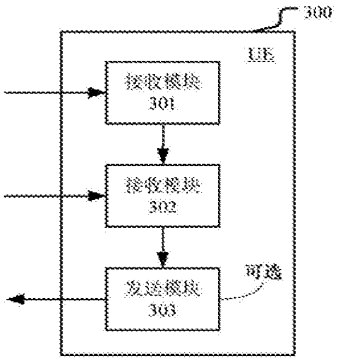
权利要求书2页 说明书8页 附图3页

(54)发明名称

一种FD-MIMO传输中的CSI反馈方法和装置

(57)摘要

本发明提出了一种FD-MIMO传输中的CSI反馈方法和装置。UE在步骤一中在第一RS资源上接收下行参考信号，在步骤一中接收下行信令获得第一PVI。其中，第一RS资源包括N个RS端口。第一PVI索引的向量包括M个元素。第一RS资源中的每一个RS端口在目标子帧集合中都是分别由M个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量都由第一PVI指示。所述N是大于1的正整数，所述M是大于1的正整数。所述子帧集合包括F个子帧，所述F是正整数。本发明的方法使得UE利用有限的空口资源有效的测量并反馈CSI，节省了空口资源的开销。



CN 105577318 A

1. 一种 UE 中的方法，其中，包括如下步骤：

- 步骤 A. 在第一 RS 资源上接收下行参考信号

- 步骤 B. 接收下行信令获得第一 PVI。

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

2. 根据权利要求 1 所述的方法，其特征在于，所述步骤 A 还包括：

- 步骤 A1. 在第二 RS 资源上接收下行参考信号。

所述方法还包括：

- 步骤 C. 发送｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。

其中，第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

3. 根据权利要求 1，2 所述的方法，其特征在于，所述步骤 B 还包括：

- 步骤 B1. 根据接收的第一 RS 资源上的 K 个所述子帧集合上的下行参考信号以及相应的 K 个 PVI 恢复出每个所述 RS 端口对应的 M 个天线单元组的信道信息。所述 K 是不小于 M 的正整数。

4. 根据权利要求 1-3 所述的方法，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

5. 一种基站中的方法，其中，包括如下步骤：

- 步骤 A. 在第一 RS 资源上发送下行参考信号

- 步骤 B. 发送下行信令指示第一 PVI。

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

6. 根据权利要求 5 所述的方法，其特征在于，所述步骤 A 还包括：

- 步骤 A1. 在第二 RS 资源上发送下行参考信号。

所述方法还包括：

- 步骤 C. 接收｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。

其中，第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

7. 根据权利要求 5，6 所述的方法，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

8. 一种用户设备，其特征在于，该设备包括：

第一模块：用于在第一 RS 资源上接收下行参考信号

第二模块：用于接收下行信令获得第一 PVI。

Samsung Exhibit 1003, Page 136 of 438

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

9. 根据权利要求 8 所述的设备，其特征在于，该设备还包括：

第三模块：用于发送｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。

其中，第一模块还用于在第二 RS 资源上接收下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

10. 一种基站设备，其特征在于，该设备包括：

第一模块：用于在第一 RS 资源上发送下行参考信号

第二模块：用于发送下行信令指示第一 PVI。

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

11. 根据权利要求 10 所述的设备，其特征在于，该设备还包括：

第三模块：用于接收｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。

其中，第一模块还用于在第二 RS 资源上发送下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

Samsung Exhibit 1003, Page 137 of 438

一种 FD-MIMO 传输中的 CSI 反馈方法和装置

技术领域

[0001] 本发明涉及移动通信技术领域中信道信息反馈的方案，特别是涉及采用了FD(Full Dimension，全维度)MIMO(Multiple Input Multiple Output，多输入输出）技术的移动通信系统中的CSI(Channel Status Information，信道状态信息）反馈方案。

背景技术

[0002] 传统的3GPP(3rd Generation Partner Project，第三代合作伙伴项目)LTE(Long Term Evolution，长期演进）系统中，MIMO信道的CSI反馈主要有两种方式

[0003] ●反馈隐式CSI

[0004] UE(User Equipment，用户设备）通过检测CRS(Cell specific Reference Signal，小区特定的参考信号）或者是CSI-RS(CSI Reference Signal，信道状态指示参考信号）得到CIR(Channel Impulse Response，信道冲激响应）并映射为隐式CSI。隐式CSI包括PMI(Precoding Matrix Indicator，预编码矩阵指示)，CQI(Channel Quality Indicator，信道质量指示）等信息。系统侧通过UE反馈的隐式CSI获得MIMO下行信道参数。

[0005] 附图1是一个现有LTE系统中基于正常CP(Cyclic Prefix，循环前缀）的在PRBP(Physical Resource Block Pair，物理资源块）内CSI-RS图案－同时标示出了CRS和DMRS(Demodulation Reference Signal，解调参考信号)，其中一个小方格是LTE的最小资源单位-RE(Resource Element，资源粒子）。斜线标示的RE可以用于发送CSI-RS。LTE系统采用端口的概念定义RS资源：一个RS端口可能由一个天线单元发送，也有可能是多个天线单元通过天线虚拟化技术形成。LTE定义了4种CSI-RS端口数量：1，2，4，8。

[0006] 隐式CSI适用于FDD(Frequency Duplex Division，频分双工）系统和TDD(Time Duplex Division，时分双工）系统。

[0007] ●反馈上行SRS(Sounding Reference Signal，侦听参考信号）

[0008] UE发送上行SRS，系统侧通过解调SRS获得上行信道CSI，再根据链路对称性获得下行CSI。该方法主要适用于TDD系统。

[0009] 3GPP R(Release，版本)12制定了3D(Dimension，维)MIMO信道模型。在RAN(Radio Access Network，无线接入网)#65次会议上，FD-MIMO被批准为3GPP R13的研究课题。FD-MIMO研究最多达到64个物理天线的场景。FD-MIMO所面临的一个挑战是如何确保基站设备准确的获得下行CSI。目前关于Massive MIMO主要的研究是基于TDD系统，即利用SRS和链路对称性是系统侧获得下行CSI。考虑到SRS的局限性（例如FDD很难采用，射频链路的非对称性，SRS导频污染，SRS资源受限等)，隐式CSI在Massive MIMO传输中可能依然扮演重要角色。

[0010] 对于FD-MIMO，如果UE直接反馈针对所有物理天线的CSI，所带来的空口开销在天线数量较多时几乎是不可接受的。针对上述问题，本发明提出了一种FD MIMO系统中的CSI反馈方法和装置。

Samsung Exhibit 1003, Page 138 of 438

发明内容

[0011] 本发明公开了一种 UE 中的方法，其中，包括如下步骤：

[0012] - 步骤 A. 在第一 RS 资源上接收下行参考信号

[0013] - 步骤 B. 接收下行信令获得第一 PVI(Precoding Vector Index，预编码向量索引)

[0014] 其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

[0015] 上述方法中，针对每一个 RS 端口，所述 UE 收集 M 个彼此不平行的 PVI(即 M 个 PVI 对应的向量组成的矩阵是满秩的)之后，能够根据相应 M 个 PVI 各自的目标子帧集合中接收到的下行 RS 信号恢复出 M 个天线单元组的下行信道信息(只要 M 个天线单元组在所述 UE 收集所述 M 个彼此不平行的 PVI 期间到 RS 端口的映射没有变化，并且下行信道信息在此期间是相关的)，因此所述 UE 能够利用(第一 RS 资源的)N 个 RS 端口恢复出 MN 个天线单元组的下行信道信息。此外，上述方法提供 了一种机制，即基站能够根据当前小区中 UE 的统计下行信道信息自适应的调整第一 RS 资源的天线虚拟化向量以提高 UE 侧信道估计的精度，或者支持低频度的发送第一 RS 资源。

[0016] 作为一个实施例，一个所述天线单元组对应一个 TXRU(Transceiver Unit，收发器单元)。作为一个实施例，一个所述天线单元组包括 1 个天线单元。作为一个实施例，所述下行信令是高层信令，所述目标子帧集合是所述下行信令的有效期。作为一个实施立，所述下行信令是用于配置第一 RS 资源的 CSI-RS-Config IE(Information Element，信息单元)。作为一个实施例，所述下行信令是物理层信令。作为一个实施例，所述 F 为 1，所述下行信令是下行调度 DCI(Downlink Control Information，下行控制信息)即用于调度下行物理层数据发送的 DCI，所述目标子帧集合是所述下行信令的调度子帧。作为一个实施例，所述 RS 端口在子帧内的图案对应一个 CSI-RS 端口的图案。作为一个实施例，所述 RS 端口在子帧内的图案对应一个 CRS 端口的图案。

[0017] 作为一个实施例，第一 PVI 指示的向量中第 m 个元素是 $\exp(2\pi(m-1)/M)$，m 从 1 到 M。

[0018] 具体的，根据本发明的一个方面，其特征在于，所述步骤 A 还包括：

[0019] - 步骤 A1. 在第二 RS 资源上接收下行参考信号。

[0020] 所述方法还包括：

[0021] - 步骤 C. 发送{第一 PMI，第二 PMI，上行 RS}中的至少一种以及第一 CQI。

[0022] 其中，第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

[0023] 第二 PMI 的参考 RS 是第二 RS 资源是指：第二 PMI 所指示的 CSI 参考资源上的 PDSCH(Physical Downlink Shared Channel，物理下行共享信道)所采用的发送天线端口分别和第二 RS 资源的 M 个 RS 端口一一对应。所述 CSI 参考资源的详细描述参考 TS36.213。第一 PMI 的参考 RS 是第一 RS 资源的含义同上。

Samsung Exhibit 1003, Page 139 of 438

[0024] 作为一个实施例，第一 RS 资源和第二 RS 资源属于同一个 CSI-RS 子帧集 (CSI subframe set)。作为一个实施例，第一 PMI 和第二 PMI 都是宽带 PMI。作为一个实施例，所述上行 RS 是 SRS。

[0025] 作为一个实施例，第二 RS 资源中的 RS 端口在给定子帧集合中都是由 N 个天线单元组采用天线虚拟化方案生成。

[0026] 具体的，根据本发明的一个方面，其特征在于，所述步骤 B 还包括：

[0027] -步骤 B1. 根据接收的第一 RS 资源上的 K 个所述子帧集合上的下行参考信号以及相应的 K 个 PVI 恢复出每个所述 RS 端口对应的 M 个天线单元组的信道信息。所述 K 是不小于 M 的正整数。

[0028] 作为一个实施例，所述 K 个 PVI 组成的矩阵的秩等于 M。

[0029] 具体的，根据本发明的一个方面，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

[0030] 所述 CSI-RS 配置参考 TS36.211 中的表格 6.10.5.2-1。

[0031] 本发明公开了一种基站中的方法，其中，包括如下步骤：

[0032] -步骤 A. 在第一 RS 资源上发送下行参考信号

[0033] -步骤 B. 发送下行信令指示第一 PVI。

[0034] 其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

[0035] 作为一个实施例，所述下行信令是 RRC(Radio Resource Control，无线资源控制)层信令，所述目标子帧集合是所述下行信令的生效子帧到下一次 RRC 信令的生效子帧的前一子帧。作为一个实施例，所述 F 为 1，所述下行信令是下行调度 DCI，所述目标子帧集合是所述下行信令的调度子帧。作为一个实施例，所述 RS 端口在子帧内的图案对应一个 CSI-RS 端口的图案。作为一个实施例，所述 RS 端口在子帧内的图案对应一个 CRS 端口的图案。

[0036] 具体的，根据本发明的一个方面，其特征在于，所述步骤 A 还包括：

[0037] -步骤 A1. 在第二 RS 资源上发送下行参考信号。

[0038] 所述方法还包括：

[0039] -步骤 C. 接收 {第一 PMI，第二 PMI，上行 RS} 中的至少一种以及第一 CQI。

[0040] 其中，第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

[0041] 作为一个实施例，第一 RS 资源和第二 RS 资源属于同一个 CSI-RS 子帧集。

[0042] 具体的，根据本发明的一个方面，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

[0043] 本发明公开了一种用户设备，其特征在于，该设备包括：

[0044] 第一模块：用于在第一 RS 资源上接收下行参考信号

[0045] 第二模块：用于接收下行信令获得第一 PVI

[0046] 其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一

Samsung Exhibit 1003, Page 140 of 438

RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

[0047] 作为一个实施例，上述设备的特征在于，该设备还包括：

[0048] 第三模块：用于发送{第一 PMI，第二 PMI，上行 RS}中的至少一种以及第一 CQI。

[0049] 其中，第一模块还用于在第二 RS 资源上接收下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

[0050] 作为一个实施例，上述设备的特征在于，第二模块还用于根据接收的第一 RS 资源上的 K 个所述子帧集合上的下行参考信号以及相应的 K 个 PVI 恢复出每个所述 RS 端口对应的 M 个天线单元组的信道信息。所述 K 是不小于 M 的正整数。

[0051] 本发明公开了一种基站设备，其特征在于，该设备包括：

[0052] 第一模块：用于在第一 RS 资源上发送下行参考信号

[0053] 第二模块：用于发送下行信令指示第一 PVI

[0054] 其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

[0055] 作为一个实施例，上述设备的特征在于，该设备还包括：

[0056] 第三模块：用于接收{第一 PMI，第二 PMI，上行 RS}中的至少一种以及第一 CQI。

[0057] 其中，第一模块还用于在第二 RS 资源上发送下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

[0058] 针对 FD MIMO 系统中测量 RS 以及 UE 所反馈的 CSI 占用过多的空口开销这一问题，本发明公开了一种 CSI-RS 配置和相应的 CSI 反馈的方法和装置。根据本发明的方法，UE 能够利用较少的 RS 端口恢复出较多的天线单元组的下行信道信息。此外，基站能够根据当前小区中 UE 的统计下行信道信息自适应的调整第一 RS 资源的天线虚拟化向量以提高 UE 侧信道估计的精度。本发明的方法使得 UE 利用有限的空口资源有效的测量并反馈 CSI，节省了空口资源的开销。

附图说明

[0059] 通过阅读参照以下附图所作的对非限制性实施例所作的详细描述，本发明的其它特征、目的和优点将会变得更加明显：

[0060] 图 1 示出了现有 LTE 系统的下行 RS 图案的一个示例；

[0061] 图 2 示出了根据本发明的一个实施例的 RS 资源配置以及 CSI 反馈的流程图；

[0062] 图 3 示出了根据本发明的一个实施例的第一 RS 资源和第二 RS 资源在 PRBP 内的图案；

Samsung Exhibit 1003, Page 141 of 438

[0063] 图 4 示出了根据本发明的一个实施例的基站侧的 4X8 垂直极化天线阵到 RS 端口的映射图；

[0064] 图 5 示出了根据本发明的一个实施例的用于 UE 中的处理装置的结构框图；

[0065] 图 6 示出了根据本发明的一个实施例的用于基站中的处理装置的结构框图；

具体实施方式

[0066] 下文将结合附图对本发明的技术方案作进一步详细说明，需要说明的是，在不冲突的情况下，本申请的实施例和子实施例中的特征可以任意相互组合。

[0067] 实施例 1

[0068] 实施例 1 是 RS 资源配置以及 CSI 反馈的流程图，如附图 2 所示。附图 2 中，基站 E1 维持的一个小区是 UE U2 的服务小区。步骤 S210 是可选步骤。

[0069] 对于基站 E1，在步骤 S10 中，在第一 RS 资源和第二 RS 资源上发送下行参考信号；在步骤 S11 中，发送下行信令指示第一 PVI；在步骤 S12 中，接收上行 CSI。

[0070] 对于 UE U2，在步骤 S20 中，在第一 RS 资源和第二 RS 资源上接收下行参考信号；在步骤 S21 中，接收下行信令获得第一 PVI；在步骤 S22 中，发送上行 CSI。

[0071] 实施例 1 中，第一 RS 资源包括 N 个 RS 端口。第二 RS 资源包括 M 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。所述上行 CSI 包括｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 也被基站 E1 采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算 假定第二 PMI 也被基站 E1 采用。所述上行 RS 是传统的 SRS 或者是扩展 SRS，所述扩展 SRS 是指出现在正常子帧（即非 TDD 特殊子帧）内的非最后一个 SC-FDMA(Single Carrier Frequency Division Multiple Access，单载波频分多址）符号上的 SRS，所述扩展 SRS 的 RS 序列以及在 SC-FDMA 符号内的图案重用传统的 SRS 方案。

[0072] 作为实施例 1 的子实施例 1，UE U2 在步骤 S210 中，根据接收的第一 RS 资源上的最近的 M 个所述子帧集合上的下行参考信号以及相应的 M 个 PVI 恢复出第一 RS 资源上每个 RS 端口对应的 M 个天线单元组的信道信息。其中，所述下行信令是物理层信令，所述 F 为 1。

[0073] 作为实施例 1 的子实施例 2，所述上行 CSI 包括｛第一 PMI，上行 RS，第二 PMI，第一 CQI｝。

[0074] 作为实施例 1 的子实施例 3，所述上行 CSI 包括｛第一 PMI，第二 PMI，第一 CQI｝。

[0075] 作为实施例 1 的子实施例 4，所述上行 CSI 包括｛第一 PMI，上行 RS，第一 CQI｝。

[0076] 实施例 2

[0077] 实施例 2 示例了本发明中的第一 RS 资源和第二 RS 资源在 PRBP 内的图案，如附图 3 所示，其中数字 x 标识的 RE 对应 RS 端口的索引，时域相邻的相同子载波上的两个 RE 采用 OCC(Orthogonal Covering Code，正交覆盖码）。附图 3 中，第一 RS 资源和第二 RS 资源在子帧内分别重用 LTE 中的一个 CSI-RS 配置对应的 CSI-RS- 第一 RS 资源包括 RS 端口 {1,2,

Samsung Exhibit 1003, Page 142 of 438

3,4,5,6,7,8}，第二 RS 资源包括 RS 端口 {9,10,11,12}。所述 RS 端口对应 LTE 中的一个 CSI-RS 端口的时、频、码域资源。

[0078] 实施例 3

[0079] 实施例 3 是基站侧配置的 4X8 垂直极化天线阵到 RS 端口的映射图，如附图 4 所示。附图 4 中，一个小方格表示一个物理天线单元，其中的数字表示该物理天线对应的 RS 端口索引（一根天线单元上有两个数字意味着一根天线单元映射到 2 个 RS 端口 - 发送两个 RS 端口的信号）。

[0080] 如附图 4 所示，同一列的 4 根发送天线采用天线虚拟化的方式映射到同一个 RS 端口（即 4 根发送天线分别发送同一个经过天线虚拟化向量预编码的信号，在接收机侧形成一根虚拟天线）- 对应 RS 端口 {1-8}。 类似的，同一行的 4 根发送天线采用天线虚拟化的方式映射到同一个 RS 端口 - 对应 RS 端口 {9-12}。

[0081] 首先基站在第一 RS 资源和第二 RS 资源上发送下行参考信号到 UE；然后基站发送下行信令给 UE 以第一 PVI；然后 UE 发送上行 CSI 到基站。

[0082] 实施例 3 中，第一 RS 资源包括 RS 端口 {1-8}，第二 RS 资源包括 RS 端口 {9-12}。第一 PVI 索引的向量 $w_{4\times1}$ 是 4 行 1 列。在目标子帧集合中，对于 RS 端口 {1} 是由附图 4 中数字 1 标识的 4 个天线单元采用天线虚拟化方案生成，对应的天线虚拟化向量是 $w_{4\times1}$。对于 RS 端口 {2-8}，也是通过类似的操作生成 - 对应的天线虚拟化向量也是 $w_{4\times1}$。所述子帧集合包括 F 个子帧，所述 F 是正整数。所述上行 CSI 包括 { 第一 PMI，第二 PMI，第一 CQI}。第一 CQI 的计算假定第一 PMI 和第二 PMI 被基站采用。

[0083] 作为实施例 3 的子实施例 1，第一 CQI 的计算采用如下方法：

[0084] - 测量第一 RS 资源的 RS 端口 {1-8} 得到下行信道 $h^1_{r\times8}$ ~ r 行 8 列，测量第二 RS 资源的 RS 端口 {9-12} 得到下行信道 $h^2_{r\times4}$ ~ r 行 4 列，r 是 UE 接收天线数

[0085] - 假定基站使用 RS 端口 {9-12} 在第一 CQI 的 CSI 参考资源上通过预编码的方法发送 PDSCH(Physical Downlink Shared Channel，物理下行共享信道）信号。如果对应的预编码矩阵是第二 PMI 索引的矩阵 $w^2_{4\times1}$，UE 计算 PDSCH 上的预编码信道 $h^2_{r\times4}\cdot w^2_{4\times1}$ 的等效信道容量 C_1；如果对应的预编码矩阵是第一 PVI 索引的向量 $w_{4\times1}$，UE 计算 PDSCH 上的预编码信道 $h^2_{r\times4}\cdot w_{4\times1}$ 的等效信道容量 C_2

[0086] - 假定基站使用 RS 端口 {1-8} 在第一 CQI 的 CSI 参考资源上通过预编码的方法发送 PDSCH(Physical Downlink Shared Channel，物理下行共享信道）信号。对应预编码矩阵是第一 PMI 索引的矩阵 $w^1_{8\times1}$，UE 计算 PDSCH 上的预编码信道 $h^1_{r\times8}\cdot w^1_{8\times1}$ 的等效信道容量 C_3

[0087] - 假定第一 PMI 和第二 PMI 被基站采用，实际等效信道容量是 C_1-C_2+C_3，根据所述实际等效信道容量查表确定第一 CQI

[0088] 上述等效信道容量的计算可以采用 {SINR(Signal Interference Noise Ratio，信干噪比），EESM(Exponential Effective SINR Mapping，指数有效 SINR 映射），RBIR(Received Block mean mutual Information Ratio，块平均互信息率）} 准则中的任

Samsung Exhibit 1003, Page 143 of 438

意一种。

[0089] 作为实施例 3 的子实施例 2，UE 根据接收的第一 RS 资源上的 4 个所述子帧集合上的下行参考信号以及相应的 4 个 PVI（采用矩阵求逆运算）恢复出第一 RS 资源上的每个所述 RS 端口对应的 4 个天线单元的信道信息。所述 4 个 PVI 对应的向量是彼此非平行的。UE 能够获得全部 32 个物理天线单元的下行信道信息 $H_{r\times 32}$-r 行 32 列。第一 CQI 的计算采用如下方法：

[0090] - 根据（基站和 UE 都知道的）预定义的方法，UE 利用第一 PMI 索引的矩阵 $W_{8\times 1}^{1}$ 和第二 PMI 索引的矩阵 $W_{4\times 1}^{2}$ 重构总的预编码矩阵 $W_{32\times b}$，b 是预编码层数

[0091] - 根据预编码信道 $H_{r\times 32}\cdot W_{32\times b}$ 计算等效信道容量，进而查表确定第一 CQI。

[0092] 实施例 4

[0093] 实施例 4 是用于 UE 中的处理装置的结构框图，如附图 5 所示。附图 5 中，UE 装置 300 由接收模块 301，接收模块 302 和发送模块 303 构成。发送模块 303 是可选模块。

[0094] 接收模块 301 用于在第一 RS 资源上接收下行参考信号，接收模块 302 用于接收下行信令获得第一 PVI，发送模块 303 用于发送｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。当发送模块 303 存在时，接收模块 301 还用于在第二 RS 资源上接收下行参考信号

[0095] 实施例 4 中，第一 RS 资源包括 N 个 RS 端口。第二 RS 资源包括 M 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

[0096] 作为实施例 4 的子实施例 1，所述下行信令是 RRC 层信令。

[0097] 作为实施例 4 的子实施例 2，第一 PVI 指示的 RS 资源是由高层信令配置的。

[0098] 实施例 5

[0099] 实施例 5 是用于基站 (eNB) 中的处理装置的结构框图，如附图 6 所示。附图 6 中，eNB 装置 400 由发送模块 401，发送模块 402 和接收模块 403 构成。接收模块 403 是可选模块。

[0100] 发送模块 401 用于在第一 RS 资源上发送下行参考信号，发送模块 402 用于发送下行信令指示第一 PVI，接收模块 403 用于接收｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。当接收模块 403 存在时，发送模块 401 还用于在第二 RS 资源上发送下行参考信号。

[0101] 实施例 5 中，第一 RS 资源包括 N 个 RS 端口。第二 RS 资源包括 M 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的

Samsung Exhibit 1003, Page 144 of 438

计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。。

[0102] 作为实施例 5 的子实施例 1，所述下行信令是用于调度下行发送的物理层信令，所述 F 为 1。

[0103] 作为实施例 5 的子实施例 2，第一 PVI 指示的 RS 资源是预定义的，即不需要专有信令显示配置。作为所述预定义的一个实施例，第一 PVI 指示的 RS 资源是第一 RS 资源和第二 RS 资源中对应（虚拟化之后）垂直方向天线单元的 RS 资源。

[0104] 本领域普通技术人员可以理解上述方法中的全部或部分步骤可以通过程序来指令相关硬件完成，所述程序可以存储于计算机可读存储介质中，如只读存储器，硬盘或者光盘等。可选的，上述实施例的全部或部分步骤也可以使用一个或者多个集成电路来实现。相应的，上述实施例中的各模块单元，可以采用硬件形式实现，也可以由软件功能模块的形式实现，本申请不限于任何特定形式的软件和硬件的结合。

[0105] 以上所述，仅为本发明的较佳实施例而已，并非用于限定本发明的保护范围。凡在本发明的精神和原则之内，所做的任何修改，等同替换， 改进等，均应包含在本发明的保护范围之内。

Samsung Exhibit 1003, Page 145 of 438

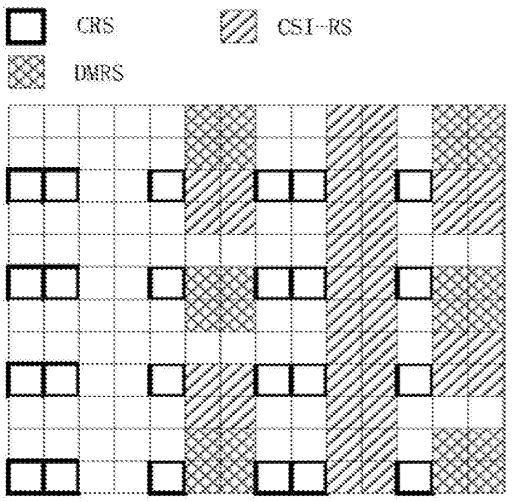


图 1

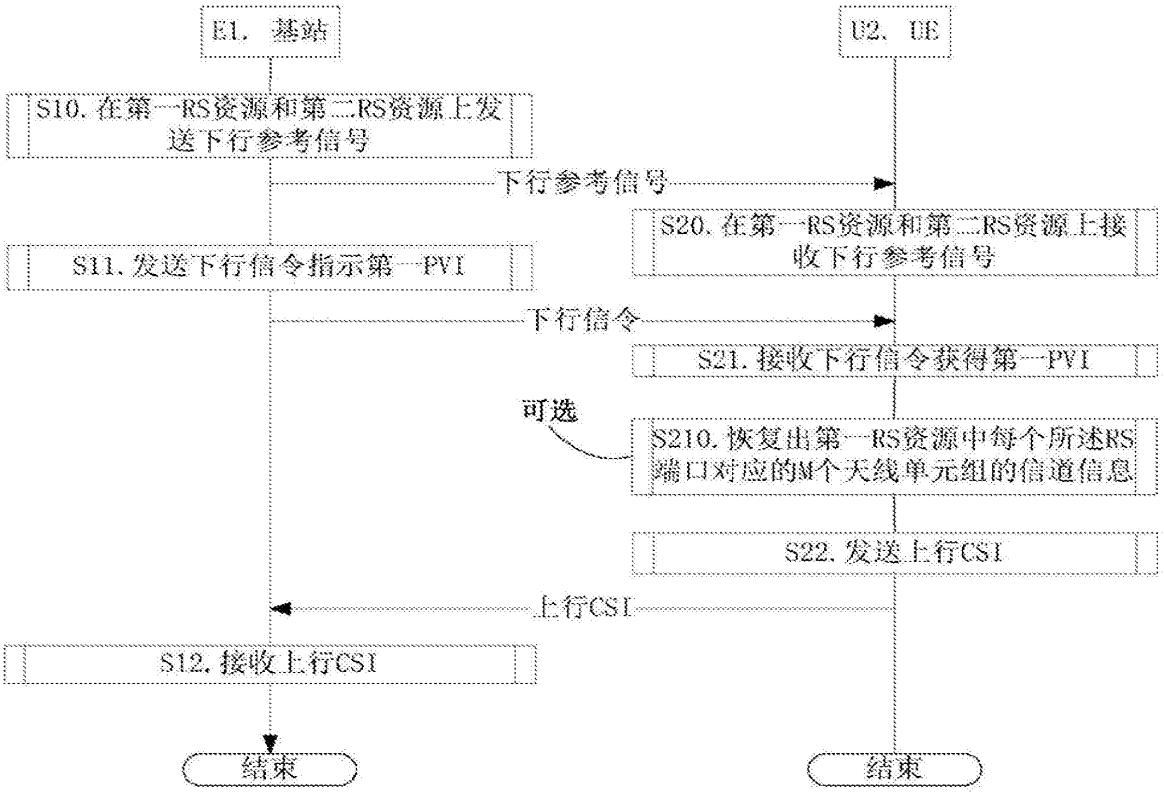


图 2

Samsung Exhibit 1003, Page 146 of 438

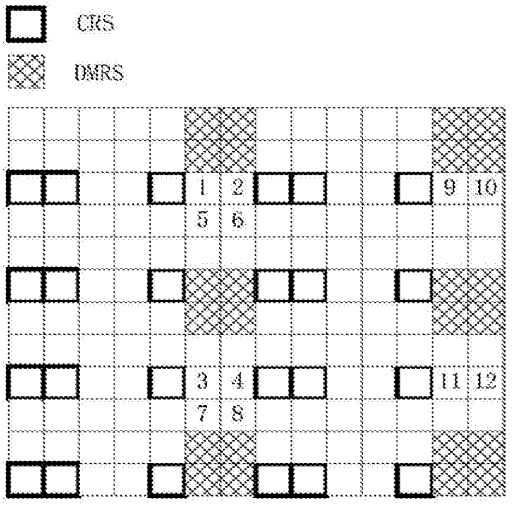


图 3

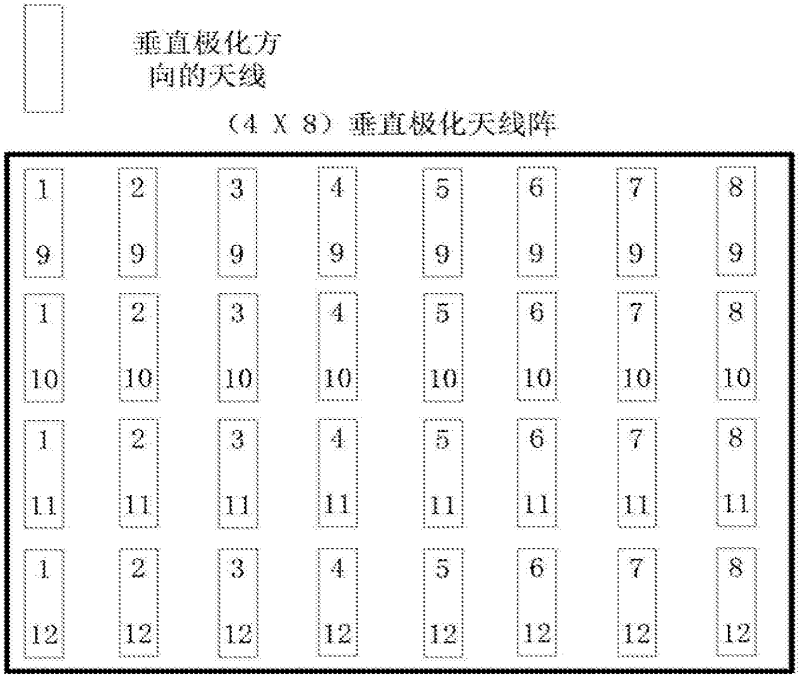


图 4

Samsung Exhibit 1003, Page 147 of 438

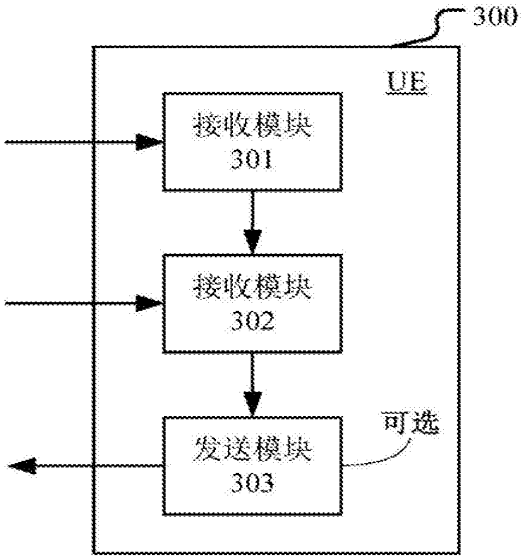


图 5

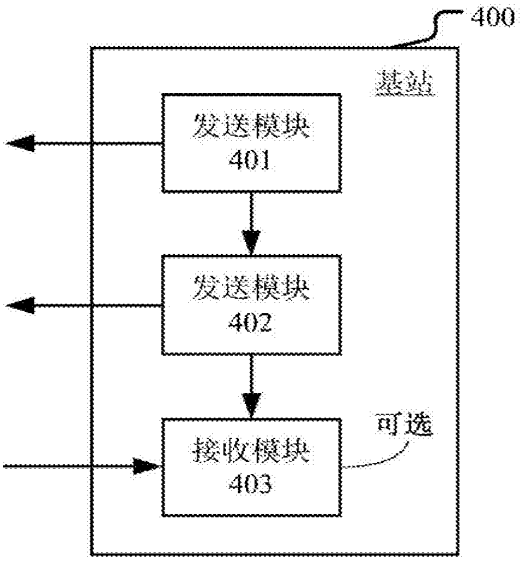


图 6

Samsung Exhibit 1003, Page 148 of 438

Espacenet

Bibliographic data: CN103687010 (A) — 2014-03-26

Method, device and system for transmitting reference signals

Inventor(s): JING MEIFANG; SU XIN; LA GAISHI; GAO QIUBIN ± (JING MEIFANG, ; SU XIN, ; LA GAISHI, ; GAO QIUBIN, ; 荆梅芳, ; 苏昕, ; 拉盖施, ; 高秋彬)

Applicant(s): CHINA ACADEMY OF TELECOMM TECH ± (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY, ; 电信科学技术研究院)

Classification: - international: ***H04L5/00; H04W72/04***
- cooperative: **H04B7/0617**; **H04B7/0684**; **H04L25/0204**; **H04L5/0023**; **H04L5/0048**; **H04L5/0051**; **H04W16/28**; **H04W72/0446**; H04L5/005

Application number: CN20121316659 20120830 Global Dossier

Priority number(s): CN20121316659 20120830

Also published as: CN103687010 (B) EP2892290 (A1) EP2892290 (A4) EP2892290 (B1) TW201409961 (A) more

Abstract of CN103687010 (A)

The invention relates to the field of wireless communication technology, in particular to a method, device and system for transmitting reference signals, and aims to solve the problems in the prior art that estimation of a vertical dimension channel can not be supported and 3D beam forming can not be supported. The method provided by the embodiment of the invention comprises the following steps: a network side determines a subframe for bearing reference signals, determines a pilot frequency port for the reference signals, and also sends the reference signals which are allocated in the pilot frequency port in the subframe, wherein the pilot frequency port at least comprises a row of horizontal dimension pilot frequency ports and a list of vertical dimension pilot frequency ports, reference signals allocated in the horizontal dimension pilot frequency ports are horizontal dimension reference signals, and reference signals allocated in the vertical dimension pilot frequency ports are vertical dimension reference signals. According to the method, device and system, provided by the embodiment of the invention, since the vertical dimension reference signals can be sent out directly, the channel estimation of the vertical dimension pilot frequency ports can be achieved, and the dynamic 3D beam forming technology can be achieved.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 103687010 A
(43)申请公布日 2014.03.26

(21)申请号 201210316659.9

(22)申请日 2012.08.30

(71)申请人 电信科学技术研究院
地址 100191 北京市海淀区学院路40号

(72)发明人 荆梅芳 苏昕 拉盖施 高秋彬

(74)专利代理机构 北京同达信恒知识产权代理有限公司 11291
代理人 刘松

(51)Int.Cl.
H04W 72/04(2009.01)
H04L 5/00(2006.01)

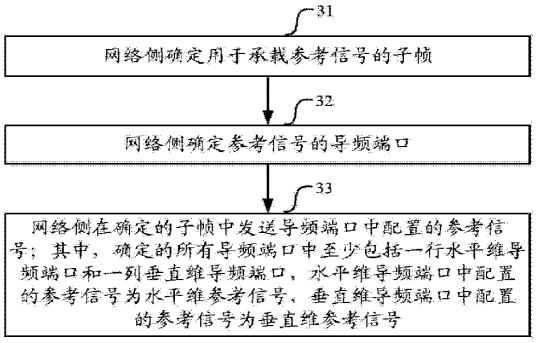
权利要求书5页 说明书16页 附图7页

(54)发明名称

一种传输参考信号的方法、装置及系统

(57)摘要

本发明涉及无线通信技术领域，特别涉及一种传输参考信号的方法、装置及系统，用于解决现有技术中不能支持垂直维信道的估计，无法支持3D波束赋形的问题，本发明实施例方法包括：网络侧确定用于承载参考信号的子帧，确定参考信号的导频端口，并在确定的子帧中发送导频端口中配置的参考信号；其中，所有导频端口至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。本发明实施例由于能够发送垂直维参考信号，可以实现对垂直维导频端口的信道估计，可以实现动态3D波束赋型技术。



CN 103687010 A

1. 一种发送参考信号的方法，其特征在于，该方法包括：

网络侧确定用于承载参考信号的子帧；

所述网络侧确定所述参考信号的导频端口；

所述网络侧在确定的子帧中发送所述导频端口中配置的参考信号；

其中，确定的所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

2. 如权利要求 1 所述的方法，其特征在于，所述水平维参考信号和所述垂直维参考信号为 3GPP 标准中定义的信道状态指示参考信号 CSI-RS。

3. 如权利要求 2 所述的方法，其特征在于，若承载所述水平维参考信号的子帧与承载所述垂直维参考信号的子帧为同一子帧，所述网络侧确定用于配置所述参考信号的导频端口包括：

所述网络侧将天线端口阵列中的所有天线端口配置为导频端口，并将每一行导频端口作为一行水平维导频端口及每一列导频端口作为一列垂直维导频端口；其中，所述天线端口阵列为由小区所支持的天线端口阵列排布而成，所述天线端口阵列中的行表示水平方向且包含 M 个天线端口，列表示垂直方向且包含 N 个天线端口，M 和 N 均为不小于 1 的正整数；或者

所述网络侧根据所述天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，所述一行导频端口的个数为 M，所述一列导频端口的个数为 N。

4. 如权利要求 3 所述的方法，其特征在于，所述网络侧将每一行导频端口作为一行水平维导频端口及每一列导频端口作为一列垂直维导频端口，还包括：

若 M×N 不大于 CSI-RS 可配置的最大端口数，所述网络侧将 3GPP 标准中定义的同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置；

其中，所述 CSI-RS 配置包括：CSI-RS 配置的发送周期、子帧偏移量及时频域位置。

5. 如权利要求 4 所述的方法，其特征在于，所述网络侧为导频端口分配的端口号为 15~(15+M×N-1)；

其中，第 i 行水平维导频端口的端口号分别为 15+(i-1)×M~15+i×M-1，相应的，每一列垂直维导频端口的端口号是根据每行水平维导频端口确定的；其中，i 为整数，且 i 的取值为 1~N；或者

第 j 列垂直维导频端口的端口号分别为 15+(j-1)×N~15+j×N-1，相应的，每行水平维导频端口的端口号是根据每列垂直维导频端口的端口号确定的；其中，j 为整数，且 j 的取值为 1~M。

6. 如权利要求 3 所述的方法，其特征在于，所述网络侧将每一行导频端口作为一行水平维导频端口及每一列导频端口作为一列垂直维导频端口，还包括：

所述网络侧将 3GPP 标准中定义的不同的 CSI-RS 配置分别作为不同行水平维导频端口的参考信号和对应的垂直维导频端口的参考信号的配置；或者

所述网络侧将 3GPP 标准中定义的不同的 CSI-RS 配置分别作为不同列垂直维导频端口

Samsung Exhibit 1003, Page 151 of 438

的参考信号和对应的水平维导频端口的参考信号的配置。

7. 如权利要求 6 所述的方法，其特征在于，所述网络侧为每一行导频端口分配的端口号为 15~(15+M-1)，其中，每一行水平维导频端口的端口号为 15~(15+M-1)，第 j 列垂直维导频端口的端口号都为 (15+j-1)，j 为整数，且 j 的取值为 1~M；

所述网络侧为每一列导频端口分配的端口号为 15~(15+N-1)，其中，每一列垂直维导频端口的端口号为 15~(15+N-1)，第 i 行水平维导频端口的端口号都为 (15+i-1)，i 为整数，且 i 的取值为 1~N。

8. 如权利要求 3 所述的方法，其特征在于，所述网络侧采用天线虚拟化处理包括：

所述网络侧从所述天线端口阵列中，选择某一行及某一列配置为导频端口；或者

所述网络侧采用固定的天线虚拟化权值进行天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口。

9. 如权利要求 8 所述的方法，其特征在于，所述网络侧将天线虚拟化处理后得到的一行导频端口作为水平维导频端口及一列导频端口作为垂直维导频端口，还包括：

若 M+N 不大于 CSI-RS 配置的最大端口数，所述网络侧将 3GPP 标准中定义的同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置。

10. 如权利要求 9 所述的方法，其特征在于，所述网络侧为导频端口分配的端口号为 15~(15+M×N-1)。

11. 如权利要求 8 所述的方法，其特征在于，所述网络侧将天线虚拟化处理后得到的一行导频端口作为水平维导频端口及一列导频端口作为垂直维导频端口，还包括：

所述网络侧将 3GPP 标准中定义的不同的 CSI-RS 配置分别作为水平维导频端口的参考信号和垂直维导频端口的参考信号的配置。

12. 如权利要求 2 所述的方法，其特征在于，若承载所述水平维参考信号的子帧与承载所述垂直维参考信号的子帧为不同子帧，所述网络侧确定用于配置所述参考信号的导频端口包括：

所述网络侧根据所述天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，所述一行导频端口的个数为 M，所述一列导频端口的个数为 N。

13. 如权利要求 12 所述的方法，其特征在于，所述网络侧采用天线虚拟化处理包括：

所述网络侧从所述天线端口阵列中，选择某一行及某一列配置为导频端口；或者

所述网络侧采用固定的天线虚拟化权值进行天线虚拟化处理，得到一行口和一列需要配置参考信号的导频端口。

14. 如权利要求 12 或 13 所述的方法，其特征在于，所述网络侧在确定的子帧中发送所述导频端口中配置的参考信号包括：

所述网络侧在每个设定的水平维参考信号发送周期内，在承载水平维参考信号的子帧中发送水平维导频端口中配置的参考信号；和 / 或

所述网络侧在每个设定的垂直维参考信号发送周期内，在承载垂直维参考信号的子帧中发送垂直维导频端口中配置的参考信号。

15. 如权利要求 14 所述的方法，其特征在于，所述垂直维参考信号发送周期与所述水

Samsung Exhibit 1003, Page 152 of 438

平维参考信号发送周期相同；或者

所述垂直维参考信号发送周期为所述水平维参考信号发送周期的 J 倍，其中，J 为不小于 1 的整数；或者

所述水平维参考信号发送周期为所述垂直维参考信号发送周期的 K 倍，其中，K 为不小于 1 的整数。

16. 如权利要求 14 所述的方法，其特征在于，所述网络侧确定水平维导频端口和垂直维导频端口包括：

所述网络侧在每个所述水平维信号发送周期内，从所述天线端口阵列的所有行中，选择不同的行配置为导频端口；

所述网络侧在每个所述垂直维信号发送周期内，从所述天线端口阵列的所有列中，选择不同的列配置为导频端口。

17. 如权利要求 11 或 12 所述的方法，其特征在于，所述网络侧为水平维导频端口分配的端口号为 15~(15+M-1)；

所述网络侧为垂直维导频端口分配的端口号为 15~(15+N-1)。

18. 如权利要求 1 或 2 所述的方法，其特征在于，所述方法还包括：

所述网络侧向接收端发送所述水平维参考信号和所述垂直维参考信号的配置信息，其中，所述配置信息包括所述水平维参考信号和所述垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

19. 如权利要求 18 所述的方法，其特征在于，所述配置信息还包括指示信息，所述指示信息用于指示所述配置信息中属于水平维参考信号的配置信息和属于垂直维参考信号的配置信息。

20. 如权利要求 18 所述的方法，其特征在于，所述网络侧通过高层信令或物理层控制信令发送所述水平维参考信号和所述垂直维参考信号的配置信息。

21. 一种接收参考信号的方法，其特征在于，该方法包括：

接收端接收来自网络侧发送的导频端口中配置的参考信号，其中，所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号；

所述接收端根据所述水平维参考信号和所述垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息。

22. 如权利要求 21 所述的方法，其特征在于，所述接收端在接收所述导频端口中配置的参考信号之前，所述方法还包括：

所述接收端接收来自所述网络侧发送的所述水平维参考信号和所述垂直维参考信号的配置信息，其中，所述配置信息包括所述水平维参考信号和所述垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

23. 一种发送参考信号的网络侧设备，其特征在于，该网络侧设备包括：

子帧确定模块，用于确定用于承载参考信号的子帧；

参考信号确定模块，用于确定所述参考信号的导频端口；

发送模块，用于在确定的子帧中发送所述导频端口中配置的参考信号；

其中，确定的所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，

Samsung Exhibit 1003, Page 153 of 438

水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

24. 如权利要求 23 所述的网络侧设备，其特征在于，所述水平维参考信号和所述垂直维参考信号为 3GPP 标准中定义的信道状态指示参考信号 CSI-RS。

25. 如权利要求 23 所述的网络侧设备，其特征在于，所述参考信号确定模块具体用于：

在承载所述水平维参考信号的子帧与承载所述垂直维参考信号的子帧为同一子帧时，将天线端口阵列中的所有天线端口配置为导频端口，并将每一行导频端口作为一行水平维导频端口及每一列导频端口作为一列垂直维导频端口，其中，所述天线端口阵列为由小区所支持的天线端口阵列排布形成，其中，天线端口阵列中的行表示水平方向且包含 M 个天线端口，列表示垂直方向且包含 N 个天线端口，M 和 N 均为不小于 1 的正整数；或者

根据所述天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，所述一行导频端口的个数为 M，所述一列导频端口的个数为 N。

26. 如权利要求 24 或 25 所述的网络侧设备，其特征在于，所述参考信号确定模块进一步用于：

若 M×N 不大于 CSI-RS 可配置的最大端口数，将同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置；

其中，所述 CSI-RS 配置包括：CSI-RS 配置的发送周期、子帧偏移量及时频域位置。

27. 如权利要求 24 或 25 所述的网络侧设备，其特征在于，所述参考信号确定模块还用于：

将不同的 CSI-RS 配置分别作为不同行水平维导频端口的参考信号和对应的垂直维导频端口的参考信号的配置；或者

将不同的 CSI-RS 配置作为不同列垂直维导频端口的参考信号和对应的水平维导频端口的参考信号的配置。

28. 如权利要求 24 或 25 所述的网络侧设备，其特征在于，所述参考信号确定模块还用于：

从所述天线端口阵列的所有行中，选择某一行及某一列配置为导频端口；或者

采用固定的天线虚拟化权值进行天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口。

29. 如权利要求 24 或 25 所述的网络侧设备，其特征在于，所述参考信号确定模块具体用于：

若 M+N 不大于 CSI-RS 可配置的最大端口数，将同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置。

30. 如权利要求 24 或 25 所述的网络侧设备，其特征在于，所述参考信号确定模块还用于：

将不同的 CSI-RS 配置分别作为水平维导频端口的参考信号和垂直维导频端口的参考信号的配置。

31. 如权利要求 23 所述的网络侧设备，其特征在于，所述参考信号确定模块还用于：

在承载所述水平维参考信号的子帧与承载所述垂直维参考信号的子帧为不同子帧时，

Samsung Exhibit 1003, Page 154 of 438

根据所述天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，所述一行导频端口的个数为 M，所述一列导频端口的个数为 N。

32. 如权利要求 31 所述的网络侧设备，其特征在于，所述发送模块还用于：

在每个设定的水平维参考信号发送周期内，在承载水平维参考信号的子帧中发送水平维导频端口中配置的参考信号；和 / 或

在每个设定的垂直维参考信号发送周期内，在承载垂直维参考信号的子帧中发送垂直维导频端口中配置的参考信号。

33. 如权利要求 32 所述的网络侧设备，其特征在于，所述参考信号确定模块还用于：

所述网络侧在每个所述水平维信号发送周期内，从所述天线端口阵列的所有行中，选择不同的行配置为导频端口；

所述网络侧在每个所述垂直维信号发送周期内，从所述天线端口阵列的所有列中，选择不同的列配置为导频端口。

34. 如权利要求 23 所述的网络侧设备，其特征在于，所述发送模块还用于：

向接收端发送所述水平维参考信号和所述垂直维参考信号的配置信息，其中，所述配置信息包括所述水平维参考信号和所述垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

35. 一种接收参考信号的接收端设备，其特征在于，所述接收端设备包括：

接收模块，用于接收来自网络侧发送的导频端口中配置的参考信号，其中，导频端口至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号；

信道估计模块，用于根据所述水平维参考信号和所述垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息。

36. 如权利要求 35 所述的接收端设备，其特征在于，所述接收模块还用于：

接收来自所述网络侧发送的所述水平维参考信号和所述垂直维参考信号的配置信息，其中，所述配置信息包括所述水平维参考信号和所述垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

37. 一种传输参考信号的系统，其特征在于，所述系统包括：

网络侧设备，用于确定用于承载参考信号的子帧；从小区所支持的天线端口中，确定用于配置所述参考信号的导频端口；及在确定的子帧中发送导频端口中配置的参考信号；

接收端设备，用于接收来自网络侧设备发送的导频端口中配置的参考信号，并根据所述水平维参考信号和所述垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息；

其中，所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

Samsung Exhibit 1003, Page 155 of 438

一种传输参考信号的方法、装置及系统

技术领域

[0001] 本发明涉及无线通信技术领域，特别涉及一种传输参考信号的方法、装置及系统。

背景技术

[0002] 目前，第三代移动通信标准化伙伴项目（3rd Generation Partnership Project，3GPP）的长期演进（Long Term Evolution，LTE）标准已经大大提高了小区峰值数据速率，但小区边缘速率却远低于小区峰值速率，针对这一问题，展开了大量提高小区边缘用户设备（User Equipment，UE）吞吐量和小区平均吞吐量的研究。

[0003] LTE 系统中，传统的天线（antenna）阵列在垂直方向的半功率波束宽度（Half-Power Beam Width，HPBW）比较窄，且具有固定的下倾角（即对小区内每个用户设备在垂直方向上提供固定的波束），使得相邻小区之间在垂直方向上很难实现波束调度和干扰协调。通过调整天线的下倾角，可以在一定程度上提高系统性能，但是下倾角的调整很缓慢，是一种三维（3 Dimension，3D）波束赋形（Beaming Forming，BF）的过渡方式。

[0004] 3D 波束赋形的技术，根据用户设备的位置为每个用户设备产生具有不同下倾角的细窄波束，在水平方向和垂直方向都进行波束赋形，能够从根本上克服传统天线的不足，提高目标用户的信噪比，从而很大程度地提升了蜂窝系统的性能。目前，业界已出现能够对每行和 / 或每列进行独立控制的有源天线，传统的 2D 天线仅在水平维上有权值端口，在垂直为上没有端口，而有源天线系统中增加了天线垂直方向上的控制端口，能够满足垂直方向上波束赋形的需要，因此，为 3D 波束赋形技术的研究提供必要的硬件支撑。

[0005] 为了支持 3D 波束赋形的传输，需要相应的信道状态信息的反馈，例如，信道质量指示（Channel Quality Indicator，CQI）信息、预编码矩阵指示（Precoding Matrix Indicator，PMI）信息及秩指示（Rank Indication，RI）信息；其中，CQI 信息用于用户调度、调整调制编码方案（Modulation and Coding Scheme，MCS）和 / 或多用户多入多出（Multi User-Multiple Input Multiple Output，MU-MIMO）配对等；PMI 信息用于确定波束赋形、多用户调度和 MU-MIMO 配对等；RI 信息可以用于确定数据传输所使用的层数等。

[0006] 上述信道状态信息都需要基于信道估计进行计算，而对信道进行估计，又需要获取相应的参考信号（Reference Signal，RS）。参考信号也称为导频信号，是由发射端提供给接收端，且用于信道估计或信道探测的一种已知信号。目前 LTE 系统中的用于信道估计的参考信号包括小区专属参考信号（Cell-specific Reference Signals，CRS）和信道状态信息参考信号（Channel State Information-Reference Signals，CSI-RS）。其中，CRS 又称为下行公共参考信号或小区公共导频，可在每一个下行子帧内进行发送。

[0007] 图 1 为现有常规循环前缀（Circular Prefix，CP）模式下的 CRS 映射示意图，每个下行子帧都配置 CRS。图 1 中的 R0、R1、R2 及 R3 分别表示天线端口 0、1、2、3 配置的 CRS。其中，（a）为只存在一个天线端口 0 的情况下，对应的 CRS 配置方式示意图；（b）和（c）为存在两个天线端口 0 和 1 的情况下，对应的 CRS 配置方式示意图；（d）、（e）、（f）和（g）为存在四个天线端口 0、1、2 和 3 的情况下，对应的 CRS 配置方式示意图。对于图 1 中的每个子图

Samsung Exhibit 1003, Page 156 of 438

来说，其纵轴方向表示频域，每一个小格代表一个资源粒子（Resource Element，RE）；横轴方向表示一个子帧，每一个子帧内包括两个时隙（奇数时隙和偶数时隙），每一个时隙内又包括 7 个符号（l=0~6）。

[0008] CSI-RS 是 LTE 系统版本 10（Release 10，Rel-10）中定义的参考信号，其为周期性配置的下行导频，标准中定义 CSI-RS 在端口 15~ 天线端口 22 中发射，现有标准中定义了多种 CSI 配置方式；图 2 为现有 CP 模式下，采用 CSI 配置 0（configuration 0）的 CSI-RS 映射示意图，图 2 中的 R15~R22 分别表示端口 15~ 天线端口 22 配置的 CSI-RS。CSI-RS 的子帧配置如表 1 所示。

[0009]

CSI-RS 子帧配置 I_{CSI-RS}	CSI-RS 周期性 T_{CSI-RS} (subframes)	CSI-RS 子帧补偿 Δ_{CSI-RS} (subframes)
0 ~ 4	5	I_{CSI-RS}
5 ~14	10	$I_{CSI-RS}-5$
15 ~ 34	20	$I_{CSI-RS}-15$
35 ~ 74	40	$I_{CSI-RS}-35$
75 ~ 154	80	$I_{CSI-RS}-75$

[0010] 表 1

[0011] 基于 3D 波束赋形的传输特性，接收端需要对水平维信道和垂直维信道进行信道估计，才能分别计算出水平维信道和垂直维信道对应的 PMI 信息反馈到发射端，进而进行 3D 波束赋形处理。接收端进行信道估计，则需要知道参考信号的配置，即导频信息的配置。而现有的参考信号的配置只包含水平维参考信号的配置，因此，只能支持水平维信道的估计，无法支持垂直维信道的估计，也无法支持 3D 波束赋形。

[0012] 综上所述，现有的参考信号的配置只包含水平维参考信号的配置，因此，只能支持水平维信道的估计，而不能支持垂直维信道的估计，进而无法得到垂直维的信道信息，也无法支持 3D 波束赋形。

发明内容

[0013] 本发明实施例提供了一种传输参考信号的方法、装置及系统，能够发送垂直维参考信号。

[0014] 本发明实施例提供了一种发送参考信号的方法，包括：

[0015] 网络侧确定用于承载参考信号的子帧；

[0016] 所述网络侧确定所述参考信号的导频端口；

[0017] 所述网络侧在确定的子帧中发送所述导频端口中配置的参考信号；

[0018] 其中，确定的所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

[0019] 本发明实施例提供了接收参考信号的方法，包括：

[0020] 接收端接收来自网络侧发送的导频端口中配置的参考信号，其中，所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号；

Samsung Exhibit 1003, Page 157 of 438

[0021] 所述接收端根据所述水平维参考信号和所述垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息。

[0022] 本发明实施例提供了一种发送参考信号的网络侧设备，包括：

[0023] 子帧确定模块，用于确定用于承载参考信号的子帧；

[0024] 导频端口确定模块，用于确定所述参考信号的导频端口；

[0025] 发送模块，用于在确定的子帧中发送所述导频端口中配置的参考信号；

[0026] 其中，确定的所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

[0027] 本发明实施例提供了一种接收参考信号的接收端设备，包括：

[0028] 接收模块，用于接收来自网络侧发送的导频端口中配置的参考信号，其中，导频端口至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号；

[0029] 信道估计模块，用于根据所述水平维参考信号和所述垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息。

[0030] 本发明实施例提供了一种传输参考信号的系统，包括：

[0031] 网络侧设备，用于确定用于承载参考信号的子帧；确定所述参考信号的导频端口；及在确定的子帧中发送所述导频端口中配置的参考信号；

[0032] 接收端设备，用于接收来自网络侧发送的导频端口中配置的参考信号，并根据所述水平维参考信号和所述垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息；

[0033] 其中，所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

[0034] 本发明实施例由于能够发送垂直维参考信号，从而使接收端能够根据垂直维参考信号对垂直维导频端口的信道进行估计，进而可以实现动态 3D 波束赋型技术，提高了小区边缘用户设备吞吐量和平均吞吐量。

附图说明

[0035] 图 1 为背景技术中在 CP 模式下的 CRS 映射示意图；

[0036] 图 2 为背景技术中在 CP 模式下的一种 CSI-RS 映射示意图；

[0037] 图 3 为本发明实施例发送参考信号的方法的流程示意图；

[0038] 图 4A 为本发明实施例水平维参考信号和垂直维参考信号配置在同一子帧示意图；

[0039] 图 4B 为本发明实施例水平维参考信号和垂直维参考信号配置在不同子帧示意图；

[0040] 图 5A 为本发明实施例第一种确定的导频端口的示意图；

[0041] 图 5B 为本发明实施例为第一种确定的导频端口分配端口号的第一实例示意图；

[0042] 图 5C 为本发明实施例为第一种确定的导频端口分配端口号的第二实例示意图；

Samsung Exhibit 1003, Page 158 of 438

[0043] 图 5D 为本发明实施例为第一种确定的导频端口分配端口号的第三实例示意图；

[0044] 图 6A 为本发明实施例第二种确定的导频端口的示意图；

[0045] 图 6B 为本发明实施例为第二种确定的导频端口分配端口号的第一实例示意图；

[0046] 图 6C 为本发明实施例为第二种确定的导频端口分配端口号的第二实例示意图；

[0047] 图 7A~ 图 7B 为本发明实施例周期性配置水平维参考信号的实例示意图；

[0048] 图 8A~ 图 8D 为本发明实施例周期性配置垂直维参考信号的实例示意图；

[0049] 图 9 为本发明实施例接收参考信号的方法的流程示意图；

[0050] 图 10 为本发明实施例发送参考信号的网络侧设备的结构示意图；

[0051] 图 11 为本发明实施例接收参考信号的网络侧设备的结构示意图；

[0052] 图 12 为本发明实施例传输参考信号的系统的结构示意图。

具体实施方式

[0053] 本发明实施例由于能够发送垂直维参考信号，从而可以实现动态 3D 波束赋型技术，提高了小区边缘用户设备吞吐量和平均吞吐量。

[0054] 下面结合说明书附图对本发明实施例作进一步详细描述。

[0055] 如图 3 所示，本发明实施例发送参考信号的方法，包括以下步骤：

[0056] 步骤 31、网络侧确定用于承载参考信号的子帧；

[0057] 步骤 32、网络侧确定参考信号的导频端口；

[0058] 步骤 33、网络侧在确定的子帧中发送导频端口中配置的参考信号；

[0059] 其中，确定的所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

[0060] 需要说明的是，本发明实施例所说的导频端口是指用于配置参考信号的天线端口。

[0061] 进一步，小区所支持的天线端口呈阵列排布，其中，天线端口阵列中的行表示水平方向且包含 M 个天线端口，列表示垂直方向且包含 N 个天线端口，M 和 N 均为不小于 1 的正整数。

[0062] 优选的，M 的取值集合为 {1, 2, 4, 8}，N 的取值集合为 {1, 2, 4, 8}。

[0063] 优选的，本发明实施例中的水平维参考信号和所述垂直维参考信号为 3GPP 标准中定义的信道状态指示参考信号 CSI-RS。

[0064] 进一步，步骤 31 中网络侧确定用于承载参考信号的子帧包括以下两种方式：

[0065] 方式一：用于承载水平维参考信号的子帧和用于承载垂直维参考信号的子帧为同一个子帧，如图 4A 所示；

[0066] 优选的，水平维参考信号和垂直维参考信号可以采用周期性配置或触发配置；其中，则水平维参考信号和垂直维参考信号的发送周期，及确定的用于承载水平维参考信号和垂直维参考信号的子帧，可由网络侧和接收端双方约定，也可以由网络侧通过高层信令或物理层控制信令通知给接收端；

[0067] 若水平维参考信号和垂直维参考信号采用周期性配置，则网络侧可以在第一次发送参考信号之前，通知接收端该水平维参考信号和垂直维参考信号的发发送周期和子帧偏

Samsung Exhibit 1003, Page 159 of 438

移量；

[0068] 若水平维参考信号和垂直维参考信号采用触发配置，则网络侧可以在每次发送参考信号之前，通知接收端用于承载水平维参考信号和垂直维参考信号的子帧。

[0069] 方式二：用于承载水平维参考信号的子帧和用于承载垂直维参考信号的子帧为不同的子帧，如图 4B 所示；

[0070] 进一步，水平维参考信号和垂直维参考信号分别配置在不同子帧的相同或不同频域资源上。

[0071] 优选的，水平维参考信号和 / 或垂直维参考信号可以采用周期性配置，也可以采用触发配置；

[0072] 若水平维参考信号和 / 或垂直维参考信号采用周期性配置，水平维参考信号发送周期和 / 或垂直维参考信号发送周期，可由网络侧和接收端双方约定，也可以由网络侧通过高层信令或物理层控制信令通知给接收端；

[0073] 若水平维参考信号和 / 或垂直维参考信号采用触发配置，用于承载水平维参考信号的子帧和用于承载垂直维参考信号的子帧，可由网络侧和接收端双方约定，也可以由网络侧通过高层信令或物理层控制信令通知给接收端；

[0074] 水平维参考信号发送周期与垂直维参考信号发送周期包括下列三种情况：

[0075] 一、水平维参考信号发送周期与垂直维参考信号发送周期相同；

[0076] 二、垂直维参考信号发送周期是水平维参考信号发送周期的 J 倍，其中，J 为不小于 1 的正整数；J 可以是固定值，也可以是从给定取值集合中选取的值；

[0077] 需要说明的是，J 的值可由网络侧和接收端双方约定，也可以由网络侧通过高层信令或物理层控制信令通知给接收端；

[0078] 三、水平维参考信号发送周期是垂直维参考信号发送周期的 K 倍，其中，K 为不小于 1 的正整数；K 可以是固定值，也可以是从给定取值集合中选取的值；

[0079] 需要说明的是，K 的值可由网络侧和接收端双方约定，也可以由网络侧通过高层信令或物理层控制信令通知给接收端。

[0080] 若水平维参考信号和 / 或垂直维参考信号采用周期性配置，则网络侧可以在第一次发送参考信号之前，通知接收端该水平维参考信号和 / 或垂直维参考信号的发送周期和子帧偏移量；

[0081] 若水平维参考信号和 / 或垂直维参考信号采用触发配置，则网络侧可以在每次发送参考信号之前，通知接收端为水平维参考信号和 / 或垂直维参考信号配置的子帧。

[0082] 需要说明的是，为了兼容现有的 3GPP 标准，本发明实施例中水平维参考信号可以采用 3GPP 36.211 标准中定义的 CSI-RS 的配置，而垂直维参考信号可以采用周期性配置或触发配置，优选的，网络侧可以在每个下行子帧内都配置垂直维参考信号。

[0083] 具体的，垂直维参考信号采用周期性配置时，垂直维参考信号的子帧配置可以重用 3GPP 36.211 标准中的 CSI-RS 配置以确定垂直维参考信号的发送周期、子帧偏移及时频域位置；

[0084] 垂直维参考信号的发送周期和子帧偏移可以独立配置，也可以和水平维参考信号进行联合配置，例如，如为了避免在同一子帧配置，垂直维参考信号的子帧偏移可设置为与水平维参考信号的子帧偏移不同。

Samsung Exhibit 1003, Page 160 of 438

[0085] 下面分为两种情况对步骤 32 中确定参考信号的导频端口进行详细说明，其中，确定的水平维导频端口的端口号及水平维参考信号的 CSI-RS 配置和垂直维导频端口的端口号及垂直维参考信号的 CSI-RS 配置，可由网络侧与接收端双方约定，也可以由网络侧通过高层信令或物理层控制信令通知给接收端。

[0086] 第一种情况、承载水平维参考信号的子帧与承载垂直维参考信号的子帧为同一子帧，步骤 32 根据以下方式中一种确定参考信号的导频端口：

[0087] 方式 A、网络侧将天线端口阵列中的所有天线端口都配置为导频端口，并将每一行导频端口作为一行水平维导频端口及每一列导频端口作为一列垂直维导频端口，如图 5A 所示，以天线端口阵列中每行包括 4 个天线端口，每列包括 2 个天线端口为例，则确定的导频端口的个数为 8；

[0088] 进一步，若 M×N 小于 3GPP 标准中定义的 CSI-RS 可配置的最大端口数，方式 A 又包括以下三种方式：

[0089] 方式 A1、网络侧将同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置；其中，CSI-RS 配置包括：CSI-RS 配置的发送周期、子帧偏移量及时频域位置。

[0090] 其中，网络侧可以从 3GPP 标准中定义的 CSI-RS 可配置的端口号中选择不同的端口号分配给每个导频端口，3GPP 标准中定义的用于配置 CSI-RS 的天线端口为端口 15~ 端口 22。

[0091] 具体的，网络侧可以从端口号 15~22 中任意选取 M×N 个，分别作为每个导频端口的端口号。

[0092] 本发明实施例中采用的 CSI-RS 配置是现有 3GPP 36.211 协议中定义的，3GPP 36.211 协议中定义了多种 CSI-RS 配置，此处不再赘述。

[0093] 优选的，网络侧为导频端口分配的端口号为 15~(15+M×N-1)。

[0094] 进一步，水平维导频端口和垂直维导频端口的排列方式优选为以下两种形式：

[0095] 第一种排列方式：第 i 行水平维导频端口的端口号分别为 15+(i-1)×M~15+i×M-1，其中，i 为整数，且 i 的取值为 1~N；相应的，每一列垂直维导频端口的端口号是根据每行水平维导频端口确定的，即：第一列垂直维导频端口的端口号依次为 15、(15+M)、(15+2M)、……、(15+（N-1）×M)，第二列垂直维导频端口的端口号依次为(15+1)、(15+1+M)、(15+1+2M)，……，(15+1+（N-1）×M) ……，以此类推，确定所有列垂直维导频端口；

[0096] 以图 5A 所示的导频端口为例进行说明，网络侧为导频端口配置的端口号如图 5B 所示，则网络侧确定导频端口 15、导频端口 16、导频端口 17 和导频端口 18 为第一行水平维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定导频端口 15、导频端口 16、导频端口 17 和导频端口 18 的参考信号为第一行水平维参考信号，并根据第一行水平维参考信号估计第一行水平维导频端口的信道信息；其他行水平维导频端口类似，此处不再赘述；

[0097] 网络侧确定导频端口 15 和导频端口 19 为第一列垂直维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定导频端口 15 和导频端口 19 的参考信号为第一列垂直维参考信号，并根据第一列垂直维参考信号估计第一列垂直维导频端口的信

Samsung Exhibit 1003, Page 161 of 438

道信息；其他列垂直维导频端口类似，此处不再赘述。

[0098] 第二种排列方式：第 j 列垂直维导频端口的端口号分别为 15+(j-1)×N~15+j×N-1，其中，j 为整数，且 j 的取值为 1~M；相应的，每行水平维导频端口的端口号是根据每列垂直维导频端口的端口号确定的，即：第一行水平维导频端口的端口号依次为 15、(15+N)、(15+2N)、……、(15+（M-1）×N)；第二行水平维导频端口的端口号依次为(15+1)、(15+1+N)、(15+1+2N)、……、(15+1+（M-1）×N)，以此类推，以确定所有行水平维导频端口。

[0099] 当然，除了上述两种优选的排列方式，水平维导频端口和垂直维导频端口还可以采用其他排列方式，如随机排列等；其中，水平维导频端口和垂直维导频端口的排列方式可以是由网络侧和接收端双方约定的，也可以是由网络侧确定，并通过高层信令或物理层控制信令等通知给接收端。

[0100] 方式 A2、网络侧将不同的 CSI-RS 配置分别作为不同行水平维导频端口的参考信号和对应的垂直维导频端口的参考信号的配置。

[0101] 其中，网络侧可以为每一行导频端口分配相同的端口号，则同一列导频端口的端口号相同。

[0102] 具体的，网络侧可以从端口号 15~22 中任意选取 M 个，分别作为每一行导频端口的端口号。

[0103] 优选的，网络侧为每一行导频端口分配的端口号为 15~(15+M-1)，其中，每一行水平维导频端口的端口号为 15~(15+M-1)，则第 j 列垂直维导频端口的端口号都为 (15+j-1)，j 为整数，且 j 的取值为 1~M，即：第一种 CSI-RS 配置的端口 15、第二种 CSI-RS 配置的端口 15、……、第 M 种 CSI-RS 配置的端口 15 为第一列垂直维导频端口；第一种 CSI-RS 配置的端口 16、第二种 CSI-RS 配置的端口 16、……、第 M 种 CSI-RS 配置的端口 16 为第二列垂直维导频端口；以此类推，以得到所有列垂直维导频端口。

[0104] 仍以图 5A 所示的导频端口为例进行说明，网络侧为导频端口配置的端口号如图 5C 所示，则网络侧确定第一种 CSI-RS 配置的导频端口 15、导频端口 16、导频端口 17 和导频端口 18 为第一行水平维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定第一种 CSI-RS 配置的导频端口 15、导频端口 16、导频端口 17 和导频端口 18 的参考信号为第一行水平维参考信号，并根据第一行水平维参考信号估计第一行水平维导频端口的信道信息；其他行水平维导频端口类似，此处不再赘述；

[0105] 网络侧确定第一种 CSI-RS 配置的导频端口 15 和第二种 CSI-RS 配置的导频端口 15 为第一列垂直维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定第一种 CSI-RS 配置的导频端口 15 和第二种 CSI-RS 配置的导频端口 15 的参考信号为第一列垂直维参考信号，并根据第一列垂直维参考信号估计第一列垂直维导频端口的信道信息；其他列垂直维导频端口类似，此处不再赘述。

[0106] 当然，导频端口配置的端口号的分配还可以采用其他方式，如随机分配等；其中，水平维导频端口和垂直维导频端口的排列方式可以是由网络侧和接收端双方约定的，也可以是由网络侧确定，并通过高层信令或物理层控制信令等通知给接收端。

[0107] 方式 A3、网络侧将不同的 CSI-RS 配置作为不同列垂直维导频端口的参考信号和对应的水平维导频端口的参考信号的配置。

Samsung Exhibit 1003, Page 162 of 438

[0108] 其中，网络侧可以为每一列导频端口分配相同的端口号，则同一行导频端口的端口号相同。

[0109] 具体的，网络侧可以从端口号 15~22 中任意选取 N 个，分别作为每一列导频端口的端口号。

[0110] 优选的，网络侧为每一列导频端口分配的端口号为 15~(15+N-1)，其中，每一列垂直维导频端口的端口号为 15~(15+N-1)，则第 i 行水平维导频端口的端口号都为 (15+i-1)，i 为整数，且 i 的取值为 1~N，即：第一种 CSI-RS 配置的端口 15、第二种 CSI-RS 配置的端口 15、……、第 N 种 CSI-RS 配置的端口 15 为第一行水平维导频端口；第一种 CSI-RS 配置的端口 16、第二种 CSI-RS 配置的端口 16、……、第 N 种 CSI-RS 配置的端口 16 为第二行水平维导频端口；以此类推，得到所有行水平维导频端口。

[0111] 仍以图 5A 所示的导频端口为例进行说明，网络侧为导频端口配置的端口号如图 5D 所示，则网络侧确定第一种 CSI-RS 配置的导频端口 15 和导频端口 16 为第一列垂直维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定第一种 CSI-RS 配置的导频端口 15 和导频端口 16 的参考信号为第一列垂直维参考信号，并根据第一列垂直维参考信号估计第一列垂直维导频端口的信道信息；其他列垂直维导频端口类似，此处不再赘述；

[0112] 网络侧确定第一种 CSI-RS 配置的导频端口 15、第二种 CSI-RS 配置的导频端口 15、第三种 CSI-RS 配置的导频端口 15 及第四种 CSI-RS 配置的导频端口 15 为第一行水平维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定第一种 CSI-RS 配置的导频端口 15、第二种 CSI-RS 配置的导频端口 15、第三种 CSI-RS 配置的导频端口 15 及第四种 CSI-RS 配置的导频端口 15 的参考信号为第一行水平维参考信号，并根据第一行水平维参考信号估计第一行水平维导频端口的信道信息；其他行水平维导频端口类似，此处不再赘述。

[0113] 当然，导频端口配置的端口号的分配还可以采用其他方式，如随机分配等；其中，水平维导频端口和垂直维导频端口的排列方式可以是由网络侧和接收端双方约定的，也可以是由网络侧确定，并通过高层信令或物理层控制信令等通知给接收端。

[0114] 进一步，若 M×N 大于 CSI-RS 可配置的最大端口数，则网络侧可根据方式 A2 和方式 A3 确定水平维导频端口和垂直维导频端口。

[0115] 方法 B、网络侧根据天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，一行导频端口的个数为 M，一列导频端口的个数为 N，共需要 M+N 个导频端口，如图 6A 所示，以虚拟化处理后得到的一行导频端口的个数为 4 个，一列导频端口的个数为 2，则确定的导频端口的个数 6 个。

[0116] 进一步，网络侧采用天线虚拟化处理包括以下两种方式：

[0117] 方式 1、网络侧从天线端口阵列中，选择某一行及某一列配置为导频端口；或者

[0118] 方式 2、网络侧采用固定的天线虚拟化权值进行天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口。

[0119] 进一步，若 M+N 不大于 3GPP 标准中定义的 CSI-RS 可配置的最大端口数，方式 B 又包括以下两种方式：

Samsung Exhibit 1003, Page 163 of 438

[0120] 方式 B1、网络侧将同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置。

[0121] 其中，网络侧可以为每个导频端口分配不相同的端口号。

[0122] 具体的，网络侧可以从端口号 15~22 中任意选取 M+N 个，分别作为每个导频端口的端口号。

[0123] 优选的，网络侧为导频端口分配的端口号为 15~(15+M×N-1)。

[0124] 以图 6A 所示的导频端口为例进行说明，网络侧为导频端口配置的端口号如图 6B 所示，则网络侧确定导频端口 15、导频端口 16、导频端口 17 和导频端口 18 为水平维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定导频端口 15、导频端口 16、导频端口 17 和导频端口 18 的 CSI-RS 为一行水平维参考信号，并根据该行水平维参考信号估计该行水平维导频端口的信道信息；

[0125] 网络侧确定导频端口 19 和导频端口 20 为第一列垂直维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定导频端口 19 和导频端口 20 的参考信号为一列垂直维参考信号，并根据该列垂直维参考信号估计该列垂直维导频端口的信道信息。

[0126] 当然，导频端口配置的端口号的分配还可以采用其他方式，如随机分配等；其中，水平维导频端口和垂直维导频端口的排列方式可以是由网络侧和接收端双方约定的，也可以是由网络侧确定，并通过高层信令或物理层控制信令等通知给接收端。

[0127] 方式 B2、网络侧将不同的 CSI-RS 配置分别作为水平维导频端口的参考信号和垂直维导频端口的参考信号的配置。

[0128] 其中，网络侧可以从端口号 15~22 中任意选取 M 个分别作为水平维导频端口的端口号，从端口号 15~22 中任意选取 N 个分别作为每个垂直维导频端口的端口号。

[0129] 优选的，网络侧为水平维导频端口分配的端口号为 15~(15+M-1)，且为垂直维导频端口分配的端口号为 15~(15+N-1)。

[0130] 仍以图 6A 所示的导频端口为例进行说明，网络侧为导频端口配置的端口号如图 6C 所示，假设网络侧为水平维参考信号配置的 CSI-RS 配置为第一种 CSI-RS 配置，为垂直维参考信号配置的 CSI-RS 配置为第二种 CSI-RS 配置，则网络侧确定第一种 CSI-RS 配置的导频端口 15、导频端口 16、导频端口 17 和导频端口 18 为水平维导频端口，并根据该行水平维参考信号估计该行水平维导频端口的信道信息；

[0131] 网络侧确定第二种 CSI-RS 配置的导频端口 15 和导频端口 16 为垂直维导频端口，相应的，接收端在接收到每个导频端口中配置的参考信号后，确定导频端口 15 和导频端口 16 的参考信号为垂直维参考信号，并根据该列垂直维参考信号估计该列垂直维导频端口的信道信息。

[0132] 当然，导频端口配置的端口号的分配还可以采用其他方式，此处不再一一举例；其中，水平维导频端口和垂直维导频端口的排列方式可以是由网络侧和接收端双方约定的，也可以是由网络侧确定，并通过高层信令或物理层控制信令等通知给接收端。

[0133] 第二种情况、承载水平维参考信号的子帧与承载垂直维参考信号的子帧为不同子帧，步骤 32 具体包括：

[0134] 网络侧根据天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考

Samsung Exhibit 1003, Page 164 of 438

信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，一行导频端口的个数为 M，一列导频端口的个数为 N。

[0135] 其中，网络侧可以从端口号 15~22 中任意选取 M 个，分别作为每个水平维导频端口的端口号；

[0136] 网络侧可以从端口号 15~22 中任意选取 N 个，分别作为每个垂直维导频端口的端口号。

[0137] 优选的，网络侧为水平维导频端口分配的端口号为 15~(15+M-1)；网络侧为垂直维导频端口分配的端口号为 15~(15+N-1)。

[0138] 需要说明的是，水平维导频端口和垂直维导频端口的端口号可以是由网络侧和接收端双方约定的，也可以是由网络侧确定，并通过高层信令或物理层控制信令等通知给接收端。

[0139] 优选的，步骤 33 中网络侧在确定的子帧中发送导频端口中配置的参考信号包括：

[0140] 网络侧在每个设定的水平维参考信号发送周期内，在承载水平维参考信号的子帧中发送水平维导频端口中配置的参考信号；和 / 或

[0141] 网络侧在每个设定的垂直维参考信号发送周期内，在承载垂直维参考信号的子帧中发送垂直维导频端口中配置的参考信号。

[0142] 进一步，垂直维参考信号发送周期与水平维参考信号发送周期相同；或者

[0143] 垂直维参考信号发送周期为水平维参考信号发送周期的 J 倍，其中，J 为不小于 1 的整数；或者

[0144] 水平维参考信号发送周期为垂直维参考信号发送周期的 K 倍，其中，K 为不小于 1 的整数。

[0145] 进一步，步骤 32 中网络侧确定水平维导频端口和垂直维导频端口又包括以下方法的一种或组合：

[0146] 方法 1、在每个水平维信号发送周期内，从天线端口阵列的所有行中，选择不同的行配置为导频端口；

[0147] 例如，在第一个水平维参考信号发射周期内，选择天线端口阵列中的第一行配置为水平维导频端口，如图 7A 所示，相应的，接收端根据在第一个水平维参考信号发射周期内接收到的水平维导频端口中配置的参考信号，进行水平维导频端口的信道估计；在第二个水平维参考信号发射周期内，选择天线端口阵列中的第二行配置为水平维导频端口，如图 7B 所示，相应的，接收端根据在第二个水平维参考信号发射周期内接收到的水平维导频端口中配置的参考信号，进行水平维导频端口的信道估计，以遍历所有水平维信道；其中，对天线阵列中的第一行和第二行对应的水平维参考信号进行配置时，可以配置在相同的资源，也可以配置在不同的资源。

[0148] 方法 2、在每个垂直维信号发送周期内，从天线端口阵列的所有列中，选择不同的列配置为导频端口。

[0149] 例如，在第一个垂直维参考信号发射周期内，选择天线端口阵列中的第一列配置为垂直维导频端口，如图 8A 所示，相应的，接收端根据在第一个垂直维参考信号发射周期内接收到的垂直维导频端口中配置的参考信号，进行垂直维导频端口的信道估计；在第二个垂直维参考信号发射周期内，选择天线端口阵列中的第二列配置为垂直维导频端口，如

Samsung Exhibit 1003, Page 165 of 438

图 8B 所示，相应的，接收端根据在第二个垂直维参考信号发射周期内接收到的垂直维导频端口中配置的参考信号，进行垂直维导频端口的信道估计；在第三个垂直维参考信号发射周期内，选择天线端口阵列中的第三列配置为垂直维导频端口，如图 8C 所示，相应的，接收端根据在第三个垂直维参考信号发射周期内接收到的垂直维导频端口中配置的参考信号，进行垂直维导频端口的信道估计；在第四个垂直维参考信号发射周期内，选择天线端口阵列中的第四列配置为垂直维导频端口，如图 8D 所示，相应的，接收端根据在第四个垂直维参考信号发射周期内接收到的垂直维导频端口中配置的参考信号，进行垂直维导频端口的信道估计，以遍历所有垂直维信道；其中，对天线阵列中的每一列对应的垂直维参考信号进行配置时，可以配置在相同的资源，也可以配置在不同的资源。

[0150] 当然，网络侧还可以采用触发配置，在每个水平维信号发送周期内，从天线端口阵列的所有行中，选择同一行或不同的行配置为导频端口；在每个垂直维信号发送周期内，从天线端口阵列的所有列中，选择同一列或不同的列配置为导频端口。

[0151] 优选的，本发明实施例在步骤 32 之后，且在步骤 33 之前还包括：

[0152] 网络侧向接收端发送水平维参考信号和垂直维参考信号的配置信息，以指示接收端根据水平维参考信号和垂直维参考信号的配置信息确定对应的水平维参考信号和垂直维参考信号，其中，配置信息包括水平维参考信号和垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

[0153] 具体的，在周期性配置情况下，配置信息包括但不限于下列信息中的一种或组合：

[0154] 水平维参考信号和垂直维参考信号的导频端口设置、导频图样(pattern)、发送周期及子帧偏移量等；

[0155] 在触发配置情况下，配置信息包括但不限于下列信息中的一种或组合：

[0156] 水平维参考信号和垂直维参考信号的导频端口设置、导频图样以及发送水平维参考信号和垂直维参考信号的子帧号或触发条件。

[0157] 优选的，网络侧通过高层信令或物理层控制信令发送水平维参考信号和垂直维参考信号的配置信息。

[0158] 优选的，该配置信息还包括指示信息，该指示信息用于指示所述配置信息中属于水平维参考信号的配置信息和属于垂直维参考信号的配置信息；

[0159] 当然，该配置信息中也可以不包含该指示信息，接收端设备收到两个维度的参考信号配置信息即可。

[0160] 参见图 9，本发明实施例提供的一种接收参考信号的方法，该方法包括：

[0161] 步骤 91、接收端接收来自网络侧发送的导频端口中配置的参考信号，其中，所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号；

[0162] 步骤 92、接收端根据水平维参考信号和垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息。

[0163] 由于水平维参考信号的配置和垂直维参考信号的配置与网络侧相同，此处不再赘述。

[0164] 进一步，步骤 91 之前，方法还包括：

Samsung Exhibit 1003, Page 166 of 438

[0165] 接收端接收来自网络侧发送的水平维参考信号和垂直维参考信号的配置信息，其中，配置信息包括水平维参考信号和垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

[0166] 基于同一发明构思，本发明实施例中还提供了一种发送参考信号的网络侧设备，由于该网络侧设备解决问题的原理与上述发送参考信号的方法相似，因此该网络侧设备的实施可以参见方法的实施，重复之处不再赘述。

[0167] 参见图 10，本发明实施例提供的一种发送参考信号的网络侧设备，包括：

[0168] 子帧确定模块 101，用于确定用于承载参考信号的子帧；

[0169] 导频端口确定模块 102，用于确定参考信号的导频端口；

[0170] 发送模块 103，用于在确定的子帧中发送导频端口中配置的参考信号；

[0171] 其中，确定的所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

[0172] 优选的，导频端口确定模块具体 102 用于：

[0173] 在承载水平维参考信号的子帧与承载垂直维参考信号的子帧为同一子帧时，将天线端口阵列中的所有天线端口配置为导频端口，并将每一行导频端口作为一行水平维导频端口及每一列导频端口作为一列垂直维导频端口；或者

[0174] 根据天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，一行导频端口的个数为 M，一列导频端口的个数为 N。

[0175] 优选的，导频端口确定模块 102 进一步用于：

[0176] 若 M×N 不大于 3GPP 标准中定义的 CSI-RS 可配置的最大端口数，将同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置；

[0177] 其中，CSI-RS 配置包括：CSI-RS 的发送周期、子帧偏移量及时频域位置。

[0178] 优选的，导频端口确定模块 102 还用于：

[0179] 将不同的 CSI-RS 配置分别作为不同行水平维导频端口的参考信号和对应的垂直维导频端口的参考信号的配置；或者

[0180] 将不同的 CSI-RS 配置作为不同列垂直维导频端口的参考信号和对应的水平维导频端口的参考信号的配置。

[0181] 优选的，导频端口确定模块 102 还用于：

[0182] 从天线端口阵列的所有行中，选择某一行及某一列配置为导频端口；或者

[0183] 采用固定的天线虚拟化权值进行天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口。

[0184] 优选的，导频端口确定模块 102 具体用于：

[0185] 若 M+N 不大于 3GPP 标准中定义的 CSI-RS 可配置的最大端口数，且为每个导频端口分配的端口号都不相同时，将同一种 CSI-RS 配置作为每一个水平维导频端口的参考信号和每一个垂直维导频端口的参考信号的配置。

[0186] 优选的，导频端口确定模块 102 还用于：

Samsung Exhibit 1003, Page 167 of 438

[0187] 将不同的CSI-RS配置分别作为水平维导频端口的参考信号和垂直维导频端口的参考信号的配置。

[0188] 优选的，导频端口确定模块102还用于：

[0189] 在承载水平维参考信号的子帧与承载垂直维参考信号的子帧为不同子帧时，根据天线端口阵列，采用天线虚拟化处理，得到一行和一列需要配置参考信号的导频端口，并将该行导频端口作为水平维导频端口及该列导频端口作为垂直维导频端口；其中，一行导频端口的个数为M，一列导频端口的个数为N。

[0190] 优选的，发送模块103还用于：

[0191] 在每个设定的水平维参考信号发送周期内，在承载水平维参考信号的子帧中发送水平维导频端口中配置的参考信号；和/或

[0192] 在每个设定的垂直维参考信号发送周期内，在承载垂直维参考信号的子帧中发送垂直维导频端口中配置的参考信号。

[0193] 优选的，导频端口确定模块102还用于：

[0194] 网络侧在每个水平维信号发送周期内，从天线端口阵列的所有行中，选择不同的行配置为导频端口；

[0195] 网络侧在每个垂直维信号发送周期内，从天线端口阵列的所有列中，选择不同的列配置为导频端口。

[0196] 优选的，发送模块103还用于：

[0197] 向接收端发送水平维参考信号和垂直维参考信号的配置信息，其中，配置信息包括水平维参考信号和垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

[0198] 基于同一发明构思，本发明实施例中还提供了一种接收参考信号的接收端设备，由于该接收端设备解决问题的原理与上述接收参考信号的方法相似，因此该接收端设备的实施可以参见接收参考信号的方法的实施，重复之处不再赘述。

[0199] 参见图11，本发明实施例提供的一种接收参考信号的接收端设备，包括：

[0200] 接收模块111，用于接收来自网络侧发送的导频端口中配置的参考信号，其中，导频端口至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号；

[0201] 信道估计模块112，用于根据水平维参考信号和垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息。

[0202] 优选的，接收模块111还用于：

[0203] 接收来自网络侧发送的水平维参考信号和垂直维参考信号的配置信息，其中，配置信息包括水平维参考信号和垂直维参考信号的子帧配置和水平维导频端口和垂直维导频端口的配置。

[0204] 其中，本发明实施例的网络侧设备可以是基站、低功率发送节点等；接收端设备可以是UE、中继等。

[0205] 基于同一发明构思，本发明实施例中还提供了一种传输参考信号的系统，由于该系统解决问题的原理与上述接收和发送参考信号的方法相似，因此该系统的实施可以参见上述方法的实施，重复之处不再赘述。

Samsung Exhibit 1003, Page 168 of 438

[0206] 参见图 12，本发明实施例提供的一种传输参考信号的系统，包括：

[0207] 网络侧设备 120，用于确定用于承载参考信号的子帧，确定参考信号的导频端口，及在确定的子帧中发送导频端口中配置的参考信号；

[0208] 接收端设备 130，用于接收来自网络侧设备 120 发送的导频端口中配置的参考信号，并根据水平维参考信号和垂直维参考信号，分别估计水平维导频端口的信道信息和垂直维导频端口的信道信息；

[0209] 其中，所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号。

[0210] 下面列举几个具体实例：

[0211] 实施例 1：水平维参考信号和垂直维参考信号配置在不同的子帧，且均采用周期性配置，重用 CSI-RS 参考信号（即采用 3GPP 标准中定义的 CSI-RS 的配置信息，如发射周期、子帧偏移量等配置信息）对水平维参考信号和垂直维参考信号进行配置，水平维参考信号和垂直维参考信号可以映射到相同或不同的频域资源；假设水平维参考信号和垂直维参考信号配置相同的发射周期 P 和不同的子帧偏移量 Δ_H（水平维参考信号的子帧偏移量）、Δ_V（垂直维参考信号的子帧偏移量）；

[0212] 则在第 $n+\Delta_H$ 个子帧配置水平维参考信号，在第 $n+\Delta_V$ 个子帧配置垂直维参考信号，在第 $n+P+\Delta_V$ 个子帧配置水平维参考信号，在第 $n+P+\Delta_V$ 个子帧配置垂直维参考信号，……，依次类推；其中，n 为正整数；

[0213] 水平维导频端口可以采用固定的天线虚拟化权值确定，也可以选取该天线阵列中的任一行作为水平维导频端口；同样的，垂直维导频端口可以采用固定的天线虚拟化权值确定，也可以选取天线阵列中的任一列作为垂直维导频端口。

[0214] 网络侧通知接收端水平维参考信号和垂直维参考信号的配置信息，该配置信息包括水平维参考信号和垂直维参考信号的资源配置和子帧配置的信息，还可以包括用于指示属于水平维参考信号的配置信息和属于垂直维参考信号的配置信息的指示信息。

[0215] 实施例 2：水平维参考信号和垂直维参考信号采用周期性配置，重用 CSI-RS 参考信号，水平维参考信号和垂直维参考信号采用相同或不同的频域资源；假设水平维参考信号和垂直维参考信号配置不同的发射周期和相同的子帧偏移量，即水平维参考信号的发送周期为 P_H、垂直维参考信号的发送周期为 P_V、及子帧偏移量为 Δ，其中，$P_V=KP_H$，K 为正整数；

[0216] 则在第 $n+\Delta$ 个子帧配置水平维参考信号，在第 $n+P_H+\Delta$ 个子帧配置水平维参考信号，……，在第 $n+KP_H+\Delta$ 个子帧同时配置水平维参考信号和垂直维参考信号，依次类推；

[0217] 水平维导频端口可以采用固定的天线虚拟化权值确定，也可以选取该天线阵列中的任一行作为水平维导频端口；同样的，垂直维导频端口可以采用固定的天线虚拟化权值确定，也可以选取天线阵列中的任一列作为垂直维导频端口。

[0218] 网络侧通知接收端水平维参考信号和垂直维参考信号的配置信息，该配置信息包括水平维参考信号和垂直维参考信号的资源配置和子帧配置的信息，还可以包括用于指示属于水平维参考信号的配置信息和属于垂直维参考信号的配置信息的指示信息。

[0219] 实施例 3：水平维参考信号和垂直维参考信号配置在不同子帧，且均采用周期性配置，重用 CSI-RS 参考信号，水平维参考信号和垂直维参考信号采用相同或不同的频域资

Samsung Exhibit 1003, Page 169 of 438

源；假设水平维参考信号和垂直维参考信号配置不同的发射周期和不同的子帧偏移量，即水平维参考信号的发射周期为 P_H、垂直维参考信号的发射周期为 P_V、水平维参考信号的子帧偏移量为 Δ_H、垂直维参考信号的子帧偏移量为 Δ_V，其中，$P_V=KP_H$，K 为正整数；

[0220] 则在第 $n+\Delta_H$ 个子帧配置水平维参考信号，在第 $n+P_H+\Delta_H$ 个子帧配置水平维参考信号，…，在第 $n+KP_H+\Delta_H$ 个子帧配置水平维参考信号，在第 $n+KP_H+\Delta_V$ 个子帧配置垂直维参考信号，依次类推；其中，n 为正整数；

[0221] 水平维导频端口可以采用固定的天线虚拟化权值确定，也可以选取天线阵列中的任一行作为水平维导频端口；同样的，垂直维导频端口可以是采用固定的天线虚拟化权值确定，也可以选取天线阵列中的任一列作为垂直维导频端。

[0222] 网络侧通知接收端水平维参考信号和垂直维参考信号的配置信息，该配置信息包括水平维参考信号和垂直维参考信号的资源配置和子帧配置的信息，还可以包括用于指示属于水平维参考信号的配置信息和属于垂直维参考信号的配置信息的指示信息。

[0223] 本领域内的技术人员应明白，本发明的实施例可提供为方法、系统、或计算机程序产品。因此，本发明可采用完全硬件实施例、完全软件实施例、或结合软件和硬件方面的实施例的形式。而且，本发明可采用在一个或多个其中包含有计算机可用程序代码的计算机可用存储介质（包括但不限于磁盘存储器、CD-ROM、光学存储器等）上实施的计算机程序产品的形式。

[0224] 本发明是参照根据本发明实施例的方法、设备（系统）、和计算机程序产品的流程图和 / 或方框图来描述的。应理解可由计算机程序指令实现流程图和 / 或方框图中的每一流程和 / 或方框、以及流程图和 / 或方框图中的流程和 / 或方框的结合。可提供这些计算机程序指令到通用计算机、专用计算机、嵌入式处理机或其他可编程数据处理设备的处理器以产生一个机器，使得通过计算机或其他可编程数据处理设备的处理器执行的指令产生用于实现在流程图一个流程或多个流程和 / 或方框图一个方框或多个方框中指定的功能的装置。

[0225] 这些计算机程序指令也可存储在能引导计算机或其他可编程数据处理设备以特定方式工作的计算机可读存储器中，使得存储在该计算机可读存储器中的指令产生包括指令装置的制造品，该指令装置实现在流程图一个流程或多个流程和 / 或方框图一个方框或多个方框中指定的功能。

[0226] 这些计算机程序指令也可装载到计算机或其他可编程数据处理设备上，使得在计算机或其他可编程设备上执行一系列操作步骤以产生计算机实现的处理，从而在计算机或其他可编程设备上执行的指令提供用于实现在流程图一个流程或多个流程和 / 或方框图一个方框或多个方框中指定的功能的步骤。

[0227] 尽管已描述了本发明的优选实施例，但本领域内的技术人员一旦得知了基本创造性概念，则可对这些实施例作出另外的变更和修改。所以，所附权利要求意欲解释为包括优选实施例以及落入本发明范围的所有变更和修改。

[0228] 本发明实施例由于能够发送垂直维参考信号，从而可以实现动态 3D 波束赋型技术，提高了小区边缘用户设备吞吐量和平均吞吐量。

[0229] 显然，本领域的技术人员可以对本发明进行各种改动和变型而不脱离本发明的精神和范围。这样，倘若本发明的这些修改和变型属于本发明权利要求及其等同技术的范围

Samsung Exhibit 1003, Page 170 of 438

之内，则本发明也意图包含这些改动和变型在内。

Samsung Exhibit 1003, Page 171 of 438

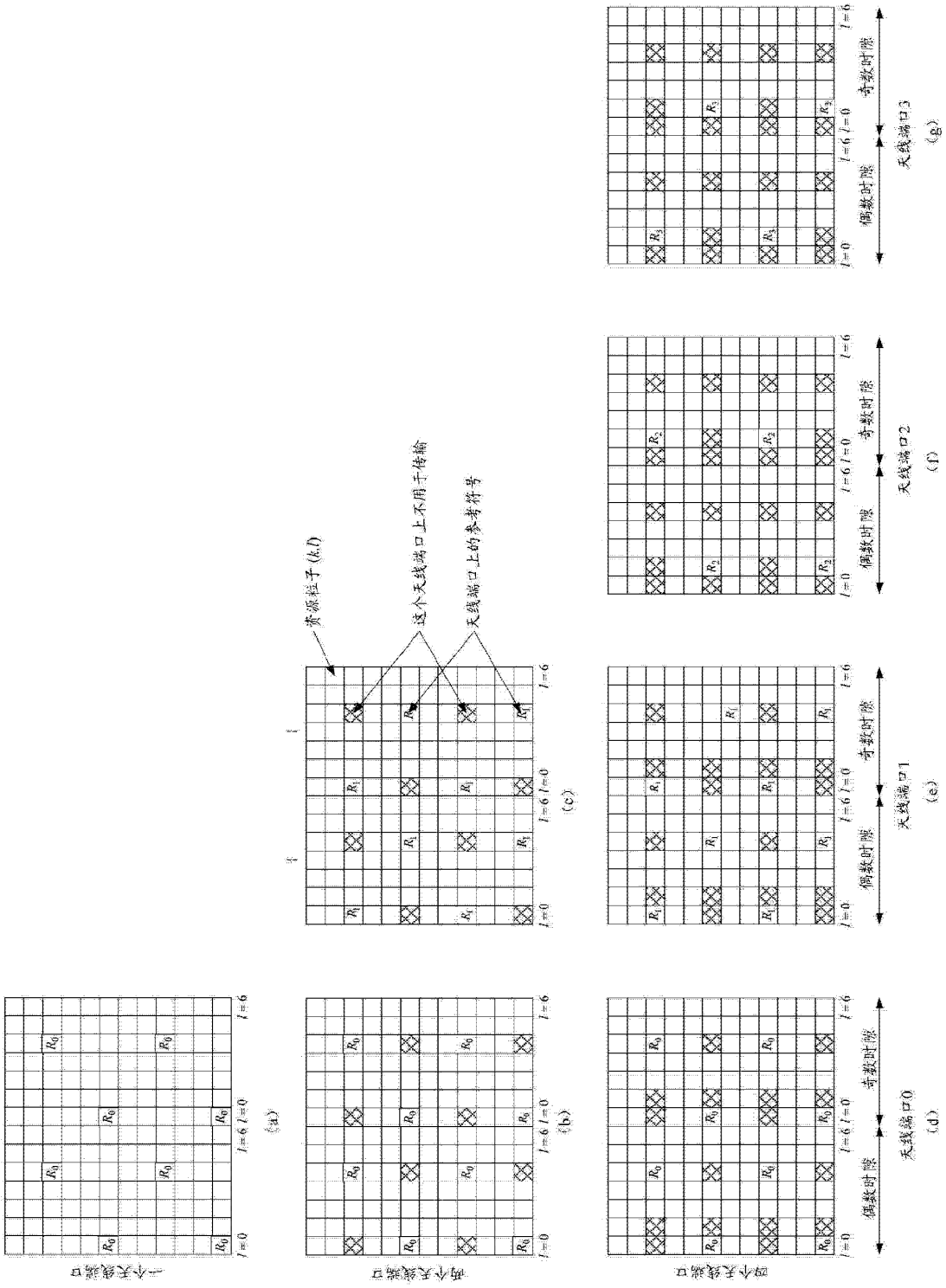


图 1

Samsung Exhibit 1003, Page 172 of 438

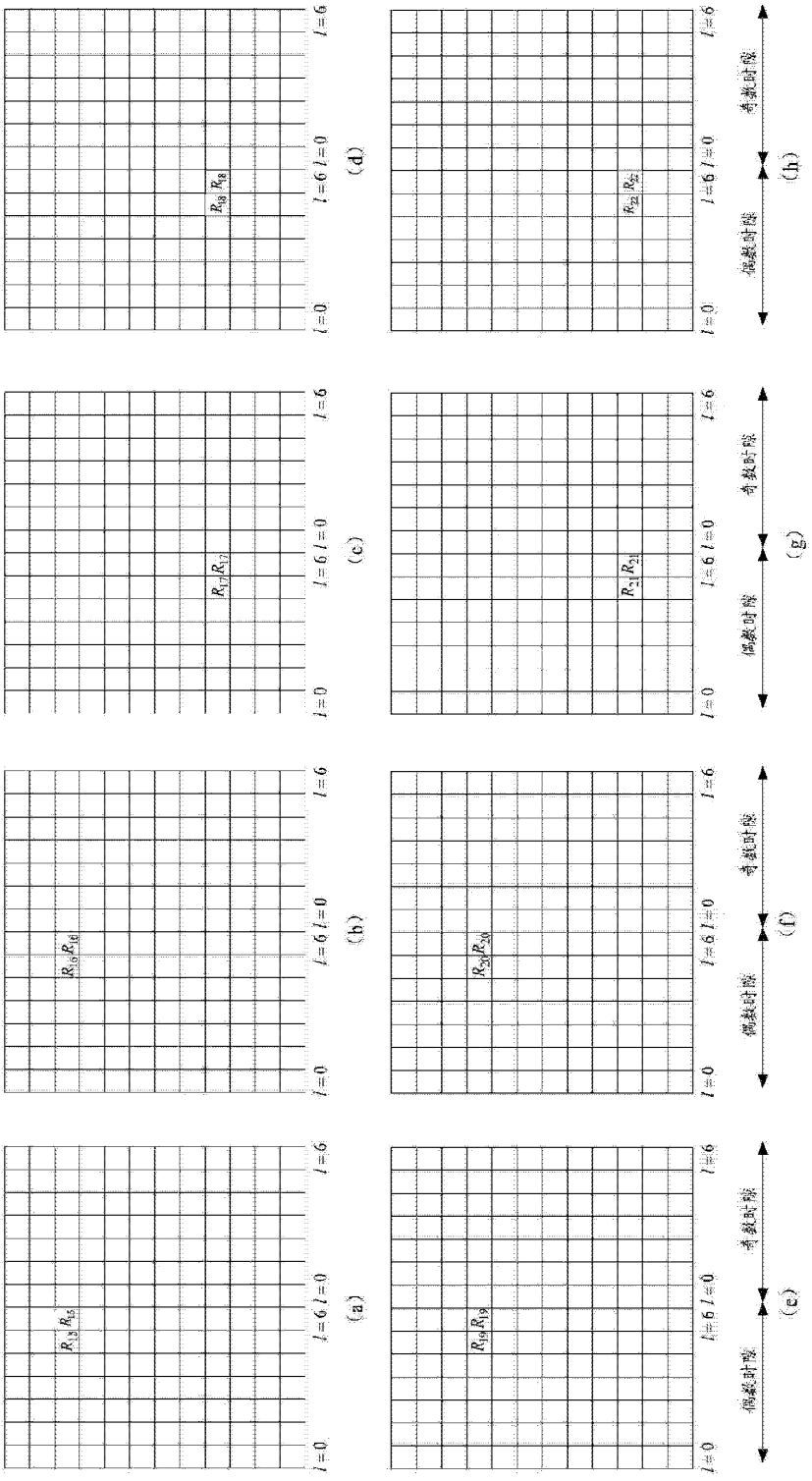


图 2

Samsung Exhibit 1003, Page 173 of 438

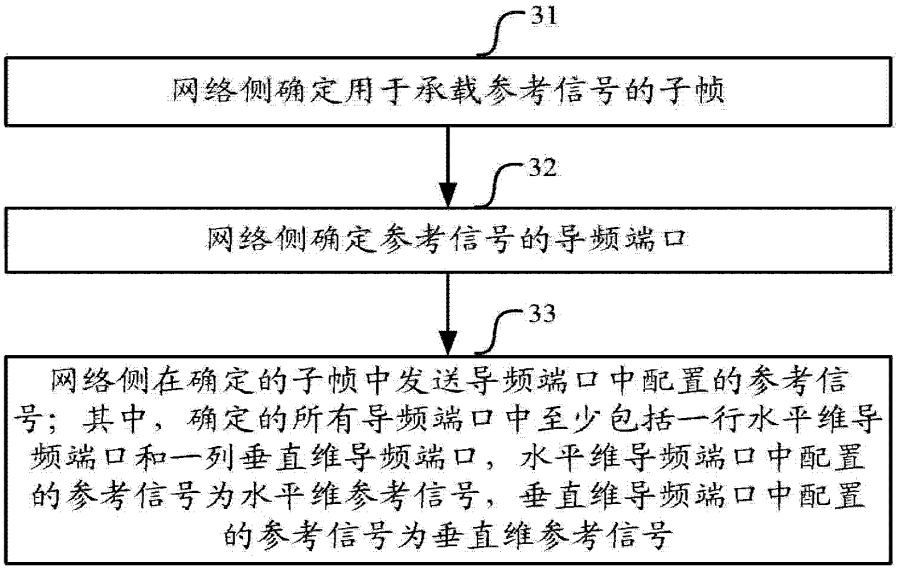


图 3

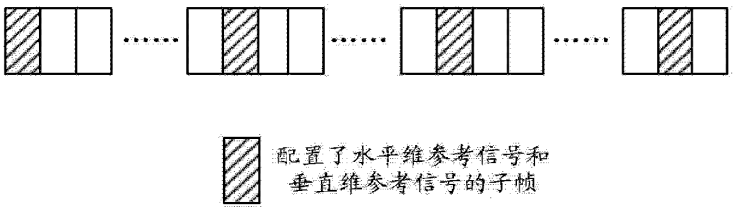


图 4A

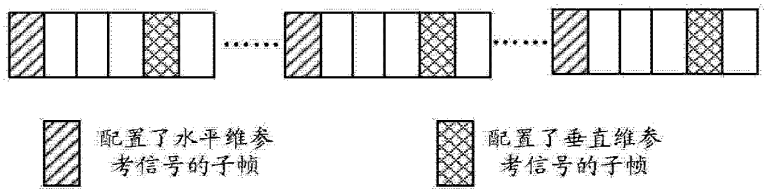


图 4B

Samsung Exhibit 1003, Page 174 of 438

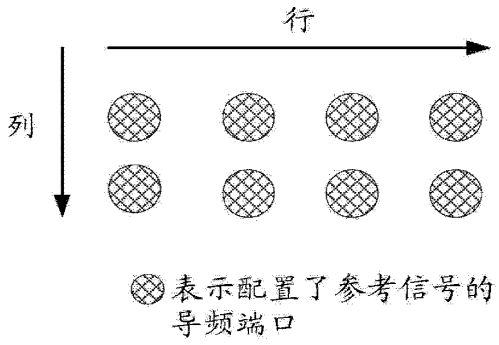


图 5A

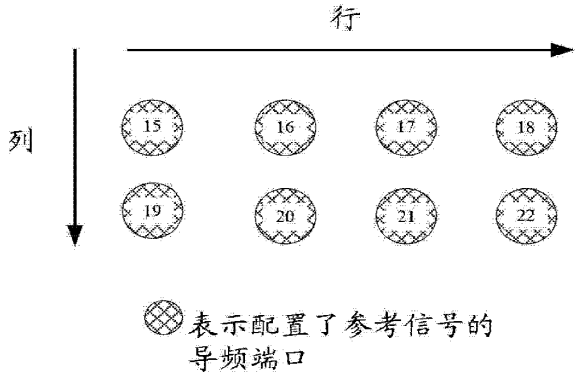


图 5B

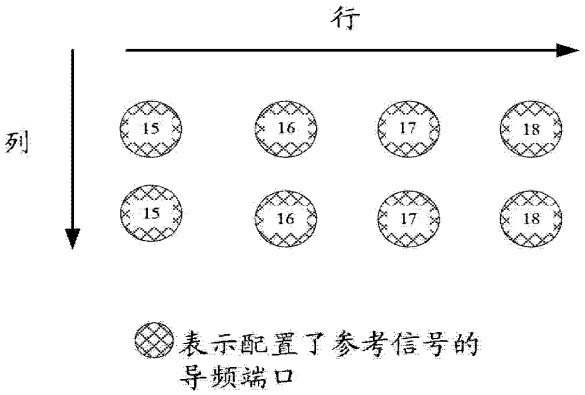


图 5C

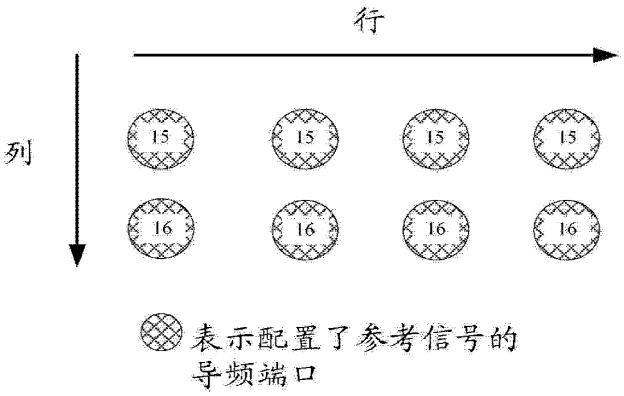


图 5D

Samsung Exhibit 1003, Page 175 of 438

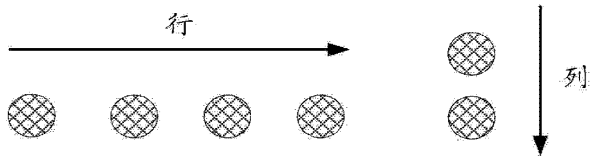


图 6A

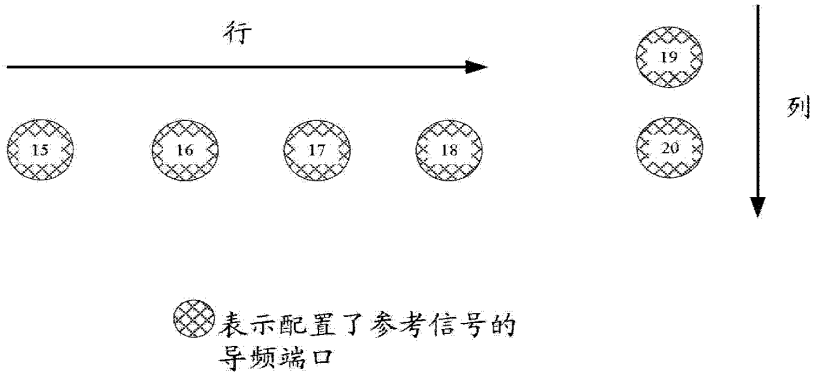


图 6B

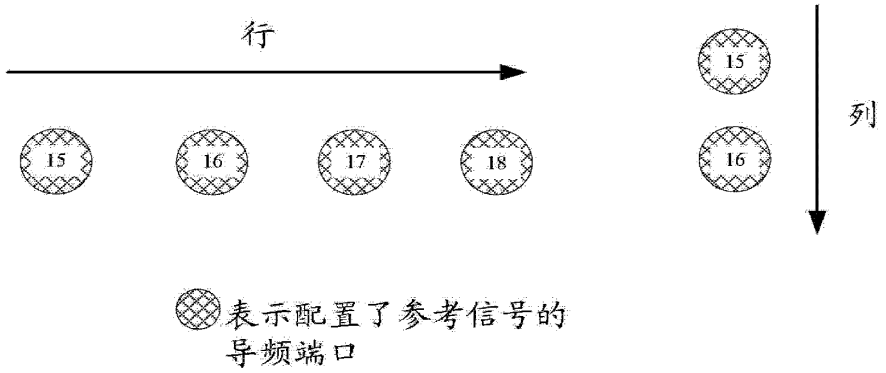
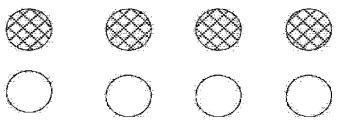


图 6C

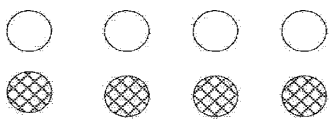
Samsung Exhibit 1003, Page 176 of 438



表示配置了水平维参考信号的导频端口

表示没有配置水平维参考信号的导频端口

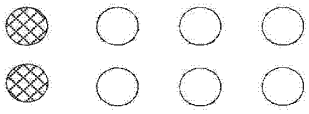
图 7A



表示配置了水平维参考信号的导频端口

表示没有配置水平维参考信号的导频端口

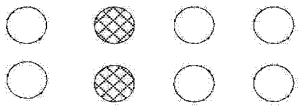
图 7B



表示配置了垂直维参考信号的导频端口

表示没有配置垂直维参考信号的导频端口

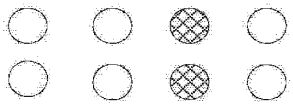
图 8A



表示配置了垂直维参考信号的导频端口

表示没有配置垂直维参考信号的导频端口

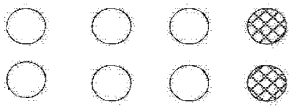
图 8B



表示配置了垂直维参考信号的导频端口

表示没有配置垂直维参考信号的导频端口

图 8C



表示配置了垂直维参考信号的导频端口

表示没有配置垂直维参考信号的导频端口

图 8D

Samsung Exhibit 1003, Page 177 of 438

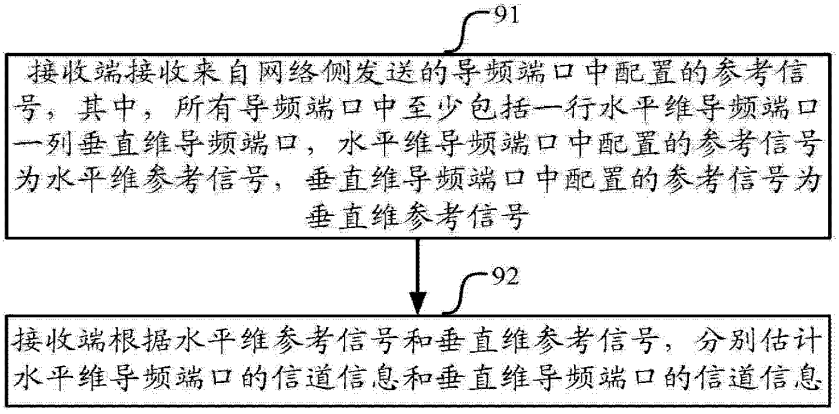


图 9

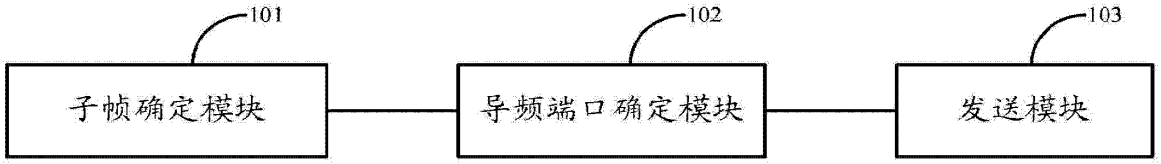


图 10

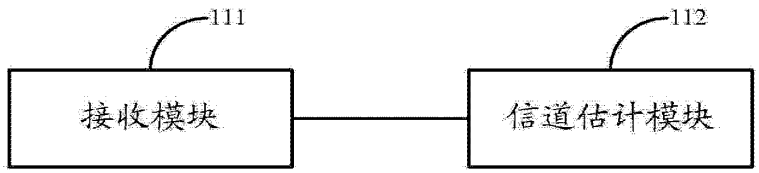


图 11

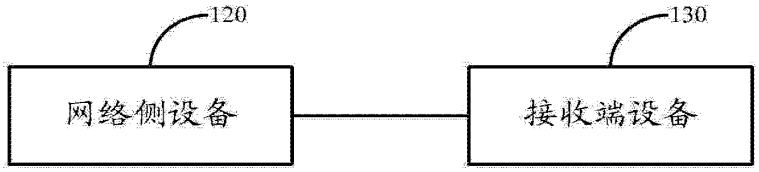


图 12

Samsung Exhibit 1003, Page 178 of 438

Espacenet

Bibliographic data: WO2016018100 (A1) — 2016-02-04

METHOD FOR REPORTING CHANNEL STATE, AND DEVICE THEREFOR

Inventor(s): KIM KIJUN [KR]; PARK JONGHYUN [KR]; KIM BONGHOE [KR] ± (김기준, ; 박종현, ; 김봉회)

Applicant(s): LG ELECTRONICS INC [KR] ± (엘지전자 주식회사)

Classification: - international: ***H04B7/06; H04L5/00***
- cooperative: **H04B7/0456**; **H04B7/06**; **H04L5/00**; **H04L5/0053**

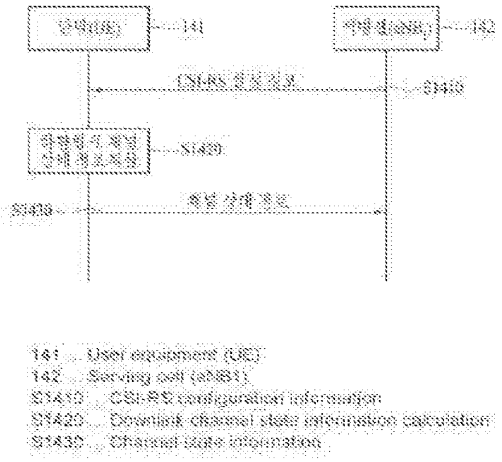
Application number: WO2015KR07995 20150730 Global Dossier

Priority number(s): US201462031876P 20140801 ; US201562132458P 20150312 ; US201562148718P 20150416

Also published as: EP3185436 (A1) EP3185436 (A4) KR20170038759 (A) US10320546 (B2) US2017195100 (A1)

Abstract of WO2016018100 (A1)

According to one embodiment of the present invention, a method for reporting a channel state of a downlink channel transmitted through two-dimensionally arranged Nt number of antenna ports is carried out by a terminal, wherein the method comprises the steps of: configuring each of the Nt number of antenna ports to be mapped to all antenna elements belonging to a specific antenna element group, and each antenna port of an antenna port group corresponding to a reference signal (RS), which is transmitted in the same OFDM symbol, to be mapped to different antenna element groups from each other, and receiving a channel state information (CSI)-RS configuration for reporting a channel state for the antenna port group; and calculating channel state information on a downlink channel through a CSI-RS received using the received CSI-RS configuration, and reporting, to a serving cell, the calculated channel state information, wherein the reported channel state information can contain a precoding matrix for selecting an antenna port group and a precoding matrix to be applied to the selected antenna port group.



Samsung Exhibit 1003, Page 179 of 438

(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

(43) 국제공개일
2016 년 2 월 4 일 (04.02.2016)

WIPO | PCT

(10) 국제공개번호
WO 2016/018100 A1

(51) 국제특허분류:
H04B 7/06 (2006.01) *H04L 5/00* (2006.01)

(21) 국제출원번호: PCT/KR2015/007995

(22) 국제출원일: 2015 년 7 월 30 일 (30.07.2015)

(25) 출원언어: 한국어

(26) 공개언어: 한국어

(30) 우선권정보:
62/031,876 2014 년 8 월 1 일 (01.08.2014) US
62/132,458 2015 년 3 월 12 일 (12.03.2015) US
62/148,718 2015 년 4 월 16 일 (16.04.2015) US

(71) 출원인: **엘지전자 주식회사 (LG ELECTRONICS INC.)** [KR/KR]; 150-721 서울시 영등포구 여의대로 128, Seoul (KR).

(72) 발명자: **김기준 (KIM, Kijun)**; 137-893 서울시 서초구 양재대로 11 길 19 LG 전자 특허센터, Seoul (KR). **박종현 (PARK, Jonghyun)**; 137-893 서울시 서초구 양재대로 11 길 19 LG 전자 특허센터, Seoul (KR). **김봉회 (KIM, Bonghoe)**; 137-893 서울시 서초구 양재대로 11 길 19 LG 전자 특허센터, Seoul (KR).

(74) 대리인: **김용인 (KIM, Yong In)** 등; 138-861 서울시 송파구 올림픽로 82, 7 층 KBK 특허법률사무소, Seoul (KR).

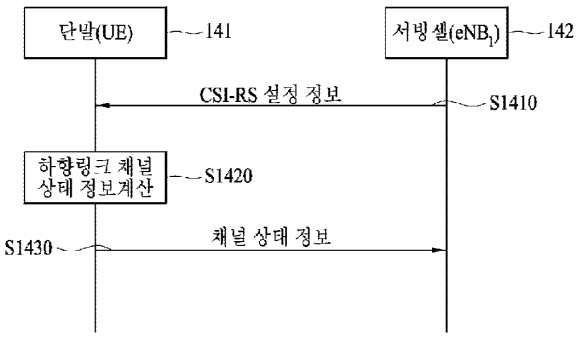
(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

[다음 쪽 계속]

(54) **Title**: METHOD FOR REPORTING CHANNEL STATE, AND DEVICE THEREFOR

(54) **발명의 명칭** : 채널 상태 보고를 위한 방법 및 이를 위한 장치



141 ... User equipment (UE)
142 ... Serving cell (eNB1)
S1410 ... CSI-RS configuration information
S1420 ... Downlink channel state information calculation
S1430 ... Channel state information

(57) **Abstract**: According to one embodiment of the present invention, a method for reporting a channel state of a downlink channel transmitted through two-dimensionally arranged N_t number of antenna ports is carried out by a terminal, wherein the method comprises the steps of: configuring each of the N_t number of antenna ports to be mapped to all antenna elements belonging to a specific antenna element group, and each antenna port of an antenna port group corresponding to a reference signal (RS), which is transmitted in the same OFDM symbol, to be mapped to different antenna element groups from each other, and receiving a channel state information (CSI)-RS configuration for reporting a channel state for the antenna port group; and calculating channel state information on a downlink channel through a CSI-RS received using the received CSI-RS configuration, and reporting, to a serving cell, the calculated channel state information, wherein the reported channel state information can contain a precoding matrix for selecting an antenna port group and a precoding matrix to be applied to the selected antenna port group.

(57) **요약서**:

[다음 쪽 계속]

WO 2016/018100 A1

공개:

— 국제조사보고서와 함께 (조약 제 21 조(3))

— 청구범위 보정 기한 만료 전의 공개이며, 보정서를 접수하는 경우 그에 관하여 별도 공개함 (규칙 48.2(h))

본 발명의 일 실시예에 따른 2 차원으로 배열된 N_t개의 안테나 포트를 통해 전송되는 하향링크 채널에 대한 채널 상태 보고를 위한 방법에 있어서, 상기 방법은 단말에 의해 수행되며, 상기 N_t개의 안테나 포트 각각은 특정 안테나 엘리먼트 그룹에 속하는 모든 안테나 엘리먼트에 맵핑되고, 동일한 OFDM 심볼에서 전송되는 참조 신호(reference signal; RS)에 대응하는 안테나 포트 그룹의 각 안테나 포트는 서로 다른 안테나 엘리먼트 그룹에 맵핑되도록 설정되며, 상기 안테나 포트 그룹에 대한 채널 상태 보고를 위한 참조 신호(channel state information-reference signal; CSI-RS) 설정을 수신하는 단계 및 상기 수신된 CSI-RS 설정을 사용하여 수신된 CSI-RS 를 통해 하향링크 채널에 대한 채널 상태 정보를 계산하여 서빙 셀로 보고하는 단계를 포함하고, 상기 보고되는 채널 상태 정보는 안테나 포트 그룹 선택을 위한 프리코딩 행렬 및 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬을 포함할 수 있다.

명세서

발명의 명칭: 채널 상태 보고를 위한 방법 및 이를 위한 장치

기술분야

[1] 본 발명은 무선 통신 시스템에 관한 것으로서, 구체적으로 채널 상태 보고를 위한 방법 및 이를 위한 장치에 관한 것이다.

배경기술

[2] 기기간(Machine-to-Machine, M2M) 통신과, 높은 데이터 전송량을 요구하는 스마트폰, 태블릿 PC 등의 다양한 장치 및 기술이 출현 및 보급되고 있다. 이에 따라, 셀룰러 망에서 처리될 것이 요구되는 데이터 양이 매우 빠르게 증가하고 있다. 이와 같이 빠르게 증가하는 데이터 처리 요구량을 만족시키기 위해, 더 많은 주파수 대역을 효율적으로 사용하기 위한 반송파 집성(carrier aggregation) 기술, 인지무선(cognitive radio) 기술 등과, 한정된 주파수 내에서 전송되는 데이터 용량을 높이기 위한 다중 안테나 기술, 다중 기지국 협력 기술 등이 발전하고 있다. 또한, 사용자기기가 주변에서 엑세스할 수 있는 노드의 밀도가 높아지는 방향으로 통신 환경이 진화하고 있다. 노드라 함은 하나 이상의 안테나를 구비하여 사용자기기와 무선 신호를 전송/수신할 수 있는 고정된 지점(point)을 말한다. 높은 밀도의 노드를 구비한 통신 시스템은 노드들 간의 협력에 의해 더 높은 성능의 통신 서비스를 사용자기기에게 제공할 수 있다.

[3] 복수의 노드에서 동일한 시간-주파수 자원을 이용하여 사용자기기와 통신을 수행하는 이러한 다중 노드 협력 통신 방식은 각 노드가 독립적인 기지국으로 동작하여 상호 협력 없이 사용자기기와 통신을 수행하는 기존의 통신 방식보다 데이터 처리량에 있어서 훨씬 우수한 성능을 갖는다.

[4] 다중 노드 시스템은 각 노드가, 기지국 혹은 엑세스 포인트, 안테나, 안테나 그룹, 무선 리모트 헤드(radio remote header, RRH), 무선 리모트 유닛(radio remote unit, RRU)로서 동작하는, 복수의 노드를 사용하여 협력 통신을 수행한다. 안테나들이 기지국에 집중되어 위치해 있는 기존의 중앙 집중형 안테나 시스템과 달리, 다중 노드 시스템에서 상기 복수의 노드는 통상 일정 간격 이상으로 떨어져 위치한다. 상기 복수의 노드는 각 노드의 동작을 제어하거나, 각 노드를 통해 송/수신될 데이터를 스케줄링하는 하나 이상의 기지국 혹은 기지국 컨트롤러(controller)에 의해 관리될 수 있다. 각 노드는 해당 노드를 관리하는 기지국 혹은 기지국 컨트롤러와 케이블 혹은 전용 회선(dedicated line)을 통해 연결된다.

[5] 이러한 다중 노드 시스템은 분산된 노드들이 동시에 서로 다른 스트림을 송/수신하여 단일 또는 다수의 사용자기기와 통신할 수 있다는 점에서 일종의 MIMO(multiple input multiple output) 시스템으로 볼 수 있다. 다만, 다중 노드 시스템은 다양한 위치에 분산된 노드들을 이용하여 신호를 전송하므로, 기존의

중앙 집중형 안테나 시스템에 구비된 안테나들에 비해, 각 안테나가 커버해야 하는 전송 영역이 축소된다. 따라서, 중앙 집중형 안테나 시스템에서 MIMO 기술을 구현하던 기존 시스템에 비해, 다중 노드 시스템에서는 각 안테나가 신호를 전송하는 데 필요한 전송 전력이 감소될 수 있다. 또한, 안테나와 사용자기기 간의 전송 거리가 단축되므로 경로 손실이 감소되며, 데이터의 고속 전송이 가능하게 된다. 이에 따라, 셀룰러 시스템의 전송 용량 및 전력 효율이 높아질 수 있으며, 셀 내의 사용자기기의 위치에 상관없이 상대적으로 균일한 품질의 통신 성능이 만족될 수 있다. 또한, 다중 노드 시스템에서는, 복수의 노드들에 연결된 기지국(들) 혹은 기지국 컨트롤러(들)이 데이터 전송/수신에 협력하므로, 전송 과정에서 발생하는 신호 손실이 감소된다. 또한, 일정 거리 이상 떨어져 위치한 노드들이 사용자기기와 협력 통신을 수행하는 경우, 안테나들 사이의 상관도(correlation) 및 간섭이 줄어들게 된다. 따라서, 다중 노드 협력 통신 방식에 의하면, 높은 신호 대 잡음비(signal to interference-plus-noise ratio, SINR)이 얻어질 수 있다.

[6] 이와 같은 다중 노드 시스템의 장점 때문에, 차세대 이동 통신 시스템에서 기지국 증설 비용과 백홀(backhaul) 망의 유지 비용을 줄이는 동시에, 서비스 커버리지의 확대와 채널용량 및 SINR의 향상을 위해, 다중 노드 시스템이 기존의 중앙집중형 안테나 시스템과 병행 혹은 대체하여 셀룰러 통신의 새로운 기반으로 대두되고 있다.

발명의 상세한 설명

기술적 과제

[7] 본 발명은 채널 상태 보고를 위한 방안을 제안하며, 특히 하향링크 전송을 위해 이차원 배열의 안테나 엘리먼트가 사용되고 상기 안테나 엘리먼트에 대한 코드북으로 수평 안테나 프리코딩 행렬과 수직 안테나 프리코딩 행렬의 크로네커 곱으로 표현되는 코드북이 사용되는 경우의 채널 상태 보고 방안을 설명한다.

[8] 본 발명에서 이루고자 하는 기술적 과제들은 상기 기술적 과제로 제한되지 않으며, 언급하지 않은 또 다른 기술적 과제들은 아래의 기재로부터 본 발명이 속하는 기술분야에서 통상의 지식을 가진 자에게 명확하게 이해될 수 있을 것이다.

과제 해결 수단

[9] 본 발명의 일 실시예에 따라 2차원으로 배열된 N_t개의 안테나 포트를 통해 전송되는 하향링크 채널에 대한 채널 상태 보고를 위한 방법이 제안되며, 상기 방법은 단말에 의해 수행되며, 상기 N_t개의 안테나 포트 각각은 특정 안테나 엘리먼트 그룹에 속하는 모든 안테나 엘리먼트에 맵핑되고, 동일한 OFDM 심볼에서 전송되는 참조 신호(reference signal; RS)에 대응하는 안테나 포트 그룹의 각 안테나 포트는 서로 다른 안테나 엘리먼트 그룹에 맵핑되도록

Samsung Exhibit 1003, Page 184 of 438

설정되며, 상기 안테나 포트 그룹에 대한 채널 상태 보고를 위한 참조 신호(channel state information-reference signal; CSI-RS) 설정을 수신하는 단계 및 상기 수신된 CSI-RS 설정을 사용하여 수신된 CSI-RS를 통해 하향링크 채널에 대한 채널 상태 정보를 계산하여 서빙 셀로 보고하는 단계를 포함하고, 상기 보고되는 채널 상태 정보는 안테나 포트 그룹 선택을 위한 프리코딩 행렬 및 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬을 포함할 수 있다.

[10] 추가적으로 또는 대안으로, 상기 안테나 포트 그룹 선택을 위한 프리코딩 행렬은 안테나 포트 그룹 선택 코드북에서 선택될 수 있다.

[11] 추가적으로 또는 대안으로, 상기 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬은 상수 모듈러스(constant modulus) 코드북에서 선택될 수 있다.

[12] 추가적으로 또는 대안으로, 상기 방법은 안테나 포트 그룹 별로 상기 CSI-RS의 전송이 활성화 또는 비활성화되었는지 여부를 지시하는 정보를 상기 서빙 셀로부터 수신하는 단계를 더 포함할 수 있다.

[13] 추가적으로 또는 대안으로, 상기 비활성화된 안테나 포트 그룹을 선택하기 위한 프리코딩 행렬은 상기 채널 상태 정보에서 제외될 수 있다.

[14] 추가적으로 또는 대안으로, 상기 방법은 상기 안테나 포트 그룹 선택을 위한 프리코딩의 랭크 제한 또는 상기 선택된 안테나 포트 그룹에 적용될 프리코딩의 랭크 제한에 대한 정보를 상기 서빙 셀로부터 수신하는 단계를 포함할 수 있다.

[15] 본 발명의 또다른 일실시예에 따라 2차원으로 배열된 N_t개의 안테나 포트를 통해 전송되는 하향링크 채널에 대한 채널 상태 보고를 하도록 구성된 단말이 제안되며, 상기 단말은 무선 주파수(radio frequency, RF) 유닛 및 상기 RF 유닛을 제어하도록 구성된 프로세서를 포함하고, 상기 N_t개의 안테나 포트 각각은 특정 안테나 엘리먼트 그룹에 속하는 모든 안테나 엘리먼트에 맵핑되고, 동일한 OFDM 심볼에서 전송되는 참조 신호(reference signal; RS)에 대응하는 안테나 포트 그룹의 각 안테나 포트는 서로 다른 안테나 엘리먼트 그룹에 맵핑되도록 설정되며, 상기 프로세서는 상기 안테나 포트 그룹에 대한 채널 상태 보고를 위한 참조 신호(channel state information-reference signal; CSI-RS) 설정을 수신하고, 그리고 상기 수신된 CSI-RS 설정을 사용하여 수신된 CSI-RS를 통해 하향링크 채널에 대한 채널 상태 정보를 계산하여 서빙 셀로 보고하도록 구성되며, 상기 보고되는 채널 상태 정보는 안테나 포트 그룹 선택을 위한 프리코딩 행렬 및 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬을 포함할 수 있다.

[16] 추가적으로 또는 대안으로, 상기 안테나 포트 그룹 선택을 위한 프리코딩 행렬은 안테나 포트 그룹 선택 코드북에서 선택될 수 있다.

[17] 추가적으로 또는 대안으로, 상기 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬은 상수 모듈러스(constant modulus) 코드북에서 선택될 수 있다.

[18] 추가적으로 또는 대안으로, 상기 프로세서는 안테나 포트 그룹 별로 상기 CSI-RS의 전송이 활성화 또는 비활성화되었는지 여부를 지시하는 정보를 상기

서빙 셀로부터 수신하도록 구성될 수 있다.

[19] 추가적으로 또는 대안으로, 상기 비활성화된 안테나 포트 그룹을 선택하기 위한 프리코딩 행렬은 상기 채널 상태 정보에서 제외될 수 있다.

[20] 추가적으로 또는 대안으로, 상기 프로세서는 상기 안테나 포트 그룹 선택을 위한 프리코딩의 랭크 제한 또는 상기 선택된 안테나 포트 그룹에 적용될 프리코딩의 랭크 제한에 대한 정보를 상기 서빙 셀로부터 수신하도록 구성될 수 있다.

[21] 상기 과제 해결방법들은 본 발명의 실시예들 중 일부에 불과하며, 본원 발명의 기술적 특징들이 반영된 다양한 실시예들이 당해 기술분야의 통상적인 지식을 가진 자에 의해 이하 상술할 본 발명의 상세한 설명을 기반으로 도출되고 이해될 수 있다.

발명의 효과

[22] 본 발명의 일 실시예에 따라 효율적인 채널 상태 보고가 가능하다.

[23] 본 발명에서 얻은 수 있는 효과는 이상에서 언급한 효과들로 제한되지 않으며, 언급하지 않은 또 다른 효과들은 아래의 기재로부터 본 발명이 속하는 기술분야에서 통상의 지식을 가진 자에게 명확하게 이해될 수 있을 것이다.

도면의 간단한 설명

[24] 본 발명에 관한 이해를 돕기 위해 상세한 설명의 일부로 포함되는, 첨부 도면은 본 발명에 대한 실시예를 제공하고, 상세한 설명과 함께 본 발명의 기술적 사상을 설명한다.

[25] 도 1 무선 통신 시스템에서 사용되는 무선 프레임 구조의 일 예를 나타낸 것이다.

[26] 도 2는 무선 통신 시스템에서 하향링크/상향링크(DL/UL) 슬롯 구조의 일례를 나타낸 것이다.

[27] 도 3은 3GPP LTE/LTE-A 시스템에서 사용되는 하향링크(downlink, DL) 서브프레임 구조를 예시한 것이다.

[28] 도 4 는 3GPP LTE/LTE-A 시스템에서 사용되는 상향링크(uplink, UL) 서브프레임 구조의 일례를 나타낸 것이다.

[29] 도 5는 코드 북 기반 빔 포밍을 설명한다.

[30] 도 6은는 LTE-A 시스템에서 12개의 서브캐리어로 구성된 RB에서 8개 안테나 포트를 갖는 CSI-RS의 전송 가능한 패턴을 나타낸다

[31] 도 7은 2-포트, 4-포트, 그리고 8-포트 CSI-RS의 전송 패턴을 도시한다.

[32] 도 8은 2차원 안테나 배열을 도시한다.

[33] 도 9는 2차원 안테나 배열을 통한 3차원 빔패턴을 도시한다.

[34] 도 10은 특정 안테나 포트의 EPRE(energy per resource element)를 도시한다.

[35] 도 11 및 도 12는 안테나 포트 그룹을 도시한다.

[36] 도 13은 안테나 포트 그룹과 안테나 엘리먼트 그룹의 맵핑 관계를 도시한다.

[37] 도 14는 본 발명의 일 실시예에 따른 동작을 도시한다.

[38] 도 15는 본 발명의 실시예(들)을 구현하기 위한 장치의 블록도를 도시한다.

발명의 실시를 위한 최선의 형태

[39] 이하, 본 발명에 따른 바람직한 실시 형태를 첨부된 도면을 참조하여 상세하게 설명한다. 첨부된 도면과 함께 이하에 개시될 상세한 설명은 본 발명의 예시적인 실시형태를 설명하고자 하는 것이며, 본 발명이 실시될 수 있는 유일한 실시형태를 나타내고자 하는 것이 아니다. 이하의 상세한 설명은 본 발명의 완전한 이해를 제공하기 위해서 구체적 세부사항을 포함한다. 그러나, 당업자는 본 발명이 이러한 구체적 세부사항 없이도 실시될 수 있음을 안다.

[40] 몇몇 경우, 본 발명의 개념이 모호해지는 것을 피하기 위하여 공지의 구조 및 장치는 생략되거나, 각 구조 및 장치의 핵심기능을 중심으로 한 블록도 형식으로 도시될 수 있다. 또한, 본 명세서 전체에서 동일한 구성요소에 대해서는 동일한 도면 부호를 사용하여 설명한다.

[41] 본 발명에 있어서, 사용자기기(user equipment, UE)는 고정되거나 이동성을 가질 수 있으며, 기지국(base station, BS)와 통신하여 사용자데이터 및/또는 각종 제어정보를 송수신하는 각종 기기들이 이에 속한다. UE는 단말(Terminal Equipment), MS(Mobile Station), MT(Mobile Terminal), UT(User Terminal), SS(Subscribe Station), 무선기기(wireless device), PDA(Personal Digital Assistant), 무선 모뎀(wireless modem), 휴대기기(handheld device) 등으로 불릴 수 있다. 또한, 본 발명에 있어서, BS는 일반적으로 UE 및/또는 다른 BS와 통신하는 고정국(fixed station)을 말하며, UE 및 타 BS와 통신하여 각종 데이터 및 제어정보를 교환한다. BS는 ABS(Advanced Base Station), NB(Node-B), eNB(evolved-NodeB), BTS(Base Transceiver System), 엑세스 포인트(Access Point), PS(Processing Server), 전송 포인트(transmission point; TP)등 다른 용어로 불릴 수 있다. 이하의 본 발명에 관한 설명에서는, BS를 eNB로 통칭한다.

[42] 본 발명에서 노드(node)라 함은 사용자기기와 통신하여 무선 신호를 전송/수신할 수 있는 고정된 지점(point)을 말한다. 다양한 형태의 eNB들이 그 명칭에 관계없이 노드로서 이용될 수 있다. 예를 들어, BS, NB, eNB, 피코-셀 eNB(PeNB), 홈 eNB(HeNB), 릴레이, 리피터 등이 노드가 될 수 있다. 또한, 노드는 eNB가 아니어도 될 수 있다. 예를 들어, 무선 리모트 헤드(radio remote head, RRH), 무선 리모트 유닛(radio remote unit, RRU)가 될 수 있다. RRH, RRU 등은 일반적으로 eNB의 전력 레벨(power level) 보다 낮은 전력 레벨을 갖는다. RRH 혹은 RRU이하, RRH/RRU)는 일반적으로 광 케이블 등의 전용 회선(dedicated line)으로 eNB에 연결되어 있기 때문에, 일반적으로 무선 회선으로 연결된 eNB들에 의한 협력 통신에 비해, RRH/RRU와 eNB에 의한 협력 통신이 원활하게 수행될 수 있다. 일 노드에는 최소 하나의 안테나가 설치된다. 상기 안테나는 물리 안테나를 의미할 수도 있으며, 안테나 포트, 가상 안테나, 또는 안테나

그룹을 의미할 수도 있다. 노드는 포인트(point)라고 불리기도 한다. 안테나들이 기지국에 집중되어 위치하여 하나의 eNB 컨트롤러(controller)에 의해 제어되는 기존의(conventional) 중앙 집중형 안테나 시스템(centralized antenna system, CAS)(즉, 단일 노드 시스템)과 달리, 다중 노드 시스템에서 복수의 노드는 통상 일정 간격 이상으로 떨어져 위치한다. 상기 복수의 노드는 각 노드의 동작을 제어하거나, 각 노드를 통해 송/수신될 데이터를 스케줄링(scheduling)하는 하나 이상의 eNB 혹은 eNB 컨트롤러에 의해 관리될 수 있다. 각 노드는 해당 노드를 관리하는 eNB 혹은 eNB 컨트롤러와 케이블(cable) 혹은 전용 회선(dedicated line)을 통해 연결될 수 있다. 다중 노드 시스템에서, 복수의 노드들로의/로부터의 통한 신호 전송/수신에는 동일한 셀 식별자(identity, ID)가 이용될 수도 있고 서로 다른 셀 ID가 이용될 수도 있다. 복수의 노드들이 동일한 셀 ID를 갖는 경우, 상기 복수의 노드 각각은 하나의 셀의 일부 안테나 집단처럼 동작한다. 다중 노드 시스템에서 노드들이 서로 다른 셀 ID를 갖는다면, 이러한 다중 노드 시스템은 다중 셀(예를 들어, 매크로-셀/펨토-셀/피코-셀) 시스템이라고 볼 수 있다. 복수의 노드들 각각이 형성한 다중 셀들이 커버리지에 따라 오버레이되는 형태로 구성되면, 상기 다중 셀들이 형성한 네트워크를 특히 다중-계층(multi-tier) 네트워크라 부른다. RRH/RRU의 셀 ID와 eNB의 셀 ID는 동일할 수도 있고 다를 수도 있다. RRH/RRU가 eNB가 서로 다른 셀 ID를 사용하는 경우, RRH/RRU와 eNB는 모두 독립적인 기지국으로서 동작하게 된다.

[43] 이하에서 설명될 본 발명의 다중 노드 시스템에서, 복수의 노드와 연결된 하나 이상의 eNB 혹은 eNB 컨트롤러가 상기 복수의 노드 중 일부 또는 전부를 통해 UE에 동시에 신호를 전송 혹은 수신하도록 상기 복수의 노드를 제어할 수 있다. 각 노드의 실체, 각 노드의 구현 형태 등에 따라 다중 노드 시스템들 사이에는 차이점이 존재하지만, 복수의 노드가 함께 소정 시간-주파수 자원 상에서 UE에 통신 서비스를 제공하는 데 참여한다는 점에서, 이들 다중 노드 시스템들은 단일 노드 시스템(예를 들어, CAS, 종래의 MIMO 시스템, 종래의 중계 시스템, 종래의 리피터 시스템 등)과 다르다. 따라서, 복수의 노드들 중 일부 또는 전부를 사용하여 데이터 협력 전송을 수행하는 방법에 관한 본 발명의 실시예들은 다양한 종류의 다중 노드 시스템에 적용될 수 있다. 예를 들어, 노드는 통상 타 노드와 일정 간격 이상으로 떨어져 위치한 안테나 그룹을 일컫지만, 후술하는 본 발명의 실시예들은 노드가 간격에 상관없이 임의의 안테나 그룹을 의미하는 경우에도 적용될 수 있다. 예를 들어, X-pol(Cross polarized) 안테나를 구비한 eNB의 경우, 상기 eNB가 H-pol 안테나로 구성된 노드와 V-pol 안테나로 구성된 노드를 제어한다고 보고 본 발명의 실시예들이 적용될 수 있다.

[44] 복수의 전송(Tx)/수신(Rx) 노드를 통해 신호를 전송/수신하거나, 복수의 전송/수신 노드들 중에서 선택된 적어도 하나의 노드를 통해 신호를 전송/수신하거나, 하향링크 신호를 전송하는 노드와 상향링크 신호를 수신하는 노드를 다르게 할 수 있는 통신 기법을 다중-eNB MIMO 또는 CoMP(Coordinated

Multi-Point TX/RX)라 한다. 이러한 노드 간 협력 통신 중 협력 전송 기법은 크게 JP(joint processing)과 스케줄링 협력(scheduling coordination)으로 구분될 수 있다. 전자는 JT(joint transmission)/JR(joint reception)과 DPS(dynamic point selection)으로 나뉘고 후자는 CS(coordinated scheduling)과 CB(coordinated beamforming)으로 나뉠 수 있다. DPS는 DCS(dynamic cell selection)으로 불리기도 한다. 다른 협력 통신 기법에 비해, 노드 간 협력 통신 기법들 중 JP가 수행될 때, 보다 더 다양한 통신환경이 형성될 수 있다. JP 중 JT는 복수의 노드들이 동일한 스트림을 UE로 전송하는 통신 기법을 말하며, JR은 복수의 노드들이 동일한 스트림을 UE로부터 수신하는 통신 기법을 말한다. 상기 UE/eNB는 상기 복수의 노드들로부터 수신한 신호들을 합성하여 상기 스트림을 복원한다. JT/JR의 경우, 동일한 스트림이 복수의 노드들로부터/에게 전송되므로 전송 다이버시티(diversity)에 의해 신호 전송의 신뢰도가 향상될 수 있다. JP 중 DPS는 복수의 노드들 중 특정 규칙에 따라 선택된 일 노드를 통해 신호가 전송/수신되는 통신 기법을 말한다. DPS의 경우, 통상적으로 UE와 노드 사이의 채널 상태가 좋은 노드가 통신 노드로서 선택되게 될 것이므로, 신호 전송의 신뢰도가 향상될 수 있다.

[45] 한편, 본 발명에서 셀(cell)이라 함은 하나 이상의 노드가 통신 서비스를 제공하는 일정 지리적 영역을 말한다. 따라서, 본 발명에서 특정 셀과 통신한다고 함은 상기 특정 셀에 통신 서비스를 제공하는 eNB 혹은 노드와 통신하는 것을 의미할 수 있다. 또한, 특정 셀의 하향링크/상향링크 신호는 상기 특정 셀에 통신 서비스를 제공하는 eNB 혹은 노드로부터의/로의 하향링크/상향링크 신호를 의미한다. UE에게 상/하향링크 통신 서비스를 제공하는 셀을 특히 서빙 셀(serving cell)이라고 한다. 또한, 특정 셀의 채널 상태/품질은 상기 특정 셀에 통신 서비스를 제공하는 eNB 혹은 노드와 UE 사이에 형성된 채널 혹은 통신 링크의 채널 상태/품질을 의미한다. 3GPP LTE-A 기반의 시스템에서, UE는 특정 노드로부터의 하향링크 채널 상태를 상기 특정 노드의 안테나 포트(들)이 상기 특정 노드에 할당된 채널 CSI-RS(Channel State Information Reference Signal) 자원 상에서 전송하는 CSI-RS(들)을 이용하여 측정할 수 있다. 일반적으로 인접한 노드들은 서로 직교하는 CSI-RS 자원들 상에서 해당 CSI-RS 자원들을 전송한다. CSI-RS 자원들이 직교한다고 함은 CSI-RS를 나르는 심볼 및 부반송파를 특정하는 CSI-RS 자원 구성(resource configuration), 서브프레임 오프셋(offset) 및 전송 주기(transmission period) 등에 의해 CSI-RS가 할당된 서브프레임들을 특정하는 서브프레임 구성(subframe configuration), CSI-RS 시퀀스 중 최소 한가지가 서로 다름을 의미한다.

[46] 본 발명에서 PDCCH(Physical Downlink Control CHannel)/PCFICH(Physical Control Format Indicator CHannel)/PHICH((Physical Hybrid automatic retransmit request Indicator CHannel)/PDSCH(Physical Downlink Shared CHannel)은 각각 DCI(Downlink Control Information)/CFI(Control Format Indicator)/하향링크

ACK/NACK(ACKnowlegement/Negative ACK)/하향링크 데이터를 나르는 시간-주파수 자원의 집합 혹은 자원요소의 집합을 의미한다. 또한, PUCCH(Physical Uplink Control CHannel)/PUSCH(Physical Uplink Shared CHannel)/PRACH(Physical Random Access CHannel)는 각각 UCI(Uplink Control Information)/상향링크 데이터/랜덤 엑세스 신호를 나르는 시간-주파수 자원의 집합 혹은 자원요소의 집합을 의미한다. 본 발명에서는, 특히, PDCCH/PCFICH/PHICH/PDSCH/PUCCH/PUSCH/PRACH에 할당되거나 이에 속한 시간-주파수 자원 혹은 자원요소(Resource Element, RE)를 각각 PDCCH/PCFICH/PHICH/PDSCH/PUCCH/PUSCH/PRACH RE 또는 PDCCH/PCFICH/PHICH/PDSCH/PUCCH/PUSCH/PRACH 자원이라고 칭한다. 이하에서 사용자기기가 PUCCH/PUSCH/PRACH를 전송한다는 표현은, 각각, PUSCH/PUCCH/PRACH 상에서 혹은 통해서 상향링크 제어정보/상향링크 데이터/랜덤 엑세스 신호를 전송한다는 것과 동일한 의미로 사용된다. 또한, eNB가 PDCCH/PCFICH/PHICH/PDSCH를 전송한다는 표현은, 각각, PDCCH/PCFICH/PHICH/PDSCH 상에서 혹은 통해서 하향링크 데이터/제어정보를 전송한다는 것과 동일한 의미로 사용된다.

[47] 도 1은 무선 통신 시스템에서 사용되는 무선 프레임 구조의 일 예를 나타낸 것이다. 특히, 도 1(a)는 3GPP LTE/LTE-A 시스템에서 사용되는 주파수분할듀플렉스(frequency division duplex, FDD)용 프레임 구조를 나타낸 것이고, 도 1(b)는 3GPP LTE/LTE-A 시스템에서 사용되는 시분할듀플렉스(time division duplex, TDD)용 프레임 구조를 나타낸 것이다.

[48] 도 1을 참조하면, 3GPP LTE/LTE-A 시스템에서 사용되는 무선프레임은 10ms(307200Ts)의 길이를 가지며, 10개의 균등한 크기의 서브프레임(subframe, SF)으로 구성된다. 일 무선프레임 내 10개의 서브프레임에는 각각 번호가 부여될 수 있다. 여기에서, Ts는 샘플링 시간을 나타내고, Ts=1/(2048*15kHz)로 표시된다. 각각의 서브프레임은 1ms의 길이를 가지며 2개의 슬롯으로 구성된다. 일 무선프레임 내에서 20개의 슬롯들은 0부터 19까지 순차적으로 넘버링될 수 있다. 각각의 슬롯은 0.5ms의 길이를 가진다. 일 서브프레임을 전송하기 위한 시간은 전송시간간격(transmission time interval, TTI)로 정의된다. 시간 자원은 무선프레임 번호(혹은 무선 프레임 인덱스라고도 함)와 서브프레임 번호(혹은 서브프레임 번호라고도 함), 슬롯 번호(혹은 슬롯 인덱스) 등에 의해 구분될 수 있다.

[49] 무선 프레임은 듀플레스(duplex) 모드에 따라 다르게 구성(configure)될 수 있다. 예를 들어, FDD 모드에서, 하향링크 전송 및 상향링크 전송은 주파수에 의해 구분되므로, 무선 프레임은 특정 주파수 대역에 대해 하향링크 서브프레임 또는 상향링크 서브프레임 중 하나만을 포함한다. TDD 모드에서 하향링크 전송 및 상향링크 전송은 시간에 의해 구분되므로, 특정 주파수 대역에 대해 무선 프레임은 하향링크 서브프레임과 상향링크 서브프레임을 모두 포함한다.

[50] 표 1은 TDD 모드에서, 무선 프레임 내 서브프레임들의 DL-UL 구성(configuration)을 예시한 것이다.

[51] 표 1

[표1]

DL-UL configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5ms	D	S	U	U	U	D	S	U	U	U
1	5ms	D	S	U	U	D	D	S	U	U	D
2	5ms	D	S	U	D	D	D	S	U	D	D
3	10ms	D	S	U	U	U	D	D	D	D	D
4	10ms	D	S	U	U	D	D	D	D	D	D
5	10ms	D	S	U	D	D	D	D	D	D	D
6	5ms	D	S	U	U	U	D	S	U	U	D

[52] 표 1에서, D는 하향링크 서브프레임을, U는 상향링크 서브프레임을, S는 특이(special) 서브프레임을 나타낸다. 특이 서브프레임은 DwPTS(Downlink Pilot TimeSlot), GP(Guard Period), UpPTS(Uplink Pilot TimeSlot)의 3개 필드를 포함한다. DwPTS는 하향링크 전송용으로 유보되는 시간 구간이며, UpPTS는 상향링크 전송용으로 유보되는 시간 구간이다. 표 2는 특이 프레임의 구성(configuration)을 예시한 것이다.

[53] 표 2

[표2]

Special subframe configuration	Normal cyclic prefix in downlink			Extended cyclic prefix in downlink		
	DwPTS	UpPTS		DwPTS	UpPTS	
		Normal cyclic prefix in uplink	Extended cyclic prefix in uplink		Normal cyclic prefix in uplink	Extended cyclic prefix in uplink
0	$6592 \cdot T_s$	$2192 \cdot T_s$	$2560 \cdot T_s$	$7680 \cdot T_s$	$2192 \cdot T_s$	$2560 \cdot T_s$
1	$19760 \cdot T_s$			$20480 \cdot T_s$		
2	$21952 \cdot T_s$			$23040 \cdot T_s$		
3	$24144 \cdot T_s$			$25600 \cdot T_s$		
4	$26336 \cdot T_s$			$7680 \cdot T_s$	$4384 \cdot T_s$	$5120 \cdot T_s$
5	$6592 \cdot T_s$	$4384 \cdot T_s$	$5120 \cdot T_s$	$20480 \cdot T_s$		
6	$19760 \cdot T_s$			$23040 \cdot T_s$		
7	$21952 \cdot T_s$			$12800 \cdot T_s$		
8	$24144 \cdot T_s$			-	-	-
9	$13168 \cdot T_s$			-	-	-

[54] 도 2는 무선 통신 시스템에서 하향링크/상향링크(DL/UL) 슬롯 구조의 일례를 나타낸 것이다. 특히, 도 2는 3GPP LTE/LTE-A 시스템의 자원격자(resource grid)의 구조를 나타낸다. 안테나 포트당 1개의 자원격자가 있다.

[55] 도 2를 참조하면, 슬롯은 시간 도메인에서 복수의 OFDM(Orthogonal Frequency Division Multiplexing) 심볼을 포함하고, 주파수 도메인에서 다수의 자원블록(resource block, RB)을 포함한다. OFDM 심볼은 일 심볼 구간을 의미하기도 한다. 도 2를 참조하면, 각 슬롯에서 전송되는 신호는 $N_{RB}^{DL/UL} * N_{sc}^{RB}$ 개의 부반송파(subcarrier)와 $N_{symb}^{DL/UL}$ 개의 OFDM 심볼로 구성되는 자원격자(resource grid)로 표현될 수 있다. 여기서, N_{RB}^{DL}은 하향링크 슬롯에서의 자원블록(resource block, RB)의 개수를 나타내고, N_{RB}^{UL}은 UL 슬롯에서의 RB의 개수를 나타낸다. N_{RB}^{DL}와 N_{RB}^{UL}은 DL 전송 대역폭과 UL 전송 대역폭에 각각

N_{symb}^{DL} 은 하향링크 슬롯 내 OFDM 심볼의 개수를 나타내며, N_{RB}^{UL} 은 UL 슬롯 내 OFDM 심볼의 개수를 나타낸다. N_{sc}^{RB} 는 하나의 RB를 구성하는 부반송파의 개수를 나타낸다.

[56] OFDM 심볼은 다중 접속 방식에 따라 OFDM 심볼, SC-FDM(Single Carrier Frequency Division Multiplexing) 심볼 등으로 불릴 수 있다. 하나의 슬롯에 포함되는 OFDM 심볼의 수는 채널 대역폭, CP(cyclic prefix)의 길이에 따라 다양하게 변경될 수 있다. 예를 들어, 정규(normal) CP의 경우에는 하나의 슬롯이 7개의 OFDM 심볼을 포함하나, 확장(extended) CP의 경우에는 하나의 슬롯이 6개의 OFDM 심볼을 포함한다. 도 2에서는 설명의 편의를 위하여 하나의 슬롯이 7 OFDM 심볼로 구성되는 서브프레임을 예시하였으나, 본 발명의 실시예들은 다른 개수의 OFDM 심볼을 갖는 서브프레임들에도 마찬가지의 방식으로 적용될 수 있다. 도 2를 참조하면, 각 OFDM 심볼은, 주파수 도메인에서, $N_{RB}^{DL/UL} * N_{sc}^{RB}$ 개의 부반송파를 포함한다. 부반송파의 유형은 데이터 전송을 위한 데이터 부반송파, 참조신호(reference signal)의 전송 위한 참조신호 부반송파, 가드 밴드(guard band) 및 직류(Direct Current, DC) 성분을 위한 널(null) 부반송파로 나뉠 수 있다. DC 성분을 위한 널 부반송파는 미사용인 채 남겨지는 부반송파로서, OFDM 신호 생성 과정 혹은 주파수 상향변환 과정에서 반송파 주파수(carrier frequency, f0)로 맵핑(mapping)된다. 반송파 주파수는 중심 주파수(center frequency)라고도 한다.

[57] 일 RB는 시간 도메인에서 $N_{symb}^{DL/UL}$ 개(예를 들어, 7개)의 연속하는 OFDM 심볼로서 정의되며, 주파수 도메인에서 c개(예를 들어, 12개)의 연속하는 부반송파에 의해 정의된다. 참고로, 하나의 OFDM 심볼과 하나의 부반송파로 구성된 자원을 자원요소(resource element, RE) 혹은 톤(tone)이라고 한다. 따라서, 하나의 RB는 $N_{symb}^{DL/UL} * N_{sc}^{RB}$ 개의 자원요소로 구성된다. 자원격자 내 각 자원요소는 일 슬롯 내 인덱스 쌍 (k, l)에 의해 고유하게 정의될 수 있다. k는 주파수 도메인에서 0부터 $N_{RB}^{DL/UL} * N_{sc}^{RB}$-1까지 부여되는 인덱스이며, l은 시간 도메인에서 0부터 $N_{symb}^{DL/UL}$-1까지 부여되는 인덱스이다.

[58] 일 서브프레임에서 N_{sc}^{RB} 개의 연속하는 동일한 부반송파를 점유하면서, 상기 서브프레임의 2개의 슬롯 각각에 1개씩 위치하는 2개의 RB를 물리자원블록(physical resource block, PRB) 쌍(pair)이라고 한다. PRB 쌍을 구성하는 2개의 RB는 동일한 PRB 번호(혹은, PRB 인덱스(index)라고도 함)를 갖는다. VRB는 자원할당을 위해 도입된 일종의 논리적 자원할당 단위이다. VRB는 PRB와 동일한 크기를 갖는다. VRB를 PRB로 맵핑하는 방식에 따라, VRB는 로컬라이즈(localized) 타입의 VRB와 분산(distributed) 타입의 VRB로 구분된다. 로컬라이즈 타입의 VRB들은 PRB들에 바로 맵핑되어, VRB 번호(VRB 인덱스라고도 함)가 PRB 번호에 바로 대응된다. 즉, $n_{PRB}=n_{VRB}$가 된다. 로컬라이즈 타입의 VRB들에는 0부터 N_{VRB}^{DL}-1순으로 번호가 부여되며, $N_{VRB}^{DL} = N_{RB}^{DL}$

이다. 따라서, 로컬라이즈 맵핑 방식에 의하면, 동일한 VRB 번호를 갖는 VRB가 첫 번째 슬롯과 두 번째 슬롯에서, 동일 PRB 번호의 PRB에 맵핑된다. 반면, 분산 타입의 VRB는 인터리빙을 거쳐 PRB에 맵핑된다. 따라서, 동일한 VRB 번호를 갖는 분산 타입의 VRB는 첫 번째 슬롯과 두 번째 슬롯에서 서로 다른 번호의 PRB에 맵핑될 수 있다. 서브프레임의 두 슬롯에 1개씩 위치하며 동일한 VRB 번호를 갖는 2개의 PRB를 VRB 쌍이라 칭한다.

[59] 도 3은 3GPP LTE/LTE-A 시스템에서 사용되는 하향링크(downlink, DL) 서브프레임 구조를 예시한 것이다.

[60] 도 3을 참조하면, DL 서브프레임은 시간 도메인에서 제어영역(control region)과 데이터영역(data region)으로 구분된다. 도 3을 참조하면, 서브프레임의 첫 번째 슬롯에서 앞부분에 위치한 최대 3(혹은 4)개의 OFDM 심볼은 제어 채널이 할당되는 제어영역(control region)에 대응한다. 이하, DL 서브프레임에서 PDCCH 전송에 이용가능한 자원 영역(resource region)을 PDCCH 영역이라 칭한다. 제어영역으로 사용되는 OFDM 심볼(들)이 아닌 남은 OFDM 심볼들은 PDSCH(Physical Downlink Shared CHannel)가 할당되는 데이터영역(data region)에 해당한다. 이하, DL 서브프레임에서 PDSCH 전송에 이용가능한 자원 영역을 PDSCH 영역이라 칭한다. 3GPP LTE에서 사용되는 DL 제어 채널의 예는 PCFICH(Physical Control Format Indicator Channel), PDCCH(Physical Downlink Control Channel), PHICH(Physical hybrid ARQ indicator Channel) 등을 포함한다. PCFICH는 서브프레임의 첫 번째 OFDM 심볼에서 전송되고 서브프레임 내에서 제어 채널의 전송에 사용되는 OFDM 심볼의 개수에 관한 정보를 나른다. PHICH는 UL 전송에 대한 응답으로 HARQ(Hybrid Automatic Repeat Request) ACK/NACK(acknowledgment/negative-acknowledgment) 신호를 나른다.

[61] PDCCH를 통해 전송되는 제어 정보를 상향링크 제어 정보(downlink control information, DCI)라고 지칭한다. DCI는 UE 또는 UE 그룹을 위한 자원 할당 정보 및 다른 제어 정보를 포함한다. 예를 들어, DCI는 DL 공유 채널(downlink shared channel, DL-SCH)의 전송 포맷 및 자원 할당 정보, UL 공유 채널(uplink shared channel, UL-SCH)의 전송 포맷 및 자원 할당 정보, 페이징 채널(paging channel, PCH) 상의 페이징 정보, DL-SCH 상의 시스템 정보, PDSCH 상에서 전송되는 임의 접속 응답과 같은 상위 계층(upper layer) 제어 메시지의 자원 할당 정보, UE 그룹 내의 개별 UE들에 대한 전송 전력 제어 명령(Transmit Control Command Set), 전송 전력 제어(Transmit Power Control) 명령, VoIP(Voice over IP)의 활성화(activation) 지시 정보, DAI(Downlink Assignment Index) 등을 포함한다. DL 공유 채널(downlink shared channel, DL-SCH)의 전송 포맷(Transmit Format) 및 자원 할당 정보는 DL 스케줄링 정보 혹은 DL 그랜트(DL grant)라고도 불리며, UL 공유 채널(uplink shared channel, UL-SCH)의 전송 포맷 및 자원 할당 정보는 UL 스케줄링 정보 혹은 UL 그랜트(UL grant)라고도 불린다. 일 PDCCH가 나르는 DCI는 DCI 포맷에 따라서 그 크기와 용도가 다르며, 부호화율에 따라 그 크기가

달라질 수 있다. 현재 3GPP LTE 시스템에서는 상향링크용으로 포맷 0 및 4, 하향링크용으로 포맷 1, 1A, 1B, 1C, 1D, 2, 2A, 2B, 2C, 3, 3A 등의 다양한 포맷이 정의되어 있다. DCI 포맷 각각의 용도에 맞게, 호핑 플래그, RB 할당(RB allocation), MCS(modulation coding scheme), RV(redundancy version), NDI(new data indicator), TPC(transmit power control), 순환 천이 DMRS(cyclic shift demodulation reference signal), UL 인덱스, CQI(channel quality information) 요청, DL 할당 인덱스(DL assignment index), HARQ 프로세스 넘버, TPMI(transmitted precoding matrix indicator), PMI(precoding matrix indicator) 정보 등의 제어정보가 취사 선택된 조합이 하향링크 제어정보로서 UE에게 전송된다.

[62] 일반적으로, UE에 구성된 전송 모드(transmission mode, TM)에 따라 상기 UE에게 전송될 수 있는 DCI 포맷이 달라진다. 다시 말해, 특정 전송 모드로 구성된 UE를 위해서는 모든 DCI 포맷이 사용될 수 있는 것이 아니라, 상기 특정 전송 모드에 대응하는 일정 DCI 포맷(들)만이 사용될 수 있다.

[63] PDCCH는 하나 또는 복수의 연속된 제어 채널 요소(control channel element, CCE)들의 집성(aggregation) 상에서 전송된다. CCE는 PDCCH에 무선 채널 상태에 기초한 부호화율(coding rate)를 제공하기 위해 사용되는 논리적 할당 유닛(unit)이다. CCE는 복수의 자원 요소 그룹(resource element group, REG)에 대응한다. 예를 들어, 하나의 CCE는 9개의 REG에 대응되고 하나의 REG는 4개의 RE에 대응한다. 3GPP LTE 시스템의 경우, 각각의 UE을 위해 PDCCH가 위치할 수 있는 CCE 세트를 정의하였다. UE가 자신의 PDCCH를 발견할 수 있는 CCE 세트를 PDCCH 탐색 공간, 간단히 탐색 공간(Search Space, SS)라고 지칭한다. 탐색 공간 내에서 PDCCH가 전송될 수 있는 개별 자원을 PDCCH 후보(candidate)라고 지칭한다. UE가 모니터링(monitoring)할 PDCCH 후보들의 모음은 탐색 공간으로 정의된다. 3GPP LTE/LTE-A 시스템에서 각각의 DCI 포맷을 위한 탐색 공간은 다른 크기를 가질 수 있으며, 전용(dedicated) 탐색 공간과 공통(common) 탐색 공간이 정의되어 있다. 전용 탐색 공간은 UE-특정(specific) 탐색 공간이며, 각각의 개별 UE를 위해 구성(configuration)된다. 공통 탐색 공간은 복수의 UE들을 위해 구성된다. 상기 탐색 공간을 정의하는 집성 레벨(aggregation level)은 다음과 같다.

[64] 표 3

[표3]

Search Space $S_K^{(L)}$			Number of PDCCH candidates $M^{(L)}$
Type	Aggregation Level L	Size[in CCEs]	
UE-specific	1	6	6
	2	12	6
	4	8	2
	8	16	2
Common	4	16	4
	8	16	2

[65] 하나의 PDCCH 후보는 CCE 집성 레벨에 따라 1, 2, 4 또는 8개의 CCE에 대응한다. eNB는 탐색 공간 내의 임의의 PDCCH 후보 상에서 실제 PDCCH (DCI)를 전송하고, UE는 PDCCH (DCI)를 찾기 위해 탐색 공간을 모니터링한다. 여기서, 모니터링이라 함은 모든 모니터링되는 DCI 포맷들에 따라 해당 탐색 공간 내의 각 PDCCH의 복호(decoding)를 시도(attempt)하는 것을 의미한다. UE는 상기 복수의 PDCCH를 모니터링하여, 자신의 PDCCH를 검출할 수 있다. 기본적으로 UE는 자신의 PDCCH가 전송되는 위치를 모르기 때문에, 매 서브프레임마다 해당 DCI 포맷의 모든 PDCCH를 자신의 식별자를 가진 PDCCH를 검출할 때까지 PDCCH의 복호를 시도하는데, 이러한 과정을 블라인드 검출(blind detection)(블라인드 복호(blind decoding, BD))이라고 한다.

[66] eNB는 데이터영역을 통해 UE 혹은 UE 그룹을 위한 데이터를 전송할 수 있다. 상기 데이터영역을 통해 전송되는 데이터를 사용자데이터라 칭하기도 한다. 사용자데이터의 전송을 위해, 데이터영역에는 PDSCH(Physical Downlink Shared CHannel)가 할당될 수 있다. PCH(Paging channel) 및 DL-SCH(Downlink-shared channel)는 PDSCH를 통해 전송된다. UE는 PDCCH를 통해 전송되는 제어정보를 복호하여 PDSCH를 통해 전송되는 데이터를 읽을 수 있다. PDSCH의 데이터가 어떤 UE 혹은 UE 그룹에게 전송되는지, 상기 UE 혹은 UE 그룹이 어떻게 PDSCH 데이터를 수신하고 복호해야 하는지 등을 나타내는 정보가 PDCCH에 포함되어 전송된다. 예를 들어, 특정 PDCCH가 "A"라는 RNTI(Radio Network Temporary Identity)로 CRC(cyclic redundancy check) 마스킹(masking)되어 있고, "B"라는 무선자원(예, 주파수 위치) 및 "C"라는 전송형식정보(예, 전송 블록 사이즈, 변조 방식, 코딩 정보 등)를 이용해 전송되는 데이터에 관한 정보가 특정 DL 서브프레임을 통해 전송된다고 가정한다. UE는 자신이 가지고 있는 RNTI 정보를 이용하여 PDCCH를 모니터링하고, "A"라는 RNTI를 가지고 있는 UE는 PDCCH를 검출하고, 수신한 PDCCH의 정보를 통해 "B"와 "C"에 의해 지시되는

PDSCH를 수신한다.

[67] UE가 eNB로부터 수신한 신호의 복조를 위해서는 데이터 신호와 비교될 참조신호 참조신호(reference signal, RS)가 필요하다. 참조신호라 함은 eNB가 UE로 혹은 UE가 eNB로 전송하는, eNB와 UE가 서로 알고 있는, 기정의된 특별한 파형의 신호를 의미하며, 파일럿(pilot)이라고도 불린다. 참조신호들은 셀 내 모든 UE들에 의해 공용되는 셀-특정(cell-specific) RS와 특정 UE에게 전용되는 복조(demodulation) RS(DM RS)로 구분된다. eNB가 특정 UE를 위한 하향링크 데이터의 복조를 위해 전송하는 DM RS를 UE-특정적(UE-specific) RS라 특별히 칭하기도 한다. 하향링크에서 DM RS와 CRS는 함께 전송될 수도 있으나 둘 중 한 가지만 전송될 수도 있다. 다만, 하향링크에서 CRS없이 DM RS만 전송되는 경우, 데이터와 동일한 프리코더를 적용하여 전송되는 DM RS는 복조 목적으로만 사용될 수 있으므로, 채널측정용 RS가 별도로 제공되어야 한다. 예를 들어, 3GPP LTE(-A)에서는 UE가 채널 상태 정보를 측정할 수 있도록 하기 위하여, 추가적인 측정용 RS인 CSI-RS가 상기 UE에게 전송된다. CSI-RS는 채널상태가 상대적으로 시간에 따른 변화도가 크지 않다는 사실에 기반하여, 매 서브프레임마다 전송되는 CRS와 달리, 다수의 서브프레임으로 구성되는 소정 전송 주기마다 전송된다.

[68] 도 4는 3GPP LTE/LTE-A 시스템에서 사용되는 상향링크(uplink, UL) 서브프레임 구조의 일례를 나타낸 것이다.

[69] 도 4를 참조하면, UL 서브프레임은 주파수 도메인에서 제어영역과 데이터영역으로 구분될 수 있다. 하나 또는 여러 PUCCH(physical uplink control channel)가 상향링크 제어 정보(uplink control information, UCI)를 나르기 위해, 상기 제어영역에 할당될 수 있다. 하나 또는 여러 PUSCH(physical uplink shared channel)가 사용자 데이터를 나르기 위해, UL 서브프레임의 데이터영역에 할당될 수 있다.

[70] UL 서브프레임에서는 DC(Direct Current) 부반송파를 기준으로 거리가 먼 부반송파들이 제어영역으로 활용된다. 다시 말해, UL 전송 대역폭의 양쪽 끝부분에 위치하는 부반송파들이 상향링크 제어정보의 전송에 할당된다. DC 부반송파는 신호 전송에 사용되지 않고 남겨지는 성분으로서, 주파수 상향변환 과정에서 반송파 주파수 f0로 맵핑된다. 일 UE에 대한 PUCCH는 일 서브프레임에서, 일 반송파 주파수에서 동작하는 자원들에 속한 RB 쌍에 할당되며, 상기 RB 쌍에 속한 RB들은 두 개의 슬롯에서 각각 다른 부반송파를 점유한다. 이와 같이 할당되는 PUCCH를, PUCCH에 할당된 RB 쌍이 슬롯 경계에서 주파수 호핑된다고 표현한다. 다만, 주파수 호핑이 적용되지 않는 경우에는, RB 쌍이 동일한 부반송파를 점유한다.

[71] PUCCH는 다음의 제어 정보를 전송하는데 사용될 수 있다.

[72] - SR(Scheduling Request): 상향링크 UL-SCH 자원을 요청하는데 사용되는 정보이다. OOK(On-Off Keying) 방식을 이용하여 전송된다.

[73] - HARQ-ACK: PDCCH에 대한 응답 및/또는 PDSCH 상의 하향링크 데이터 패킷(예, 코드워드)에 대한 응답이다. PDCCH 혹은 PDSCH가 성공적으로 수신되었는지 여부를 나타낸다. 단일 하향링크 코드워드에 대한 응답으로 HARQ-ACK 1비트가 전송되고, 두 개의 하향링크 코드워드에 대한 응답으로 HARQ-ACK 2비트가 전송된다. HARQ-ACK 응답은 포지티브 ACK(간단히, ACK), 네거티브 ACK(이하, NACK), DTX(Discontinuous Transmission) 또는 NACK/DTX를 포함한다. 여기서, HARQ-ACK이라는 용어는 HARQ ACK/NACK, ACK/NACK과 혼용된다.

[74] - CSI(Channel State Information): 하향링크 채널에 대한 피드백 정보(feedback information)이다. MIMO(Multiple Input Multiple Output)-관련 피드백 정보는 RI(Rank Indicator) 및 PMI(Precoding Matrix Indicator)를 포함한다.

[75] UE가 서브프레임에서 전송할 수 있는 상향링크 제어정보(UCI)의 양은 제어 정보 전송에 가용한 SC-FDMA의 개수에 의존한다. UCI에 가용한 SC-FDMA는 서브프레임에서 참조 신호 전송을 위한 SC-FDMA 심볼을 제외하고 남은 SC-FDMA 심볼을 의미하고, SRS(Sounding Reference Signal)가 구성된 서브프레임의 경우에는 서브프레임의 마지막 SC-FDMA 심볼도 제외된다. 참조 신호는 PUCCH의 코히런트(coherent) 검출에 사용된다. PUCCH는 전송되는 정보에 따라 다양한 포맷을 지원한다.

[76] 표 4는 LTE/LTE-A 시스템에서 PUCCH 포맷과 UCI의 맵핑 관계를 나타낸다.

[77] 표 4

[표4]

PUCCH format	Modulation scheme	Number of bits per subframe	Usage	Etc.
1	N/A	N/A (exist or absent)	SR (Scheduling Request)	
1a	BPSK	1	ACK/NACK orSR + ACK/NACK	One codeword
1b	QPSK	2	ACK/NACK orSR + ACK/NACK	Two codeword
2	QPSK	20	CQI/PMI/RI	Joint coding ACK/NACK (extended CP)
2a	QPSK+BPSK	21	CQI/PMI/RI + ACK/NACK	Normal CP only
2b	QPSK+QPSK	22	CQI/PMI/RI + ACK/NACK	Normal CP only
3	QPSK	48	ACK/NACK orSR + ACK/NACK orCQI/PMI/RI + ACK/NACK	

[78] 표 4를 참조하면, PUCCH 포맷 1 계열은 주로 ACK/NACK 정보를 전송하는 데 사용되며, PUCCH 포맷 2 계열은 주로 CQI/PMI/RI 등의 채널상태정보(channel state information, CSI)를 나르는 데 사용되고, PUCCH 포맷 3 계열은 주로 ACK/NACK 정보를 전송하는 데 사용된다.

[79] **코드북 기반 프리코딩 기법**

[80] 다중 안테나 전송을 지원하기 위하여 전송 정보를 각각의 안테나에 채널 상황 등에 따라 적절하게 분배해주는 프리코딩(precoding)을 적용할 수 있다. 코드북(Codebook) 기반의 프리코딩 기법은, 송신단과 수신단에서 프리코딩 행렬의 집합을 미리 정하여 두고, 수신단이 송신단으로부터의 채널정보를 측정하여 가장 알맞은 프리코딩 행렬이 무엇인지(즉, 프리코딩 행렬 인덱스(Precoding Matrix Index; PMI)를 송신단에게 피드백하여 주고, 송신단은 PMI에 기초하여 적절한 프리코딩을 신호 전송에 적용하는 기법을 말한다. 미리 정해둔 프리코딩 행렬 집합 중에서 적절한 프리코딩 행렬을 선택하는 방식이므로, 항상 최적의 프리코딩이 적용되는 것은 아니지만, 실제 채널 정보에 최적의 프리코딩 정보를 명시적으로(explicitly) 피드백하는 것에 비하여 피드백

오버헤드를 줄일 수 있는 장점이 있다.

[81] 도 5는 코드북 기반 프리코딩의 기본 개념을 설명하기 위한 도면이다.

[82] 코드북 기반 프리코딩 방식에 따를 경우, 송신단과 수신단은 전송 랭크, 안테나 개수 등에 따라 미리 정해진 소정 개수의 프리코딩 행렬들을 포함하는 코드북 정보를 공유하게 된다. 즉, 피드백 정보가 유한한(finite) 경우에 프리코딩 기반 코드북 방식이 사용될 수 있다. 수신단은 수신 신호를 통해 채널 상태를 측정하여, 상술한 코드북 정보를 기반으로 유한한 개수의 선호하는 프리코딩 행렬 정보(즉, 해당 프리코딩 행렬의 인덱스)를 송신단에 피드백할 수 있다. 예를 들어, 수신단에서는 ML(Maximum Likelihood) 또는 MMSE(Minimum Mean Square Error) 방식으로 수신 신호를 측정하여 최적의 프리코딩 행렬을 선택할 수 있다. 도 5에서는 수신단이 송신단에 프리코딩 행렬 정보를 코드워드별로 전송하는 것을 도시하고 있으나, 이에 한정될 필요는 없다.

[83] 수신단으로부터 피드백 정보를 수신한 송신단은 수신된 정보에 기반하여 코드북으로부터 특정 프리코딩 행렬을 선택할 수 있다. 프리코딩 행렬을 선택한 송신단은 전송 랭크에 대응하는 개수의 레이어 신호에 선택된 프리코딩 행렬을 곱하는 방식으로 프리코딩을 수행하며, 프리코딩이 수행된 전송 신호를 복수의 안테나를 통해 전송할 수 있다. 프리코딩 행렬에서 행(row)의 개수는 안테나의 개수와 동일하며, 열(column)의 개수는 랭크 값과 동일하다. 랭크 값은 레이어의 개수와 동일하므로, 열(column)의 개수는 레이어 개수와 동일하다. 예를 들어, 전송 안테나의 개수가 4 이고 전송 레이어의 개수가 2 인 경우에는 프리코딩 행렬이 4by2 행렬로 구성될 수 있다. 프리코딩 행렬을 통하여 각각의 레이어를 통해 전송되는 정보가 각각의 안테나에 매핑될 수 있다.

[84] 송신단에서 프리코딩되어 전송된 신호를 수신한 수신단은 송신단에서 이루어진 프리코딩의 역처리를 수행하여 수신 신호를 복원할 수 있다. 일반적으로 프리코딩 행렬은 $U^{*}U^{H} = I$와 같은 유니터리 행렬(U) 조건을 만족하는바, 상술한 프리코딩의 역처리는 송신단의 프리코딩에 이용된 프리코딩 행렬(P)의 에르미트(Hermit) 행렬 (P^{H})을 수신 신호에 곱하는 방식으로 이루어질 수 있다.

[85] 예를 들어, 다음의 표 5는 3GPP LTE 릴리즈-8/9 에서 2-tx(전송) 안테나를 사용한 하향링크 전송에 사용되는 코드북을 나타내는 것이고, 표 6은 3GPP LTE 릴리즈-8/9 에서 4-tx(전송) 안테나를 사용한 하향링크 전송에 사용되는 코드북을 나타내는 것이다.

[86] 표 5

[표5]

Codebook index	Number of layers υ	
	1	2
0	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}$
1	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-1\end{bmatrix}$	$\frac{1}{2}\begin{bmatrix}1 & 1\\1 & -1\end{bmatrix}$
2	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\j\end{bmatrix}$	$\frac{1}{2}\begin{bmatrix}1 & 1\\j & -j\end{bmatrix}$
3	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	-

[87] 표 6

[표6]

Codebook index	u_n	Number of layers υ			
		1	2	3	4
0	$u_0=[1\ \ -1\ \ -1\ \ -1]^T$	$W_0^{\{1\}}$	$W_0^{\{14\}}/\sqrt{2}$	$W_0^{\{124\}}/\sqrt{3}$	$W_0^{\{1234\}}/2$
1	$u_1=[1\ \ -j\ \ 1\ \ j]^T$	$W_1^{\{1\}}$	$W_1^{\{12\}}/\sqrt{2}$	$W_1^{\{123\}}/\sqrt{3}$	$W_1^{\{1234\}}/2$
2	$u_2=[1\ \ 1\ \ -1\ \ 1]^T$	$W_2^{\{1\}}$	$W_2^{\{12\}}/\sqrt{2}$	$W_2^{\{123\}}/\sqrt{3}$	$W_2^{\{3214\}}/2$
3	$u_3=[1\ \ j\ \ 1\ \ -j]^T$	$W_3^{\{1\}}$	$W_3^{\{12\}}/\sqrt{2}$	$W_3^{\{123\}}/\sqrt{3}$	$W_3^{\{3214\}}/2$
4	$u_4=[1\ \ (-1-j)/\sqrt{2}\ \ -j\ \ (1-j)/\sqrt{2}]^T$	$W_4^{\{1\}}$	$W_4^{\{14\}}/\sqrt{2}$	$W_4^{\{124\}}/\sqrt{3}$	$W_4^{\{1234\}}/2$
5	$u_5=[1\ \ (1-j)/\sqrt{2}\ \ j\ \ (-1-j)/\sqrt{2}]^T$	$W_5^{\{1\}}$	$W_5^{\{14\}}/\sqrt{2}$	$W_5^{\{124\}}/\sqrt{3}$	$W_5^{\{1234\}}/2$
6	$u_6=[1\ \ (1+j)/\sqrt{2}\ \ -j\ \ (-1+j)/\sqrt{2}]^T$	$W_6^{\{1\}}$	$W_6^{\{13\}}/\sqrt{2}$	$W_6^{\{134\}}/\sqrt{3}$	$W_6^{\{1324\}}/2$
7	$u_7=[1\ \ (-1+j)/\sqrt{2}\ \ j\ \ (1+j)/\sqrt{2}]^T$	$W_7^{\{1\}}$	$W_7^{\{13\}}/\sqrt{2}$	$W_7^{\{134\}}/\sqrt{3}$	$W_7^{\{1324\}}/2$
8	$u_8=[1\ \ -1\ \ 1\ \ 1]^T$	$W_8^{\{1\}}$	$W_8^{\{12\}}/\sqrt{2}$	$W_8^{\{124\}}/\sqrt{3}$	$W_8^{\{1234\}}/2$
9	$u_9=[1\ \ -j\ \ -1\ \ -j]^T$	$W_9^{\{1\}}$	$W_9^{\{14\}}/\sqrt{2}$	$W_9^{\{134\}}/\sqrt{3}$	$W_9^{\{1234\}}/2$
10	$u_{10}=[1\ \ 1\ \ 1\ \ -1]^T$	$W_{10}^{\{1\}}$	$W_{10}^{\{13\}}/\sqrt{2}$	$W_{10}^{\{123\}}/\sqrt{3}$	$W_{10}^{\{1324\}}/2$
11	$u_{11}=[1\ \ j\ \ -1\ \ j]^T$	$W_{11}^{\{1\}}$	$W_{11}^{\{13\}}/\sqrt{2}$	$W_{11}^{\{134\}}/\sqrt{3}$	$W_{11}^{\{1324\}}/2$
12	$u_{12}=[1\ \ -1\ \ -1\ \ 1]^T$	$W_{12}^{\{1\}}$	$W_{12}^{\{12\}}/\sqrt{2}$	$W_{12}^{\{123\}}/\sqrt{3}$	$W_{12}^{\{1234\}}/2$
13	$u_{13}=[1\ \ -1\ \ 1\ \ -1]^T$	$W_{13}^{\{1\}}$	$W_{13}^{\{13\}}/\sqrt{2}$	$W_{13}^{\{123\}}/\sqrt{3}$	$W_{13}^{\{1324\}}/2$
14	$u_{14}=[1\ \ 1\ \ -1\ \ -1]^T$	$W_{14}^{\{1\}}$	$W_{14}^{\{13\}}/\sqrt{2}$	$W_{14}^{\{123\}}/\sqrt{3}$	$W_{14}^{\{3214\}}/2$
15	$u_{15}=[1\ \ 1\ \ 1\ \ 1]^T$	$W_{15}^{\{1\}}$	$W_{15}^{\{12\}}/\sqrt{2}$	$W_{15}^{\{123\}}/\sqrt{3}$	$W_{15}^{\{1234\}}/2$

[88] 상기 표 6에서, $W_n^{\{s\}}$는 $W_n = I - 2u_n u_n^H / u_n^H u_n$와 같이 표현되는 수학식으로부터 구성되는 세트 {S}로 얻어진다. 이 때,I는 4×4 단일행렬을 나타내고 U_n는 표 6에서 주어지는 값이다.

[89] 상기 표 5에서 나타내는 바와 같이, 2 개의 송신안테나에 대한 코드북의 경우 총 7개의 프리코딩 벡터/행렬을 가지고 있으며 여기서, 단일 행렬은

개-루프(open-loop) 시스템을 위한 것이므로, 폐-루프(loop) 시스템의 프리코딩을 위한 프리코딩 벡터/행렬은 총 6개가 된다. 또한, 상기 표 6과 같은 4개의 송신안테나에 대한 코드북의 경우 총 64개의 프리코딩 벡터/행렬을 가지고 있다.

[90] 위와 같은 코드북은 일정 모듈러스(Constant modulus; CM) 특성, 네스티드 특성(Nested property), 제한된 알파벳(Constrained alphabet) 등의 공통적인 특성을 가진다. CM 특성은 코드북 내의 모든 프리코딩 행렬의 각각의 요소(element)는 '0'을 포함하지 않으며, 같은 크기를 가지도록 구성되는 특성이다. 네스티드 특성은, 낮은 랭크의 프리코딩 행렬이 높은 랭크의 프리코딩 행렬의 특정 열의 서브셋(subset) 으로 구성되도록 설계된 것을 의미한다. 제한된 알파벳 특성은, 코드북 내의 모든 프리코딩 행렬의 각각의 요소(element)가 제한되는 것을 의미한다. 예를 들어, 프리코딩 행렬의 각각의 요소가 BPSK(Binary Phase Shift Keying)에 사용되는 요소(±1)로만 제한되거나, QPSK(Quadrature Phase Shift Keying) 에 사용되는 요소(±1,±j)로만 제한되거나, 또는 8-PSK 에 사용되는 요소($\pm 1, \pm j, \pm\frac{(1+j)}{\sqrt{2}}, \pm\frac{(-1+j)}{\sqrt{2}}$)로만 제한될 수 있다. 상기 표 5의 코드북의 예시에서는 코드북 내의 모든 프리코딩 행렬의 각각의 요소(element)의 알파벳이 $\pm 1, \pm j, \pm\frac{(1+j)}{\sqrt{2}}, \pm\frac{(-1+j)}{\sqrt{2}}$ 으로 구성되므로, 제한된 알파벳 특성을 가진다고 표현할 수 있다.

[91] **참조 신호 (Reference Signal; RS)**

[92] 무선 통신 시스템에서 패킷을 전송할 때, 전송되는 패킷은 무선 채널을 통해서 전송되기 때문에 전송과정에서 신호의 왜곡이 발생할 수 있다. 왜곡된 신호를 수신측에서 올바로 수신하기 위해서는 채널 정보를 이용하여 수신 신호에서 왜곡을 보정하여야 한다. 채널 정보를 알아내기 위해서, 송신측과 수신측에서 모두 알고 있는 신호를 전송하여, 상기 신호가 채널을 통해 수신될 때의 왜곡 정도를 가지고 채널 정보를 알아내는 방법을 주로 사용한다. 상기 신호를 파일럿 신호(Pilot Signal) 또는 참조신호(Reference Signal)라고 한다.

[93] 다중안테나를 사용하여 데이터를 송수신하는 경우에는 각 송신 안테나와 수신 안테나 사이의 채널 상황을 알아야 올바른 신호를 수신할 수 있다. 따라서, 각 송신 안테나 별로, 좀더 자세하게는 안테나 포트(안테나 포트)별로 별도의 참조신호가 존재하여야 한다.

[94] 참조신호는 상향링크 참조신호와 하향링크 참조신호로 구분될 수 있다. 현재 LTE 시스템에는 상향링크 참조신호로써,

[95] i) PUSCH 및 PUCCH를 통해 전송된 정보의 코히런트(coherent)한 복조를 위한 채널 추정을 위한 복조 참조신호(DeModulation-Reference Signal, DM-RS)

[96] ii) 기지국이, 네트워크가 다른 주파수에서의 상향링크 채널 품질을 측정하기 위한 사운딩 참조신호(Sounding Reference Signal, SRS)가 있다.

[97] 한편, 하향링크 참조신호에는,

[98] i) 셀 내의 모든 단말이 공유하는 셀-특정 참조신호(Cell-specific Reference Signal, CRS)

[99] ii) 특정 단말만을 위한 단말-특정 참조신호(UE-specific Reference Signal)

[100] iii) PDSCH가 전송되는 경우 코히런트한 복조를 위해 전송되는 (DeModulation-Reference Signal, DM-RS)

[101] iv) 하향링크 DMRS가 전송되는 경우 채널 상태 정보(Channel State Information; CSI)를 전달하기 위한 채널상태정보 참조신호(Channel State Information-Reference Signal, CSI-RS)

[102] v) MBSFN(Multimedia Broadcast Single Frequency Network) 모드로 전송되는 신호에 대한 코히런트한 복조를 위해 전송되는 MBSFN 참조신호(MBSFN Reference Signal)

[103] vi) 단말의 지리적 위치 정보를 추정하는데 사용되는 위치 참조신호(Positioning Reference Signal)가 있다.

[104] 참조신호는 그 목적에 따라 크게 두 가지로 구분될 수 있다. 채널 정보 획득을 위한 목적의 참조신호와 데이터 복조를 위해 사용되는 참조신호가 있다. 전자는 UE가 하향 링크로의 채널 정보를 획득할 수 있는데 그 목적이 있으므로, 광대역으로 전송되어야 하고, 특정 서브 프레임에서 하향 링크 데이터를 수신하지 않는 단말이라도 그 참조신호를 수신하여야 한다. 또한 이는 핸드 오버 등의 상황에서도 사용된다. 후자는 기지국이 하향링크를 보낼 때 해당 자원에 함께 보내는 참조신호로서, 단말은 해당 참조신호를 수신함으로써 채널 측정을 하여 데이터를 복조할 수 있게 된다. 이 참조신호는 데이터가 전송되는 영역에 전송되어야 한다.

[105] 앞서 언급한 것처럼, LTE 시스템에서는 유니캐스트 서비스를 위해서 셀-특정 RS(CRS)와 UE-특정 RS의 두 가지 종류의 하향링크 RS가 정의되어 있다. UE-특정 RS는 데이터 복조용으로만 사용되며 CRS는 데이터 복조 이외에도 CSI 획득 및 핸드오버 등의 RRM 측정 등의 목적으로 모두 사용된다. CRS는 시스템 전체 대역에 대해서 매 서브프레임마다 전송되며, 기지국의 전송 안테나 개수에 따라서 최대 4개의 안테나 포트에 대한 RS가 전송된다. 예를 들어 기지국의 송신 안테나의 개수가 두 개일 경우, 0번과 1번 안테나 포트에 대한 CRS가 전송되고, 네 개인 경우 0 내지 3 번 안테나 포트에 대한 CRS가 각각 전송된다.

[106] LTE-A 시스템에서 기지국의 하향링크로 최대 8개의 송신 안테나를 지원한다. LTE-A 시스템에서 기존 LTE의 CRS와 같은 방식으로 최대 8개의 송신 안테나에 대한 RS를 매 서브프레임마다 전 대역에 전송하게 되면 RS 오버헤드가 지나치게 커지게 된다. 따라서, LTE-A 시스템에서는 MCS, PMI 등의 선택을 위한 CSI 측정 목적의 CSI-RS와 데이터 복조를 위한 DM-RS로 분리되어 두 개의 RS가 추가되었다. CSI-RS는 RRM 측정 등의 목적으로도 사용될 수는 있지만 CSI 획득의 주목적을 위해서 디자인되었다. CSI-RS는 데이터 복조에 사용되지 않으므로 매 서브프레임마다 전송될 필요는 없다. 그러므로 CSI-RS의

오버헤드를 줄이기 위하여 시간 축 상에서 간헐적으로 전송하도록 한다. 데이터 복조를 위해서는 해당 시간-주파수 영역에서 스케줄링된 UE에게 전용(dedicatedly)으로 DM-RS가 전송된다. 즉, 특정 UE의 DM-RS는 해당 UE가 스케줄링된 영역, 즉 데이터를 수신받는 시간-주파수 영역에만 전송된다.

[107] 도 6은 LTE-A 시스템에서 12개의 서브캐리어로 구성된 RB에서 8개 안테나 포트를 갖는 CSI-RS의 전송 가능한 패턴을 나타낸 것으로서, 하나의 안테나 포트에 대한 RS는 두개의 OFDM 심볼에 걸쳐서 확산(spread)되어 전송되며 두 RS가 두 RE를 공유하며 직교 코드를 사용하여 구분된다. 예를 들어, 숫자 0과 1로 표현된 RE는 CSI-RS 포트 0과 1이 전송되는 두 RE를 의미한다. 본 명세서에서는 설명의 편의를 위해서 CSI-RS 포트 0, 1 등과 같은 표현을 사용하며, CRS나 UE-특정 RS와 같은 다른 종류의 RS와의 구분을 위해서 CSI-RS 포트 0, 1 등은 포트 15, 16 등과 같은 인덱스를 가질 수 있다. CSI-RS는 8 포트 이외에도 1, 2, 4 포트를 가지도록 설정될 수 있다.

[108] 표 7은 일반 CP의 전송 방식에서 N-포트 CSI-RS의 전송 RE의 위치를 RB내에서 서브캐리어 인덱스 k와 OFDM 심볼 인덱스 l, 그리고 슬롯 인덱스 n_s로 나타내고 있다. 표에 나타나있듯이 LTE 시스템의 프레임 구조 타입 1(FDD모드)과 타입 2(TDD모드)에 공통으로 8-포트 CSI-RS는 하나의 서브프레임에서 5개의 전송 패턴만을 갖는다. 도 7은 2-포트, 4-포트, 그리고 8-포트 CSI-RS의 전송 패턴을 도시한다.

[109] 표 7

[표7]

	CSI-RS configuration	Number of CSI-RSs configured					
		1 or 2		4		8	
		(k',l')	$n_s$mod2	(k',l')	$n_s$mod2	(k',l')	$n_s$mod2
FS-1 and FS-2	0	(9,5)	0	(9,5)	0	(9,5)	0
	1	(11,2)	1	(11,2)	1	(11,2)	1
	2	(9,2)	1	(9,2)	1	(9,2)	1
	3	(7,2)	1	(7,2)	1	(7,2)	1
	4	(9,5)	1	(9,5)	1	(9,5)	1
	5	(8,5)	0	(8,5)	0		
	6	(10,2)	1	(10,2)	1		
	7	(8,2)	1	(8,2)	1		
	8	(6,2)	1	(6,2)	1		
	9	(8,5)	1	(8,5)	1		
	10	(3,5)	0				
	11	(2,5)	0				
	12	(5,2)	1				
	13	(4,2)	1				
	14	(3,2)	1				
	15	(2,2)	1				
	16	(1,2)	1				
	17	(0,2)	1				
	18	(3,5)	1				
	19	(2,5)	1				

[110] 현재 LTE 표준에서 CSI-RS 설정(configuration)은 antennaPortsCount, subframeConfig, resourceConfig 등으로 구성되어 있어, CSI-RS가 몇 개의 안테나 포트에서 전송되는지, CSI-RS가 전송될 서브프레임의 주기 및 오프셋이 어떻게 되는지, 그리고 해당 서브프레임에서 어떤 RE 위치(주파수와 OFDM 심볼 인덱스)에서 전송되는지 알려준다. 구체적으로 기지국은 특정 CSI-RS 설정을 UE에게 전달할 때 다음과 같은 내용의 정보들을 전달한다.

[111] - ***antennaPortsCount*** : CSI 참조 신호들의 전송에 사용되는 안테나 포트들의 수를 나타내는 파라미터 (예컨대, 1 CSI-RS 포트, 2 CSI-RS 포트, 4 CSI-RS 포트

또는 8 CSI-RS 포트)

[112] - ***resourceConfig*** : CSI-RS 할당 자원 위치에 관한 파라미터

[113] - ***subframeConfig*** : CSI-RS가 전송될 서브프레임 주기 및 오프셋에 관한 파라미터

[114] - ***p-C*** : CSI 피드백 CSI-RS를 위해 참조 PDSCH 전송 전력에 대한 UE의 가정에 관한 것이며, Pc는 UE가 CSI 피드백을 도출할 때 1dB 스텝 사이즈로 [-8, 15]dB 범위의 값들을 가질 수 있을 때, PDSCH EPRE(energy per resource element)에 대한 CSI-RS EPRE의 비율에 해당한다.

[115] - ***zeroTxPowerResourceConfigList*** : 제로-전력(zero-power) CSI-RS 설정에 관한 파라미터

[116] - ***zeroTxPowerSubframeConfig*** : 제로 전력 CSI-RS가 전송될 서브프레임 주기 및 오프셋에 관한 파라미터

[117] 진화된 무선 통신 시스템에서는 능동 안테나 시스템(active antenna system: 이하 AAS)의 도입이 고려되고 있다. 신호의 위상 및 크기를 조정할 수 있는 증폭기와 안테나가 분리되어 있는 기존의 수동 안테나 시스템과 달리, AAS는 각각의 안테나가 증폭기와 같은 능동 소자를 포함하도록 구성된 시스템을 의미한다. 상기 AAS는 능동 안테나 사용에 따라 증폭기와 안테나를 연결하기 위한 별도의 케이블, 커넥터, 기타 하드웨어 등이 필요하지 않고, 따라서 에너지 및 운용 비용 측면에서 효율성이 높은 특징을 갖는다. 특히 상기 AAS는 각 안테나 별 전자식 빔 제어(electronic beam control) 방식을 지원하기 때문에 빔 방향 및 빔 폭을 고려한 정교한 빔 패턴 형성 또는 3차원 빔 패턴을 형성하는 등의 진보된 MIMO 기술을 가능하게 한다.

[118] 상기 AAS 등의 진보된 안테나 시스템의 도입으로 다수의 입출력 안테나와 다차원 안테나 구조를 갖는 대규모 MIMO 구조 또한 고려되고 있다. 일례로 기존의 일자 형 안테나 배열과 달리 2차원 안테나 배열을 형성할 경우, AAS의 능동 안테나에 의해 3차원 빔 패턴을 형성할 수 있다. 일반적인 2차원 안테나 배열로써 도 8에 도시된 것처럼, $N_t=N_v \cdot N_h$ 개의 안테나가 정방향의 모양을 갖는 경우를 고려할 수 있다. 여기서, N_h는 안테나 열의 수, N_v는 안테나 행의 수를 나타낸다.

[119] 송신 안테나 관점에서 상기 3차원 빔 패턴을 활용할 경우, 빔의 수평 방향뿐만 아니라 수직 방향으로의 준-정적 또는 동적인 빔 형성을 수행할 수 있으며 일례로 수직 방향의 섹터 형성 등의 응용을 고려할 수 있다. 또한, 수신 안테나 관점에서는 대규모 안테나를 활용하여 수신 빔을 형성할 때, 안테나 배열 이득(antenna array gain)에 따른 신호 전력 상승 효과를 기대할 수 있다. 따라서 상향링크의 경우, 기지국이 다수의 안테나를 통해 단말로부터 전송되는 신호를 수신할 수 있으며, 이때 단말은 간섭 영향을 줄이기 위해 대규모 수신 안테나의 이득을 고려하여 자신의 송신 전력을 매우 낮게 설정할 수 있는 장점이 있다. 도 9는 상기 예를 도식화 한 것으로 기지국 또는 단말이 AAS 기반의 3D 빔 형성이

가능한 다수의 송/수신 안테나를 갖고 있는 시스템을 도시한 것이다.

[120] 본 발명에서는 FDM(frequency division multiplexing)+TDM(time division multiplexing) 방식에서 동일 OFDM(orthogonal frequency division multiplexing) 심볼에 전송되는 RS(reference signal)들의 안테나 포트들을 그룹핑하고, 물리적 안테나 엘리먼트들도 그룹핑하여 안테나 포트 그룹내의 각 안테나 포트가 서로 다른 안테나 엘리먼트 그룹의 다수의 안테나 엘리먼트들을 통해 전송되도록 한다. 제안 방식에서 데이터 전송 및 CSI 보고를 위한 프리코딩 행렬의 코드북은 안테나 포트 그룹 선택을 위한 선택 코드북과 선택된 안테나 포트 그룹에서 사용할 빔패턴을 결정하기 위한 상수 모듈러스 코드북(constant modulus codebook)을 결합하여 사용한다.

[121] 제안방식에서 선택 코드북은 안테나 포트 그룹 중에서 어떤 그룹들을 사용할지에 대한 정보를 알려주기 위해 사용되며, 상수 모듈러스 코드북은 해당 안테나 포트 그룹내의 포트들에게 어떤 프리코딩을 적용할지에 대한 정보를 알려주기 위해 사용된다.

[122] [안테나 당 전송 전력 제한]

[123] 기지국 안테나가 N_t개이고 기지국 송신기의 최대 전송 전력이 P_t[Watt]로 허용되어 있는 경우에, 각 안테나당 최대 전송 전력 능력은 $P_a=P_t/N_t$를 갖는 것이 안테나의 앰프 크기 및 가격 측면에서 가장 효율적이다. 여기서, 안테나 당 앰프는 독립된 소자로 구성되어 안테나 앰프간의 전송 전력 교환은 불가능한 경우를 고려한다. 즉, 각 안테나의 전송 전력 능력을 다 사용해야 기지국 송신기의 최대 전송 전력으로 신호 전송이 가능하다.

[124] OFDM 전송 방식에서 각 안테나 포트의 전송 OFDM 심볼의 특정 서브캐리어를 RE(resource element)라고 명칭하고, n-번째 안테나 포트의 n-번째 OFDM 심볼의 k-번째 서브캐리어의 RE를 RE(k,l,n)으로 표시한다. 그리고 각 안테나 포트의 RE당 전송되는 평균 에너지를 EPRE(energy per resource element)라고 부르도록 한다. 전송 시간이 T인 K개의 서브캐리어로 구성된 OFDM 전송 방식에서 각 RE 당 모든 안테나를 합친 전체 평균 전송 에너지는 $E_t=T\cdot P_t/K$이며, 각 안테나 포트의 RE당 평균 전송 에너지, 즉 EPRE는 $E_t=T\cdot P_a/K$이다. K개의 서브캐리어는 단일 앰프에 의해 증폭 전송되므로 서브캐리어간의 전송 전력 교환은 용이하다. 즉, 동일 OFDM 심볼에서 K개의 서브캐리어 전체의 전송 에너지가 $K\cdot E_a$를 초과하지 않으면 된다.

[125] [안테나 포트 맵핑]

[126] 안테나 포트는 논리적 안테나의 개념으로 실질적인 (물리) 안테나 엘리먼트를 의미하지는 않는다. 그러므로 안테나 포트를 가상 안테나로, 그리고 안테나 엘리먼트를 물리 안테나로 부르기도 한다. 각 논리적 안테나 포트가 물리적 안테나 엘리먼트에 맵핑되는 방식은 전체 MIMO 시스템을 설계하는데 중요한 요소이다. 안테나 맵핑 방식으로 안테나 포트를 하나의 안테나 엘리먼트에 맵핑하는 일대일 맵핑과 안테나 포트를 다수의 안테나 엘리먼트에 맵핑하는

일대다 맵핑을 고려할 수 있다.

[127] 안테나 포트에서 안테나 엘리먼트로의 맵핑은 다음의 수학식에서 가상화 행렬 B로 표현된다. 여기서, x는 안테나 포트에서의 전송 신호를 나타내며, z는 안테나 엘리먼트에서의 전송 신호를 나타낸다. 안테나 포트의 개수는 안테나 엘리먼트의 개수보다 작아도 되지만, 설명의 편의를 위해 안테나 포트의 개수도 N_t인 경우를 고려한다. b_n은 n번째 안테나 포트가 안테나 엘리먼트들에 맵핑되는 관계를 나타내는 가상화 벡터를 나타낸다. 가상화 벡터 b_n의 비-제로 엘리먼트(non-zero element)가 한 개이면 일대일 맵핑 방식을 의미하며 다수개일 경우에는 일대다 맵핑 방식을 나타낸다.

[128] 수학식 1

[수식1]

$$z=Bx=\left[\begin{array}{cccc} b_0 & b_1 & \cdots & b_{N_t-1} \end{array}\right]x$$

[129] 여기서 안테나 포트에서의 신호 에너지와 안테나 엘리먼트에서의 신호 에너지가 동일하기 위해 가상화 벡터는

$$||b_n||=1$$

로 노멀라이즈(normalized)되었다고 가정한다.

[130] [데이터 프리코딩 및 수신 신호]

[131] 전송 데이터 레이어가 R개인 데이터 전송을 위해서 전송 데이터 심볼 벡터는 아래 수학식처럼 프리코딩에 의해 N_t개 안테나 각각을 통해 전송되게 되는데, 이때 전송 전력이 최대 전력 P_t이기 위하여 프리코딩 행렬 W는 각 엘리먼트가 동일 크기를 갖는, 즉

$|w_{i,j}|^2 = 1/R$

인 것이 바람직하다. 동시에 전송되는 데이터 레이어 개수 R은 스트림 개수 또는 랭크(rank)로 부르기도 한다.

[132] 수학식 2

[수식2]

$$\mathbf{x}=\sqrt{E_a}\mathbf{W}\mathbf{s}=\sqrt{E_a}\begin{bmatrix} w_{0,0} & w_{0,1} & \cdots & w_{0,R-1} \\ w_{1,0} & w_{1,1} & \cdots & w_{1,R-1} \\ \vdots & \vdots & \ddots & \vdots \\ w_{Nt-1,0} & w_{Nt-1,1} & \cdots & w_{Nt-1,R-1} \end{bmatrix}\begin{bmatrix} s_0 \\ s_1 \\ \vdots \\ s_{R-1} \end{bmatrix}.$$

[133] 수학식 3

[수식3]

$$\mathbf{z} = \mathbf{Bx} = \sqrt{E_a}\mathbf{BWs} = \sqrt{E_a}\begin{bmatrix} w'_{0,0} & w'_{0,1} & \cdots & w'_{0,R-1} \\ w'_{1,0} & w'_{1,1} & \cdots & w'_{1,R-1} \\ \vdots & \vdots & \ddots & \vdots \\ w'_{Nt-1,0} & w'_{Nt-1,1} & \cdots & w'_{Nt-1,R-1} \end{bmatrix}\begin{bmatrix} s_0 \\ s_1 \\ \vdots \\ s_{R-1} \end{bmatrix}.$$

[134] 수학식3의 전송 신호는 채널을 통과한 후에 N_r개의 수신 안테나를 갖는 수신기에 수신되는데, 수신 신호는 다음의 수학식으로 표현될 수 있다. 여기서, H는 $N_r \times N_t$채널 행렬을 나타내며, n은 $N_r \times 1$ 노이즈 벡터를 나타낸다.

[135] 수학식 4

[수식4]

$$\mathbf{y} = \mathbf{Hz} + \mathbf{n} = \sqrt{E_a}\mathbf{HBWs} + \mathbf{n}.$$

[136] 데이터 복조를 위해서는 유효 채널 H·B·W을 알면 되므로, DM-RS 전송을 통해 유효 채널을 직접적으로 추정하는 방법도 가능하다. 그러나 전송 효율을 최대화하는 프리코딩 행렬 W를 정하기 위해서는 채널 행렬 H·B를 추정해야 한다.

[137] 수학식 5

[수식5]

$$\mathbf{H} \cdot \mathbf{B} = \widetilde{\mathbf{H}} = \begin{bmatrix} \widetilde{\mathbf{h}}_0 & \widetilde{\mathbf{h}}_1 & \cdots & \widetilde{\mathbf{h}}_{N_t-1} \end{bmatrix}$$

[138] 유효 채널 행렬

$\widetilde{\mathbf{H}}$

는 수학식 5처럼 N_t개의 채널 열벡터로 표현될 수 있는데, 여기서

$\widetilde{\mathbf{h}}_n$

는 n-번째 전송 안테나 포트와 N_r개의 수신 안테나 사이의 유효 채널을 나타낸다. 유효 채널 행렬의 추정은 각 안테나 포트에서 독립된 RS를 전송하여 각 유효 채널 벡터

$\widetilde{\mathbf{h}}_n$

를 개별 추정하도록 한다. RS는 채널 추정의 정확도를 위해 각 안테나 포트를 위한 RS가 직교 자원을 통해 전송되어야 한다. 즉, 수학식 2에서 0-번째 안테나 포트를 위한 RS를 전송하기 위하여 프리코딩 행렬은 랭크가 1인 열벡터로써 첫 번째 엘리먼트를 제외한 모든 엘리먼트가 0인, 즉

$|w_i|^2 = 0,$

, (i≠0)이어야 한다. 여기서 첫 번째 엘리먼트인 w_0의 크기는

$\sqrt{N_t}$

인 것이 바람직한데, 이는 데이터 심볼이 $N_t \cdot E_a$의 에너지로 전송되므로 동일한 전송 에너지로 전송되어 동일 셀 커버리지를 가지기 위해서이다.

[139] [RS의 FDM 전송 방식]

[140] N_t개 안테나 포트를 위한 RS를 FDM하여 전송하는 방식에서는 $RE(k_i,l,n_i)$에서 n_i-번째 포트의 RS가 전송되고 $RE(k_j,l,n_j)$에서 n_j-번째 포트의 RS가 전송되는 경우에 $RE(k_i,l,n_i)$와 $RE(k_j,l,n_j)$에 신호 전송을 하지 않으므로 $RE(k_i,l,n_i)$와 $RE(k_j,l,n_j)$에서의 RS 전송 전력을 높일 수 있게 된다. 이는 서브캐리어간의 전송 전력 교환이 가능하기 때문이다. 도 10은 N_t가 4인 경우에 k=2+n인 서브캐리어에 n-번째 안테나 포트의 RS를 전송하는 방식에서 0-번째 안테나 포트의 RE에 전송되는 EPRE의 일례를 나타내었다. 도 10에서 k=3, 4, 5인 RE에 0-번째 안테나 포트에서는 다른 포트에서 전송되는 RS에 간섭을 주지 않기 위하여 어떠한 신호도 전송하지 않는 뮤팅(muting) 동작을 수행하여 해당 RE에서 전송 가능했던 에너지를 0-번째 안테나 포트의 RS가 전송되는 RE(2,l,0)로 가져와 전송하게 된다. 도 10에서 k=0, 1, 6, 7인 RE에는 데이터 심볼이 전송되는 경우로써 데이터 심볼이 갖는 EPRE의 일례를 나타낸다. 안테나당 EPRE의 관점에서 RS 전송 RE의 EPRE가 데이터 전송 RE의 EPRE보다 N_t배 크지만, 모든 안테나의 전송 에너지의 합의 에너지 관점에서 RS 전송 에너지와 데이터 전송 에너지는 동일하게 된다.

[141] 주파수 선택적 페이딩 환경에서 전 대역의 채널을 측정하기 위하여 RS는 주파수 축에서 일정 간격으로 반복 전송된다. 채널의 코히어런스(coherence) 대역폭 BW_c마다 적어도 한번 이상의 RS가 전송되어야 하므로 동일 안테나 포트의 RS가 전송되는 서브캐리어의 간격은 $T \cdot BW_c$보다 낮게 설정되어야 한다. 전체 안테나의 개수 Nt가 $T \cdot BW_c$보다 큰 경우에 N_t개의 안테나 포트별 RS 모두를 FDM 방식으로 전송할 수 없게 된다. 그러므로 많은 수의 RS를 전송하기 위하여 TDM 또는 CDM 방식을 추가적으로 고려하여야 한다.

[142] [RS의 FDM+TDM 전송 방식]

[143] FDM+TDM 방식은 주파수 축에서 M_f개, 그리고 시간 축에서 M_t개의 자원을 결합하여 전체 $N_t=M_f \cdot M_t$개의 RE를 사용하여 N_t개의 RS를 전송하도록 한다. 도 11은 FDM+TDM 방식의 일례로써 OFDM 자원 격자에서 4개 서브캐리어와 4개 OFDM 심볼을 사용하여 전체 16개의 RE에 16개 RS를 전송하는 일례이다. 0-번째 안테나 포트는 RE(2,2,0)에 RS를 전송하고, 다른 안테나 포트의 RS가 전송되는 RE에서는 뮤팅을 수행한다. 서브캐리어 간의 전송 전력 교환이 가능하므로 RE(k,2,0), k=3, 4, 5에서 가능했던 전송 에너지를 RE(2,2,0)로 가져올 수 있지만, 전송 시점이 다르면 전송 에너지 교환이 불가능하므로 RE(k,l,0)(k=2,...,5, l=3,4,5)에서 가능했던 전송 에너지는 RE(k,2,0)로 가져올 수 없다.

[144] [안테나 가상화 행렬의 특성(property)]

[145] 본 명세서에서는 안테나 엘리먼트 앰프의 전송 파워 제한이 주어진 상태에서 FDM+TDM의 RS 전송 방식의 전송 에너지 효율을 높이기 위한 안테나 포트 맵핑 방식을 설명한다. 본 명세서에서는 FDM+TDM의 RS 전송 방식에서도 RS의 전송 에너지가 $N_t \cdot E_a$가 되기 위하여 수학식 1의 안테나 가상화를 적용하도록 한다. 안테나 맵핑 방식으로 하나의 안테나 포트가 M_t의 안테나 엘리먼트에 전송되도록 하여 M_t의 안테나 엘리먼트의 전송 능력을 모두 사용할 수 있도록 한다. 결과적으로, FDM+TDM의 RS 전송 방식에서 RS 전송 에너지는 FDM된 RS간의 전송 전력 교환으로 M_f배 부스팅(boosting)되며, 일대다 안테나 맵핑 방식으로 전송 전력을 M_t배 부스팅하여, 최종적으로 전송 전력을 N_t배로 부스팅하도록 한다.

[146] 설명의 편의를 위해 동일 OFDM 심볼에서 전송되는 RS들의 안테나 포트들을 하나의 그룹으로 형성하여, 안테나 포트들을 디스조인트(disjoint)하게 그룹핑하도록 한다. 도 11의 안테나 포트 인덱스를 고려하여 $i \cdot M_f$ 번째 안테나 포트부터 $(i+1) \cdot M_f$-1번째 안테나 포트까지를 그룹 T(i)라 부른다. 또한, N_t개의 안테나 엘리먼트들을 M_t개씩 나누어 M_f개의 그룹을 만들어, i번째 안테나 엘리먼트 그룹을 그룹 E(i)라 부른다.

[147] 제안 방식에서 하나의 안테나 포트는 하나의 안테나 엘리먼트 그룹 E(i)에 속하는 모든 안테나 엘리먼트에 맵핑된다. 즉, 안테나 포트와 안테나 엘리먼트 그룹간에 일대일 맵핑된다. 또한, 동일 그룹 T(i)에 속하는 안테나 포트들은 각각 다른 안테나 엘리먼트 그룹에 매핑되도록 한다. 안테나 포트 그룹 T(i)와 안테나 포트 그룹 T(j)에 적용되는 안테나 엘리먼트의 그룹핑은 다를 수 있다. 하지만 본 명세서의 이하에서는 설명의 편의를 위하여 안테나 엘리먼트의 그룹핑 방식이 유지되는 경우에 한정해서 설명한다. 특히, $i \cdot M_t$ 번째 안테나 엘리먼트부터 $(i+1) \cdot M_t$-1번째 안테나 엘리먼트 까지를 그룹 E(i)로 그룹핑하는 경우를 대표 예로 설명한다. 이 경우에 동일 안테나 엘리먼트 그룹에 맵핑되는 안테나 포트들을 그룹핑하여 이를 안테나 포트 그룹 F(i)로 정의한다.

[148] 제안 방식을 안테나 가상화 행렬의 특징으로 설명하도록 한다. 수학식 1의 안테나 가상화 행렬 B는 다음 수학식과 같이 M_t의 행렬로 나타낸다.

[149] 수학식 6

[수식6]

$$\mathbf{B} = \begin{bmatrix} \mathbf{C}_0 & \mathbf{C}_1 & \cdots & \mathbf{C}_{M_f-1} \end{bmatrix}$$

[150] 여기서, C_n은 n번째 안테나 포트 그룹 T(n)에 적용되는 가상화 행렬을 나타낸다. C_n은 다음의 수학식처럼 $M_t \times 1$ 열벡터로 표현될 수 있다.

[151] 수학식 7

[수식7]

$$\mathbf{C}_n = \begin{bmatrix} \mathbf{c}_{n,0} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{c}_{n,1} & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{c}_{n,M_f-1} \end{bmatrix}.$$

[152] 여기서, 0는 $M_t \times 1$ 영벡터를 나타내며, $C_{n,i}$는 $M_t \times 1$ 가상화 벡터를 나타내는데, 안테나 포트 그룹 T(n)의 i번째 안테나 포트가 안테나 엘리먼트 그룹 E(i)에 어떻게 맵핑되는지를 나타낸다. 수학식 7의 가상화 행렬은 각 행벡터가 비-제로(non-zero) 엘리먼트를 하나만 갖는다. 이는 각 안테나 엘리먼트가 안테나 포트 그룹 T(n) 내의 하나의 안테나 포트에 맵핑되도록 하기 위해서이다.

[153] 제안 방식에서, 열벡터 $C_{n,i}$의 모든 엘리먼트는 비-제로로써, 동일 크기를 갖도록하며, 안테나 포트간에 독립된 채널 특성을 갖도록 하기 위해 $C_{n,i}$와 $C_{m,i}$ 간에 상호 직교하도록 한다. 가상화 벡터 설계를 용이하게 하기 위해 안테나 포트 그룹 T(n)에 적용되는 $M_t \times 1$ 가상화 행렬은 모두 동일하게 즉, $C_{n,i} = C_{n,j}$ 이도록 할 수 있다.

[154] 수학식 6과 수학식 7에 의해 안테나 포트 그룹 T(n)의 i번째 안테나 포트가 동일 그룹 E(i)에 맵핑되므로 그룹 F(i)를 형성한다. 도 11의 실시예에서 그룹 E(i)는 i번째 안테나 포트부터 M_f개의 간격으로 떨어져있는 M_t개의 안테나 포트들로 구성된다. 실시예에서 그룹 F(i)에 속하는 각각의 안테나 포트가 동일 서브캐리어의 다른 OFDM 심볼에 전송된다. 제안방식에서, 그룹 T(n)을 형성하는 안테나 포트들의 RS는 동일 OFDM 심볼에서 전송되어야 하지만, 그룹 T(n)과 그룹 T(n+1)에 속하는 포트들의 RS들이 연속된 OFDM 심볼에 전송될 필요는 없다.

[155] [2D AAS에 적용]

[156] 본 절에서는 본 명세서에서 제안한 내용을 도 12의 2D AAS에 적용한 예를 설명한다. 2D AAS에서 RS 포트가 일대다 맵핑되는 안테나 엘리먼트의 그룹을 수평 방향의 안테나 행으로 구성된 그룹 또는 수직 방향의 안테나 열로 구성된 그룹에 적용할 수 있다. 전자의 경우(도 12(a))에 그룹당 안테나 엘리먼트의 개수는 Mt=Nh로 설정되며, 그룹의 개수는 $M_f=N_v$로 설정된다. 이와 달리 후자의 경우(도 12(b))에는 $M_t=N_v$와 $M_f=N_h$로 설정된다.

[157] 도 12(a)의 경우, 하나의 안테나 포트는 N_h개의 안테나 엘리먼트에 맵핑되어, N_v개의 안테나 포트들이 그룹 T(n)을 형성하여 해당 RS들이 동일한 OFDM 심볼에서 전송된다. 도 12(b)의 경우 하나의 안테나 포트는 N_v개의 안테나 엘리먼트에 맵핑되어, N_h개의 안테나 포트들이 그룹 T(n)을 형성하여 해당 RS들이 동일한 OFDM 심볼에서 전송된다.

[158] [2D AAS의 코드북 특성, 크로네커 곱]

[159] 2D AAS에서 안테나 엘리먼트의 간격이 작을수록 3차원상의 빔의 모양은 수평 방향의 빔과 수직 방향의 빔의 곱으로 표현될 수 있다. 그러므로, 2D AAS에서 사용할 코드북으로 수평 안테나의 프리코딩 행렬

$\mathbf{W}_D^{(H)}$

과 수직 안테나의 프리코딩 행렬

$\mathbf{W}_D^{(V)}$

의 크로네커 곱(kronecker product)으로 표현되는 행렬로 구성된 코드북을 고려하고 있다. 도 11의 안테나 포트의 인덱싱 순서에 의해 도 12(a)의 예의 경우 수학식 8처럼 표현되며, 도 12(b)의 경우 수학식 9처럼 크로네커 곱이 표현된다.

[160] 수학식 8

[수식8]

$$\mathbf{W}_D = \mathbf{W}_D^{(H)} \otimes \mathbf{W}_D^{(V)}$$

[161] 수학식 9

[수식9]

$$\mathbf{W}_D = \mathbf{W}_D^{(V)} \otimes \mathbf{W}_D^{(H)}$$

[162] 여기서,

$\mathbf{W}_D^{(H)}$

의 랭크가 R_H이고,

$\mathbf{W}_D^{(V)}$

의 랭크가 R_V인 경우, 전체 프리코딩의 랭크는 $R_H \cdot R_V$이다. 수평 안테나의 프리코딩 행렬의 집합을 수평 안테나의 코드북 $CB^{(H)}(N_h)$로 정의하며, 수직 안테나의 프리코딩 행렬의 집합을 수직안테나 코드북 $CB^{(V)}(N_v)$로 정의한다.

[163] 앞서 언급한 안테나 포트와 안테나 엘리먼트 간의 맵핑 방식을 고려하여, 도 12(a)의 경우 수평 안테나 코드북으로 선택 코드북을 사용하고, 수직 안테나 코드북으로 상수 모듈러스 코드북을 사용하도록 한다. 이와 달리, 도 12(b)의 경우 수직 안테나 코드북으로 선택 코드북을 사용하고 수평 안테나 코드북으로 상수 모듈러스 코드북을 사용하도록 한다. 여기서, 상기 선택 코드북은 비-제로 엘리먼트가 1개인 열벡터들로 형성된 행렬만을 프리코딩 행렬로 갖는 코드북을 의미하며, 상기 상수 모듈러스 코드북은 엘리먼트가 동일한 크기를 갖는 행렬만을 프리코딩 행렬로 갖는 코드북을 의미한다. 이러한 코드북의 구성은 수학식 3의 전송 신호에 사용된 최종 프리코딩 행렬 B·W의 각 엘리먼트가 동일한 크기를 갖도록 하기 위해서이다.

[164] 제안 방식에서 상기 선택 코드북은 M_t개의 안테나 포트 그룹 T(n) 중에서 어떤 그룹들을 사용할지에 대한 정보를 알려주며, 상기 상수 모듈러스 코드북은 해당

안테나 포트 그룹 내의 안테나 포트들에게 어떤 프리코딩을 적용할지에 대한 정보를 알려준다.

[165] [선택 코드북 구성 방법]

[166] 안테나 크기 N의 안테나 포트 선택 코드북은 랭크=1인 프리코딩 벡터로 비-제로 엘리먼트가 한 개인 선택 벡터들로만 구성되며, 랭크>1인 프리코딩 행렬은 각 행이 선택 벡터로 표현되는 행렬로 구성된다. 표 8에는 안테나 크기 4의 선택 코드북에서 랭크=1과 2에 해당하는 프리코딩 행렬의 일례를 나타낸다. 안테나 크기 N의 안테나 포트 선택 코드북은 랭크 M의 코드북을 N 중에서 M를 선택하는 개수 즉, combination(N,M) 만큼을 가질 수 있다.

[167] 또한 안테나 포트들을 다수 개의 안테나 포트 집합으로 나누고 랭크 M의 코드북은 동일 안테나 포트 집합 내의 안테나 포트 M개를 선택하도록 제한될 수 있다. 일례로 안테나 크기 N의 안테나 포트 선택 코드북에서 안테나 포트 집합을 2개로 나눈 경우에, 랭크 M의 코드북은 2개의 안테나 포트 집합의 각각에서 집합 내의 포트들 N/2중에서 M를 선택하는 개수 즉, 2*combination(N/2,M)개가 존재할 수 있다. 이를 일반화하여 안테나 크기 N의 안테나 포트 선택 코드북에서 안테나 포트 집합을 G개로 나눈 경우에, 랭크 M의 코드북은 G개의 안테나 포트 집합의 각각에서 집합 내의 포트들 N/G중에서 M를 선택하는 개수 즉, G*combination(N/G,M)개가 존재할 수 있다.

[168] 제안 방식은 N개의 안테나 포트들의 전송 빔이 모두 직교하지 않는 경우에 적용하도록 한다. 제안 방식에서 안테나 포트들의 전송 빔이 직교하는 포트들만을 집합으로 구성하도록 한다. 즉, 안테나 포트 집합 내의 포트들 간에는 전송 빔이 직교하도록 한다. 다른 안테나 포트 집합에 속하는 포트들 간에는 전송 빔이 직교하지 않을 수 있다. 그러므로, 랭크 M의 코드북은 동일 안테나 포트 집합 내의 안테나 포트들만을 선택하게 하여 전송 레이어 간에 직교성을 보장하도록 한다.

[169] 안테나 포트 선택 코드북의 최대 랭크는 미리 지정될 수 있고, 각 랭크에서 사용될 수 있는 코드북은 RRC 시그널링의 비트맵 지시자에 의해 제한될 수 있다.

[170] 표 8

[표8]

Rank = 1	Rank = 2
$\begin{bmatrix}1\\0\\0\\0\end{bmatrix}, \begin{bmatrix}0\\1\\0\\0\end{bmatrix}, \begin{bmatrix}0\\0\\1\\0\end{bmatrix}, \begin{bmatrix}0\\0\\0\\1\end{bmatrix}$	$\begin{bmatrix}1&0\\0&1\\0&0\\0&0\end{bmatrix}, \begin{bmatrix}1&0\\0&0\\0&1\\0&0\end{bmatrix}, \begin{bmatrix}1&0\\0&0\\0&0\\0&1\end{bmatrix}, \begin{bmatrix}0&0\\1&0\\0&1\\0&0\end{bmatrix}, \begin{bmatrix}0&0\\1&0\\0&0\\0&1\end{bmatrix}, \begin{bmatrix}0&0\\0&0\\1&0\\0&1\end{bmatrix}$

[171] [비-크로네커 곱 코드북으로의 일반화]

[172] 본 발명을 일반화하여 2D AAS에서 안테나 엘리먼트의 간격이 커져서

3차원상의 빔의 모양이 수평 방향의 빔과 수직 방향의 빔의 곱으로 표현되지 않는 일반적인 경우의 코드북 디자인 및 이에 따른 CSI 보고 방식을 설명하도록 한다. 이하에서는 편의상 도 12(b)의 경우로 설명하도록 한다. 그러나 V와 H를 상호 교환하여 도 12(a)의 경우에도 동일하게 적용 가능하다.

[173] 제안 방식의 일반화된 코드북은 다음과 같이 주어진다.

[174] 수학식 10

[수식10]

$$\mathbf{W}_D = \left[\mathbf{w}_0^{(V)} \otimes \mathbf{W}_0^{(H)} \quad \mathbf{w}_1^{(V)} \otimes \mathbf{W}_1^{(H)} \quad \cdots \quad \mathbf{w}_{R_V-1}^{(V)} \otimes \mathbf{W}_{R_V-1}^{(H)}\right]$$

[175] 여기서,

$$\mathbf{W}_D^{(V)} = \left[\mathbf{w}_0^{(V)} \quad \mathbf{w}_1^{(V)} \quad \cdots \quad \mathbf{w}_{R_V-1}^{(V)}\right]$$

이다.

[176] 여기서,

$\mathbf{W}_D^{(V)}$

는 안테나 포트 선택 코드북에서 선택되며,

$\mathbf{W}_D^{(H)}$

는 상수 모듈러스 코드북에서 선택된다. R_V는

$\mathbf{W}_D^{(V)}$

의 랭크로써 몇 개의 안테나 포트 그룹이 선택되었는지를 알려주며,

$\mathbf{W}_r^{(V)}$

는 안테나 포트 선택 벡터로써 r번째로 어떤 안테나 포트 그룹을 선택했는지를 알려준다.

$\mathbf{W}_r^{(H)}$

는 선택된 r번째 안테나 포트 그룹에 적용되는 프리코딩을 나타낸다.

$\mathbf{W}_r^{(H)}$

의 랭크가 $R_H(r)$로 표현되면 전체 프리코딩의 랭크는 다음과 같이 주어진다.

[177] 수학식 11

[수식11]

$$\sum_{r=0}^{R_V-1} R_H(r)$$

[178] 즉, 전체 프리코딩의 랭크는 선택된 안테나 포트 그룹들의 각각에 적용된 프리코딩 행렬의 랭크들의 합이 된다

[179] [CSI-RS 설정]

[180] 제안 방식을 적용한 N_t개의 안테나 포트 CSI-RS는 다수 개의 그룹으로 그룹핑되어 있으며, 동일 그룹에 속하는 안테나 포트의 RS는 동일 OFDM

심볼에서 전송되도록 한다. 즉, 동일 OFDM 심볼에서 전송되는 RS들의 안테나 포트가 하나의 그룹을 형성할 수도 있으며, 또는 다수 개의 안테나 포트 그룹의 RS가 동일 OFDM 심볼에서 전송될 수 있다. N_t개의 안테나 포트CSI-RS는 M_t개의 그룹으로 그룹핑되면 m번째 RS 그룹에 속하는 RS의 개수는 $M_f(m)$로 정의하면, 다음의 관계를 만족해야 한다.

[181] 수학식 12

[수식12]

$$N_t = \sum_{m=0}^{M_f-1} M_f(m)$$

[182] 제안 방식을 단순화하여 그룹 당 안테나 포트 개수는 모두 동일할 수 있다. 이 경우에 $M_f(m)=N_t/M_t$로 주어진다.

[183] 제안 방식을 적용한 N_t개의 안테나 포트 CSI-RS는 다수 개의 그룹으로 그룹핑되어 있으며, 동일 그룹에 속하는 포트의 CSI-RS는 도 7의 기존 CSI-RS 전송 패턴을 사용하도록 한다. 이 경우에 한 그룹에 포함되는 안테나 포트의 개수는 1, 2, 4, 또는 8 중에서 선택된다. 동일 그룹에 속하는 포트의 CSI-RS들은 도 7의 FDM+CDM 방식에 의한 다중화되어 전송된다. 그러나 다른 그룹에 속하는 포트의 RS는 다른 OFDM 심볼에 전송될 수 있다. 이러한 구조에서 전체 CSI-RS는 FDM+CDM+TDM되어 전송된다고 할 수 있다.

[184] 제안방식의 CSI-RS를 기지국이 UE에게 설정해 줄 때, CSI-RS 설정으로 다음의 정보들이 전달된다.

[185] -전체 안테나 포트 개수

[186] -안테나 포트 그룹 개수

[187] -그룹 당 안테나 포트 개수

[188] -그룹 당 CSI-RS 전송 자원의 위치

[189] -그룹 당 CSI-RS 전송 주기 및 오프셋

[190] -안테나 포트 그룹 당 Pc

[191] 여기서, Pc는 PDSCH EPRE와 CSI-RS EPRE의 비율로써 UE가 CSI 보고를 위하여 가정하고 PDSCH의 품질을 결정하기 위한 파라미터이다. 여기서, 안테나 포트 그룹당 다른 Pc를 적용하게 하여 각 안테나 포트 그룹에서 전송되는 데이터 레이어 간에 다른 전송 전력 설정이 가능하도록 해준다.

[192] 안테나 포트 그룹 당 CSI-RS 전송 자원의 위치는 CSI-RS 설정을 통해 개별 지정해 줄 수도 있지만, 첫번째 그룹의 CSI-RS 전송 자원 위치만 알려주고 나머지 그룹의 CSI-RS 전송 자원 위치는 첫번째 그룹의 상대 위치로 미리 지정해 놓을 수 있다. CSI-RS 전송 주기 및 오프셋은 모든 안테나 포트 그룹에 있어서 동일하게 설정될 수도 있지만, CSI-RS 전송 효율을 높이기 위하여 안테나 포트 그룹 당 다른 전송 주기 및 오프셋이 설정될 수 있다. 특히, CSI-RS의 모든 안테나 포트 그룹의 RS를 자원 부족으로 동일 서브프레임에서 전송하지 못할 경우에,

모든 안테나 포트 그룹의 RS가 동일 주기로 전송되더라도 전송 서브프레임의 오프셋은 안테나 포트 그룹별로 다르게 지정하도록 한다.

[193] [안테나 포트 그룹별 활성/비활성화]

[194] 기지국은 CSI-RS 전송에 대한 오버헤드를 줄이기 위해 특정 CSI-RS의 전송이 불필요하다고 판단된 경우에 해당 CSI-RS의 전송을 중단할 수 있다. 해당 CSI-RS가 사전에 UE들에게 설정되어 있는 CSI-RS인 경우에는 해당 UE들에서 MAC 또는 RRC 시그널링을 통해 해당 CSI-RS가 비활성화되었음을 알려주어, 해당 CSI-RS에 대한 CSI 추정을 더 이상 하지 않도록 한다.

[195] 이러한 방식을 다수의 안테나 포트 그룹으로 구성된 CSI-RS 설정에 적용하여 기지국이 안테나 포트 그룹별로 CSI-RS 전송이 활성화 또는 비활성화되었는지를 알려주도록 한다. 즉, 기지국은 CSI-RS 활성화/비활성화 명령을 UE에게 알려줄 때 몇 번째 CSI-RS 설정의 몇 번째 안테나 포트 그룹이 활성화 또는 비활성화되었는지를 알려주도록 한다.

[196] UE는 기지국의 활성화/비활성화 명령에 의해 비활성화된 안테나 포트 그룹은 안테나 포트 선택에서 제외하도록 한다. 즉, 안테나 포트 선택 코드북의 일부 코드북이 자동으로 제한된다. 일례로써 4개의 안테나 포트 그룹으로 구성된 CSI-RS 설정을 설정받은 상태에서 4번째 안테나 포트 그룹이 비활성화되었다는 명령을 수신하면, UE는 표 8의 안테나 포트 선택 코드북에서 4번째 안테나 포트 그룹을 선택하는 코드북은 자동 제한되어 UE가 CSI 보고시에 해당 코드북을 선택하지 않도록 한다.

[197] [CSI-RS 피드백]

[198] 본 절에서는 다수 개의 안테나 포트 그룹들로 형성된 CSI-RS 설정에 대한 CSI 보고 방식에 대해 설명하도록 한다.

[199] 제안 방식에 UE는 안테나 포트 선택 코드북을 사용하여 어떤 안테나 포트 그룹을 선택할지에 대한 정보를 보고하도록 한다. 선택되는 안테나 포트 그룹의 개수는 보고된 안테나 포트 선택 프리코딩 행렬

$\mathbf{W}_D^{(F)}$

의 랭크에 의해 결정된다. 또한, UE는 r번째로 선택된 안테나 포트 그룹에 대하여 어떤 프리코딩 행렬

$\mathbf{W}_r^{(H)}$

을 사용하여 데이터를 전송할 지에 대한 정보를 보고하도록 한다. 이 때, 안테나 포트 그룹에 적용되는 프리코딩 행렬은 상수 모듈러스 코드북에서 선택된다.

[200] 제안 방식에서 UE는 CSI 보고를 위하여 안테나 포트 그룹 선택을 위한 랭크 R_V와 프리코딩 행렬

$\mathbf{W}_D^{(F)}$

을 보고하며, 선택된 안테나 포트 그룹 각각에 적용되는 프리코딩을 위해 R_V개의 랭크 $R_H(r)$와 프리코딩 행렬

Samsung Exhibit 1003, Page 217 of 438

$\mathbf{W}_r^{(H)}$

를 보고할 수 있다. 그리고, UE는 보고되는 프리코딩 행렬들이 적용되었을 때 얻을 수 있는 CQI에 대해 보고한다. 여기서 각 보고 항목의 보고 주기는 다르게 설정될 수 있다. 예로써, 랭크 R_V의 보고 주기는 프리코딩 행렬

$\mathbf{W}_D^{(P)}$

의 보고 주기보다 크거나 같을 수 있다. 즉, 랭크 R_V가 500 서브프레임마다 한번 보고되면

$\mathbf{W}_D^{(P)}$

는 100 서브프레임마다 한번 보고되도록 설정될 수 있다. 또한, 프리코딩 행렬

$\mathbf{W}_D^{(P)}$

의 보고 주기는 랭크 $R_H(r)$ 또는

$\mathbf{W}_r^{(H)}$

의 보고 주기보다 크거나 같을 수 있다. 또한, 랭크 $R_H(r)$의 보고 주기는 프리코딩 행렬

$\mathbf{W}_r^{(H)}$

의 보고 주기보다 크거나 같을 수 있다.

[201] 또한, 여기서 각 보고 항목의 적용 주파수 대역은 다르게 설정될 수 있다. 즉, 각 보고 항목은 대역별로 채널을 측정하여 그 결과에 따라 독립적으로 선택되어 보고되는데, 각 보고 항목의 대역 크기는 다르게 설정될 수 있다. 예로써, 랭크 R_V가 독립적으로 결정되는 대역의 크기는 프리코딩 행렬

$\mathbf{W}_D^{(P)}$

의 대역의 크기보다 크거나 같을 수 있다. 즉, 랭크 R_V가 100 RB마다 한번 결정되어 보고되면

$\mathbf{W}_D^{(P)}$

는 20 RB마다 한번 결정되어 보고될 수 있다. 또는, 랭크 R_V가 시스템 대역에 걸쳐 하나의 값이 보고되지만

$\mathbf{W}_D^{(P)}$

는 서브 대역 별로 각각 보고될 수 있다. 또한, 프리코딩 행렬

$\mathbf{W}_D^{(P)}$

의 결정 대역은 랭크 $R_H(r)$ 또는

$\mathbf{W}_r^{(H)}$

의 결정 대역보다 크거나 같을 수 있다. 또한, 랭크 $R_H(r)$의 결정 대역은 프리코딩 행렬

$\mathbf{W}_r^{(H)}$

의 결정 대역보다 크거나 같도록 할 수 있다. 예로써, 프리코딩 행렬

$\mathbf{W}_D^{(V)}$

은 시스템 대역에 걸쳐 하나의 값이 보고되지만,

$\mathbf{W}_r^{(H)}$

은 서브 대역 별로 각각 보고되도록 할 수 있다.

[202] 제안 방식의 변형으로 UE는 CSI 보고를 위하여 안테나 포트 그룹 각각에 적용되는 랭크 $R_H(m)$과 프리코딩 행렬

$\mathbf{W}_m^{(H)}$

을 보고할 수 있다. 즉 안테나 포트 그룹이 M_t개면 M_t개의 랭크 $R_H(m)$와 프리코딩 행렬

$\mathbf{W}_m^{(H)}$

를 보고할 수 있다. 이때 m번째 안테나 그룹에서 데이터 전송을 원하지 않으면, UE는 $R_H(m)=0$으로 보고하고 프리코딩 행렬

$\mathbf{W}_m^{(H)}$

를 보고하지 않는다.

[203] 제안 방식의 단순화된 경우로 전체 프리코딩 행렬이 수학식 9의 크로네커 곱으로 표현되는 경우로서, UE는 CSI 보고를 위하여 안테나 포트 그룹 선택을 위한 랭크 R_V와 프리코딩 행렬

$\mathbf{W}_D^{(V)}$

을 보고할 수 있으며, 선택된 안테나 포트 그룹들에 적용되는 프리코딩을 위해 랭크 R_H와 프리코딩 행렬

$\mathbf{W}_D^{(H)}$

을 보고할 수 있다. 그리고, UE는 보고되는 프리코딩 행렬들이 적용되었을 때 얻을 수 있는 CQI에 대해 보고할 수 있다. CSI 정보 X의 보고 주기를 Period(X)라고 표시하면, $\text{Period}(R_V) \geq \text{Period}($

$\mathbf{W}_D^{(V)}$

$)\geq \text{Period}(R_H) \geq \text{Period}($

$\mathbf{W}_D^{(H)}$

)가 되도록 설정할 수 있다. 또는, $\text{Period}(R_V) \geq \text{Period}(R_H) \geq \text{Period}($

$\mathbf{W}_D^{(V)}$

$) \geq \text{Period}($

$\mathbf{W}_D^{(H)}$

)가 되도록 설정할 수 있다.

[204] 또한, CSI 정보 X의 결정 대역을 Bw(X)라고 표시하면, $\text{Bw}(R_V) \geq \text{Bw}($

$\mathbf{W}_D^{(V)}$

)≥ Bw(R_H) ≥ Bw(

$\mathbf{W}_D^{(V)}$

)가 되도록 설정할 수 있다. 또는, Bw(R_V) ≥ Bw(R_H)≥ Bw(

$\mathbf{W}_D^{(V)}$

) ≥ Bw(

$\mathbf{W}_D^{(H)}$

)가 되도록 설정할 수 있다. 일례로 UE는 R_V,

$\mathbf{W}_D^{(V)}$

, R_H를 시스템 대역에 전체에 있어 하나의 값으로 결정하여 보고하고

$\mathbf{W}_D^{(H)}$

는 서브 대역별로 각각 보고하도록 한다. 또는, 일례로 UE는 R_V, R_H를 시스템 대역에 전체에 있어 하나의 값으로 결정하여 보고하고

$\mathbf{W}_D^{(H)}$

,

$\mathbf{W}_D^{(V)}$

는 서브 대역별로 각각 보고하도록 한다.

[205] 수학식 9의 전송 방식에서 R_H=2경우에 첫번째 데이터 레이어와 두번째 데이터 레이어는 동일 안테나 포트 그룹을 통해 전송되게 된다. 연속된 데이터 레이어들을 다른 안테나 포트 그룹을 통해 전송하기 위해서는 수학식 9의 프리코딩 행렬을 다음과 같이 변형하여야 한다.

[206] 수학식 13

[수식13]

$$\mathbf{W}_D = \begin{bmatrix} \mathbf{W}_D^{(V)} \otimes \mathbf{w}_0^{(H)} & \mathbf{W}_D^{(V)} \otimes \mathbf{w}_1^{(H)} & \cdots & \mathbf{W}_D^{(V)} \otimes \mathbf{w}_{R_H-1}^{(H)} \end{bmatrix}$$

[207] 여기서,

$$\mathbf{W}_D^{(H)} = \begin{bmatrix} \mathbf{w}_0^{(H)} & \mathbf{w}_1^{(H)} & \cdots & \mathbf{w}_{R_H-1}^{(H)} \end{bmatrix}$$

이다.

[208] 본 발명에서 제안하는 안테나 포트 그룹핑이 적용된 CSI-RS 설정의 그룹핑된 안테나 포트들을 서브-CSI-RS로 정의하여 다수 개의 서브-CSI-RS로 구성된 CSI-RS 설정으로 구성할 수 있다. 또는, 다수 개의 CSI-RS 설정이 결합하여 수퍼(super) CSI-RS를 설정하는 방식도 고려할 수 있다.

[209] 본 발명을 32개 안테나 엘리먼트를 갖는 2D AAS에 적용한 경우를 도 13을 참고하여 설명하도록 한다. 도 13의 좌측은 32개의 안테나 엘리먼트로써 물리 안테나를 나타낸다. 도 13의 우측은 32개의 안테나 포트로써 논리적 안테나를 나타낸다. 도 13은 안테나 엘리먼트의 그룹핑 방식과 안테나 포트의 그룹핑 방식을 나타내며, 또한 안테나 엘리먼트와 안테나 포트간의 맵핑을 나타낸다.

[210] 도 13의 실시예는 안테나 엘리먼트를 수직 방향의 안테나 열로 그룹핑하는 도 12(b)에 해당하는데, 여기서 안테나 엘리먼트는 4개의 그룹 E(0), E(1), E(2), E(3)으로 나뉜다. 32개의 안테나 포트들도 4개의 그룹으로 구분되어 그룹 F(0), F(1), F(2), F(3)을 형성한다. 제안 방식의 일례로 그룹 F(i)에 속하는 안테나 포트들은 그룹 E(i)에 속하는 모든 안테나 엘리먼트를 사용하여 가상화(virtualization) 되도록 한다. 그룹 F(i)에 속하는 안테나 포트 각각의 가상화 벡터는 다르게 설정되도록 한다. 또한, 각 안테나 포트 그룹에서 한 개씩의 포트를 선택하여 그룹 T(i)를 형성하도록 한다. 그룹 T(i)에 속하는 각 안테나 포트는 동일한 가상화 벡터를 사용하여 각각 다른 안테나 엘리먼트 그룹에 맵핑되도록 한다. 그룹 T(i)에 속하는 각 안테나 포트를 위한 RS는 동일 OFDM 심볼에 전송되도록 한다.

[211] 제안 방식을 확장하여 2D AAS에서 사용할 코드북으로 수학식 8과 9에서 처럼 두 개의 코드북의 크로네커 곱을 이용하는 경우에, 또는 수학식 10과 11에서 처럼 두 종류의 코드북의 결합으로 구성되는 경우에 하나의 코드북은 상수 모듈러스 코드북을 사용하고 또 다른 하나의 코드북은 안테나 포트 선택 코드북과 상수 모듈러스 코드북 중에서 선택하여 사용할 수 있도록 한다. 이러한 방식은 기지국의 CSI-RS 전송 방식에 따라 코드북을 선택하여 사용할 수 있는 유연성을 갖는다. 이 경우에, UE는 안테나 포트 선택 코드북을 사용하여 CSI를 보고할지 상수 모듈러스 코드북을 사용하여 CSI를 보고할지를 지정 받도록 한다. 구체적으로, 기지국은 MIMO 전송 모드를 전송해 주는 RRC 시그널링을 통해

$\mathbf{W}_D^{(F)}$

에 적용될 코드북이 안테나 포트 선택 코드북인지 상수 모듈러스 코드북인지를 지정해 줄 수 있다.

[212] 제안 방식을 확장하여 2D AAS에서 사용할 코드북으로 수학식 8과 9에서 처럼 두 개의 코드북의 크로네커 곱을 이용하는 경우에, 또는 수학식 10과 11에서 처럼 두 종류의 코드북의 결합으로 구성되는 경우에 하나의 코드북은 상수 모듈러스 코드북을 사용하고 또 다른 하나의 코드북은 안테나 포트 선택 프리코더와 상수 모듈러스 프리코더가가 섞여 있는 혼합 코드북(mixed codebook)을 사용하도록 한다. 이 경우에 기지국은 CSI-RS 전송 방식에 따라 혼합 코드북에 코드북 제한을 가해서 특정 종류의 프리코더, 즉 안테나 포트 선택 프리코더 또는 상수 모듈러스 프리코더들만 사용하도록 할 수 있다.

[213] [CSI-RS 피드백 랭크 제한]

[214] 위의 제안 방식에서 안테나 포트 그룹 선택을 위한 랭크 R_V는 사전에 특정 몇 개의 값으로 제한될 수 있다. 즉, 랭크 R_V는 1과 2 중에서만 선택되도록 한정 될 수 있다. 또는, 기지국은 MIMO 전송 모드를 전송해 주는 RRC 시그널링을 통해 랭크 R_V가 가질 수 있는 값을 제한할 수 있다. 또한, 선택된 안테나 포트 그룹 각각에 적용되는 랭크 $R_H(r)$도 사전에 특정 몇 개의 값으로 제한될 수 있다. 또는,

Samsung Exhibit 1003, Page 221 of 438

수학식 12의 전체 프리코딩의 랭크가 사전에 특정 몇 개의 값으로 제한될 수 있다. 대표적으로 수학식 12의 전체 프리코딩의 랭크는 단말기의 수신 안테나 개수 또는 단말기가 수신할 수 있는 최대 데이터 레이터의 개수를 초과하여 설정할 수 없도록 제한될 수 있다. 또는, 안테나 포트 그룹 각각에 적용되는 랭크 $R_H(r)$의 최대값은 각각의 안테나 포트 그룹의 전송 특징에 의해 특정 값 이하로 제한될 수 있다. 이러한 안테나 포트 그룹 각각에 적용되는 $R_H(r)$의 최대값 및 전체 프리코딩의 랭크의 최대값은 기지국이 MIMO 전송 모드를 전송해 주는 RRC 시그널링을 통해 UE에게 알려 줄 수 있다.

[215] 도 14는 본 발명의 일 실시예에 따른 동작을 도시한다.

[216] 본 실시예는 2차원으로 배열된 N_t개의 안테나 포트를 통해 전송되는 하향링크 채널에 대한 채널 상태 보고와 관련된다. 상기 N_t개의 안테나 포트 각각은 특정 안테나 엘리먼트 그룹에 속하는 모든 안테나 엘리먼트에 맵핑되고, 동일한 OFDM 심볼에서 전송되는 참조 신호(reference signal; RS)에 대응하는 안테나 포트 그룹이 서로 다른 안테나 엘리먼트 그룹에 맵핑되도록 설정된다.

[217] 단말(141)은 서빙 셀(142)로부터 상기 안테나 포트 그룹에 대한 채널 상태 보고를 위한 참조 신호(chaneel state information-reference signal; CSI-RS) 설정을 수신할 수 있다(S1410).

[218] 상기 단말은 상기 수신된 CSI-RS 설정을 사용하여 수신된 CSI-RS를 통해 하향링크 채널에 대한 채널 상태 정보를 계산할 수 있다(S1420).

[219] 그리고나서, 상기 단말은 상기 채널 상태 정보를 상기 서빙 셀로 보고할 수 있다(S1430).

[220] 상기 보고되는 채널 상태 정보는 안테나 포트 그룹 선택을 위한 프리코딩 행렬 및 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬을 포함할 수 있다.

[221] 또한, 상기 안테나 포트 그룹 선택을 위한 프리코딩 행렬은 안테나 포트 그룹 선택 코드북에서 선택될 수 있다. 상기 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬은 상수 모듈러스(constant modulus) 코드북에서 선택될 수 있다.

[222] 또한, 상기 단말은 안테나 포트 그룹 별로 상기 CSI-RS의 전송이 활성화 또는 비활성화되었는지 여부를 지시하는 정보를 상기 서빙 셀로부터 수신할 수 있다. 상기 비활성화된 안테나 포트 그룹을 선택하기 위한 프리코딩 행렬은 상기 채널 상태 정보에서 제외될 수 있다.

[223] 또한, 상기 단말은 상기 안테나 포트 그룹 선택을 위한 프리코딩의 랭크 제한 또는 상기 선택된 안테나 포트 그룹에 적용될 프리코딩의 랭크 제한에 대한 정보를 상기 서빙 셀로부터 수신할 수 있다.

[224] 도 14에 도시된 단말 또는 기지국의 동작은 도 14를 참조하여 설명한 실시예 뿐만 아니라, 앞서 설명한 본 발명의 구체적인 실시예들 중 적어도 하나를 포함할 수 있을 것이다.

[225] 도 15는 본 발명의 실시예들을 수행하는 전송장치(10) 및 수신장치(20)의 구성요소를 나타내는 블록도이다. 전송장치(10) 및 수신장치(20)는 정보 및/또는

데이터, 신호, 메시지 등을 나르는 무선 신호를 전송 또는 수신할 수 있는 RF(Radio Frequency) 유닛(13, 23)과, 무선통신 시스템 내 통신과 관련된 각종 정보를 저장하는 메모리(12, 22), 상기 RF 유닛(13, 23) 및 메모리(12, 22)등의 구성요소와 동작적으로 연결되어, 상기 구성요소를 제어하여 해당 장치가 전술한 본 발명의 실시예들 중 적어도 하나를 수행하도록 메모리(12, 22) 및/또는 RF 유닛(13,23)을 제어하도록 구성된 프로세서(11, 21)를 각각 포함한다.

[226] 메모리(12, 22)는 프로세서(11, 21)의 처리 및 제어를 위한 프로그램을 저장할 수 있고, 입/출력되는 정보를 임시 저장할 수 있다. 메모리(12, 22)가 버퍼로서 활용될 수 있다. 프로세서(11, 21)는 통상적으로 전송장치 또는 수신장치 내 각종 모듈의 전반적인 동작을 제어한다. 특히, 프로세서(11, 21)는 본 발명을 수행하기 위한 각종 제어 기능을 수행할 수 있다. 프로세서(11, 21)는 컨트롤러(controller), 마이크로 컨트롤러(microcontroller), 마이크로 프로세서(microprocessor), 마이크로 컴퓨터(microcomputer) 등으로도 불릴 수 있다. 프로세서(11, 21)는 하드웨어(hardware) 또는 펌웨어(firmware), 소프트웨어, 또는 이들의 결합에 의해 구현될 수 있다. 하드웨어를 이용하여 본 발명을 구현하는 경우에는, 본 발명을 수행하도록 구성된 ASICs(application specific integrated circuits) 또는 DSPs(digital signal processors), DSPDs(digital signal processing devices), PLDs(programmable logic devices), FPGAs(field programmable gate arrays) 등이 프로세서(11, 21)에 구비될 수 있다. 한편, 펌웨어나 소프트웨어를 이용하여 본 발명을 구현하는 경우에는 본 발명의 기능 또는 동작들을 수행하는 모듈, 절차 또는 함수 등을 포함하도록 펌웨어나 소프트웨어가 구성될 수 있으며, 본 발명을 수행할 수 있도록 구성된 펌웨어 또는 소프트웨어는 프로세서(11, 21) 내에 구비되거나 메모리(12, 22)에 저장되어 프로세서(11, 21)에 의해 구동될 수 있다.

[227] 전송장치(10)의 프로세서(11)는 상기 프로세서(11) 또는 상기 프로세서(11)와 연결된 스케줄러로부터 스케줄링되어 외부로 전송될 신호 및/또는 데이터에 대하여 소정의 부호화(coding) 및 변조(modulation)를 수행한 후 RF 유닛(13)에 전송한다. 예를 들어, 프로세서(11)는 전송하고자 하는 데이터 열을 역다중화 및 채널 부호화, 스크램블링, 변조과정 등을 거쳐 K개의 레이어로 변환한다. 부호화된 데이터 열은 코드워드로 지칭되기도 하며, MAC 계층이 제공하는 데이터 블록인 전송 블록과 등가이다. 일 전송블록(transport block, TB)은 일 코드워드로 부호화되며, 각 코드워드는 하나 이상의 레이어의 형태로 수신장치에 전송되게 된다. 주파수 상향 변환을 위해 RF 유닛(13)은 오실레이터(oscillator)를 포함할 수 있다. RF 유닛(13)은 Nt개(Nt는 1보다 이상의 양의 정수)의 전송 안테나를 포함할 수 있다.

[228] 수신장치(20)의 신호 처리 과정은 전송장치(10)의 신호 처리 과정의 역으로 구성된다. 프로세서(21)의 제어 하에, 수신장치(20)의 RF 유닛(23)은 전송장치(10)에 의해 전송된 무선 신호를 수신한다. 상기 RF 유닛(23)은 Nr개의 수신 안테나를 포함할 수 있으며, 상기 RF 유닛(23)은 수신 안테나를 통해 수신된

신호 각각을 주파수 하향 변환하여(frequency down-convert) 기저대역 신호로 복원한다. RF 유닛(23)은 주파수 하향 변환을 위해 오실레이터를 포함할 수 있다. 상기 프로세서(21)는 수신 안테나를 통하여 수신된 무선 신호에 대한 복호(decoding) 및 복조(demodulation)를 수행하여, 전송장치(10)가 본래 전송하고자 했던 데이터를 복원할 수 있다.

[229] RF 유닛(13, 23)은 하나 이상의 안테나를 구비한다. 안테나는, 프로세서(11, 21)의 제어 하에 본 발명의 일 실시예에 따라, RF 유닛(13, 23)에 의해 처리된 신호를 외부로 전송하거나, 외부로부터 무선 신호를 수신하여 RF 유닛(13, 23)으로 전달하는 기능을 수행한다. 안테나는 안테나 포트로 불리기도 한다. 각 안테나는 하나의 물리 안테나에 해당하거나 하나보다 많은 물리 안테나 요소(element)의 조합에 의해 구성될 수 있다. 각 안테나로부터 전송된 신호는 수신장치(20)에 의해 더 이상 분해될 수 없다. 해당 안테나에 대응하여 전송된 참조신호(reference signal, RS)는 수신장치(20)의 관점에서 본 안테나를 정의하며, 채널이 일 물리 안테나로부터의 단일(single) 무선 채널인지 혹은 상기 안테나를 포함하는 복수의 물리 안테나 요소(element)들로부터의 합성(composite) 채널인지에 관계없이, 상기 수신장치(20)로 하여금 상기 안테나에 대한 채널 추정을 가능하게 한다. 즉, 안테나는 상기 안테나 상의 심볼을 전달하는 채널이 상기 동일 안테나 상의 다른 심볼이 전달되는 상기 채널로부터 도출될 수 있도록 정의된다. 복수의 안테나를 이용하여 데이터를 송수신하는 다중 입출력(Multi-Input Multi-Output, MIMO) 기능을 지원하는 RF 유닛의 경우에는 2개 이상의 안테나와 연결될 수 있다.

[230] 본 발명의 실시예들에 있어서, UE는 상향링크에서는 전송장치(10)로 동작하고, 하향링크에서는 수신장치(20)로 동작한다. 본 발명의 실시예들에 있어서, eNB는 상향링크에서는 수신장치(20)로 동작하고, 하향링크에서는 전송장치(10)로 동작한다.

[231] 상기 전송장치 및/또는 상기 수신장치는 앞서 설명한 본 발명의 실시예들 중 적어도 하나 또는 둘 이상의 실시예들의 조합을 수행할 수 있다.

[232] 상술한 바와 같이 개시된 본 발명의 바람직한 실시예들에 대한 상세한 설명은 당업자가 본 발명을 구현하고 실시할 수 있도록 제공되었다. 상기에서는 본 발명의 바람직한 실시예들을 참조하여 설명하였지만, 해당 기술 분야의 숙련된 당업자는 하기의 특허 청구의 범위에 기재된 본 발명을 다양하게 수정 및 변경시킬 수 있음을 이해할 수 있을 것이다. 따라서, 본 발명은 여기에 나타난 실시형태들에 제한되려는 것이 아니라, 여기서 개시된 원리들 및 신규한 특징들과 일치하는 최광의 범위를 부여하려는 것이다.

산업상 이용가능성

[233] 본 발명은 단말, 릴레이, 기지국 등과 같은 무선 통신 장치에 사용될 수 있다.

청구범위

[청구항 1] 2차원으로 배열된 N_t개의 안테나 포트를 통해 전송되는 하향링크 채널에 대한 채널 상태 보고를 위한 방법에 있어서, 상기 방법은 단말에 의해 수행되며,
상기 N_t개의 안테나 포트 각각은 특정 안테나 엘리먼트 그룹에 속하는 모든 안테나 엘리먼트에 맵핑되고, 동일한 OFDM 심볼에서 전송되는 참조 신호(reference signal; RS)에 대응하는 안테나 포트 그룹의 각 안테나 포트는 서로 다른 안테나 엘리먼트 그룹에 맵핑되도록 설정되며,
상기 안테나 포트 그룹에 대한 채널 상태 보고를 위한 참조 신호(chaneel state information-reference signal; CSI-RS) 설정을 수신하는 단계; 및
상기 수신된 CSI-RS 설정을 사용하여 수신된 CSI-RS를 통해 하향링크 채널에 대한 채널 상태 정보를 계산하여 서빙 셀로 보고하는 단계를 포함하고,
상기 보고되는 채널 상태 정보는 안테나 포트 그룹 선택을 위한 프리코딩 행렬 및 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬을 포함하는 것을 특징으로 하는, 채널 상태 보고 방법.

[청구항 2] 제1항에 있어서, 상기 안테나 포트 그룹 선택을 위한 프리코딩 행렬은 안테나 포트 그룹 선택 코드북에서 선택되는 것을 특징으로 하는, 채널 상태 보고 방법.

[청구항 3] 제1항에 있어서, 상기 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬은 상수 모듈러스(constant modulus) 코드북에서 선택되는 것을 특징으로 하는, 채널 상태 보고 방법.

[청구항 4] 제1항에 있어서, 안테나 포트 그룹 별로 상기 CSI-RS의 전송이 활성화 또는 비활성화되었는지 여부를 지시하는 정보를 상기 서빙 셀로부터 수신하는 단계를 더 포함하는 것을 특징으로 하는, 채널 상태 보고 방법.

[청구항 5] 제4항에 있어서, 상기 비활성화된 안테나 포트 그룹을 선택하기 위한 프리코딩 행렬은 상기 채널 상태 정보에서 제외되는 것을 특징으로 하는, 채널 상태 보고 방법.

[청구항 6] 제1항에 있어서, 상기 안테나 포트 그룹 선택을 위한 프리코딩의 랭크 제한 또는 상기 선택된 안테나 포트 그룹에 적용될 프리코딩의 랭크 제한에 대한 정보를 상기 서빙 셀로부터 수신하는 단계를 포함하는 것을 특징으로 하는, 채널 상태 보고 방법.

[청구항 7] 2차원으로 배열된 N_t개의 안테나 포트를 통해 전송되는 하향링크 채널에 대한 채널 상태 보고를 하도록 구성된 단말에 있어서,
무선 주파수(radio frequency, RF) 유닛; 및
상기 RF 유닛을 제어하도록 구성된 프로세서를 포함하되,
상기 N_t개의 안테나 포트 각각은 특정 안테나 엘리먼트 그룹에 속하는

모든 안테나 엘리먼트에 맵핑되고, 동일한 OFDM 심볼에서 전송되는 참조 신호(reference signal; RS)에 대응하는 안테나 포트 그룹의 각 안테나 포트는 서로 다른 안테나 엘리먼트 그룹에 맵핑되도록 설정되며,
상기 프로세서는 상기 안테나 포트 그룹에 대한 채널 상태 보고를 위한 참조 신호(chaneel state information-reference signal; CSI-RS) 설정을 수신하고, 그리고
상기 수신된 CSI-RS 설정을 사용하여 수신된 CSI-RS를 통해 하향링크 채널에 대한 채널 상태 정보를 계산하여 서빙 셀로 보고하도록 구성되며,
상기 보고되는 채널 상태 정보는 안테나 포트 그룹 선택을 위한 프리코딩 행렬 및 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬을 포함하는 것을 특징으로 하는, 단말.

[청구항 8] 제7항에 있어서, 상기 안테나 포트 그룹 선택을 위한 프리코딩 행렬은 안테나 포트 그룹 선택 코드북에서 선택되는 것을 특징으로 하는, 단말.

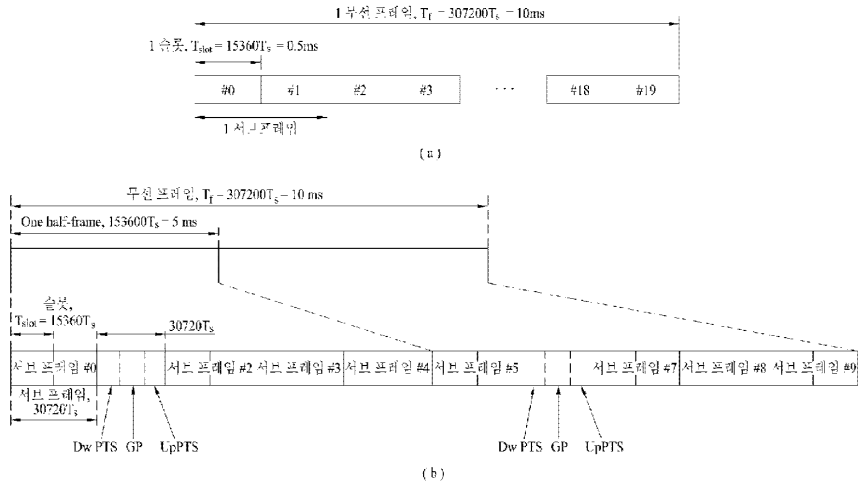
[청구항 9] 제7항에 있어서, 상기 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬은 상수 모듈러스(constant modulus) 코드북에서 선택되는 것을 특징으로 하는, 단말.

[청구항 10] 제7항에 있어서, 상기 프로세서는 안테나 포트 그룹 별로 상기 CSI-RS의 전송이 활성화 또는 비활성화되었는지 여부를 지시하는 정보를 상기 서빙 셀로부터 수신하도록 구성되는 것을 특징으로 하는, 단말.

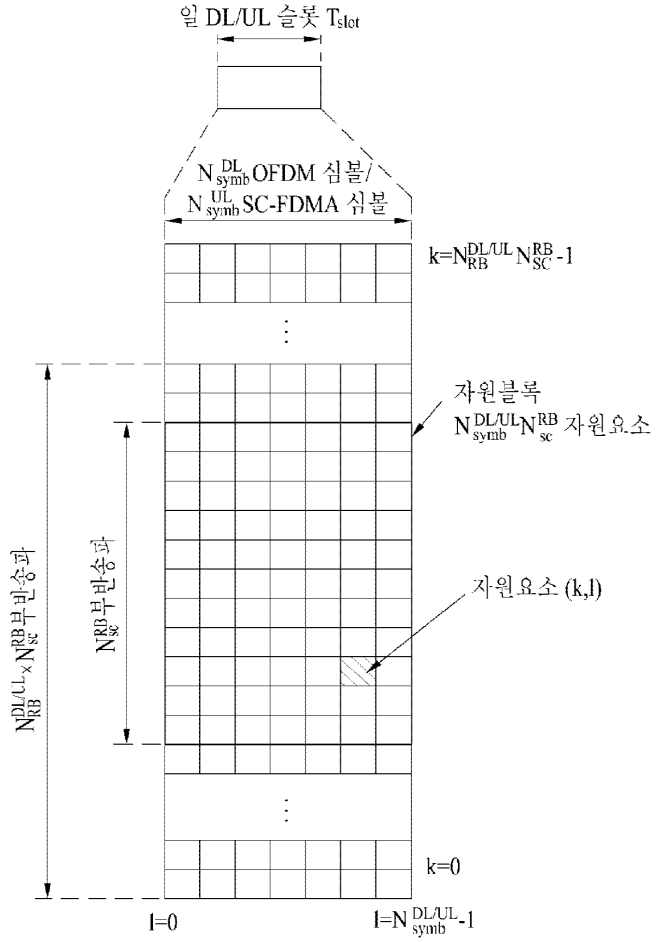
[청구항 11] 제10항에 있어서, 상기 비활성화된 안테나 포트 그룹을 선택하기 위한 프리코딩 행렬은 상기 채널 상태 정보에서 제외되는 것을 특징으로 하는, 단말.

[청구항 12] 제7항에 있어서, 상기 프로세서는 상기 안테나 포트 그룹 선택을 위한 프리코딩의 랭크 제한 또는 상기 선택된 안테나 포트 그룹에 적용될 프리코딩의 랭크 제한에 대한 정보를 상기 서빙 셀로부터 수신하도록 구성되는 것을 특징으로 하는, 단말.

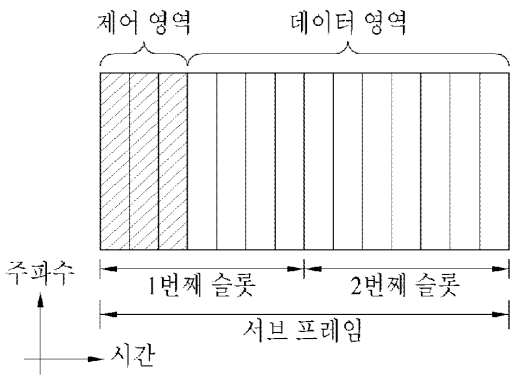
[도1]


1 무선 프레임, $T_f = 307200T_s = 10ms$
1 슬롯, $T_{slot} = 15360T_s = 0.5ms$
#0
#1
#2
#3
#18
#19
1 서브프레임
(a)
무선 프레임, $T_f = 307200T_s = 10$ ms
One half-frame, $153600T_s = 5$ ms
슬롯, $T_{slot} = 15360T_s$
$30720T_s$
서브 프레임 #0
서브 프레임 #2
서브 프레임 #3
서브 프레임 #4
서브 프레임 #5
서브 프레임 #7
서브 프레임 #8
서브 프레임 #9
서브 프레임, $30720T_s$
DwPTS
GP
UpPTS
DwPTS
GP
UpPTS
(b)

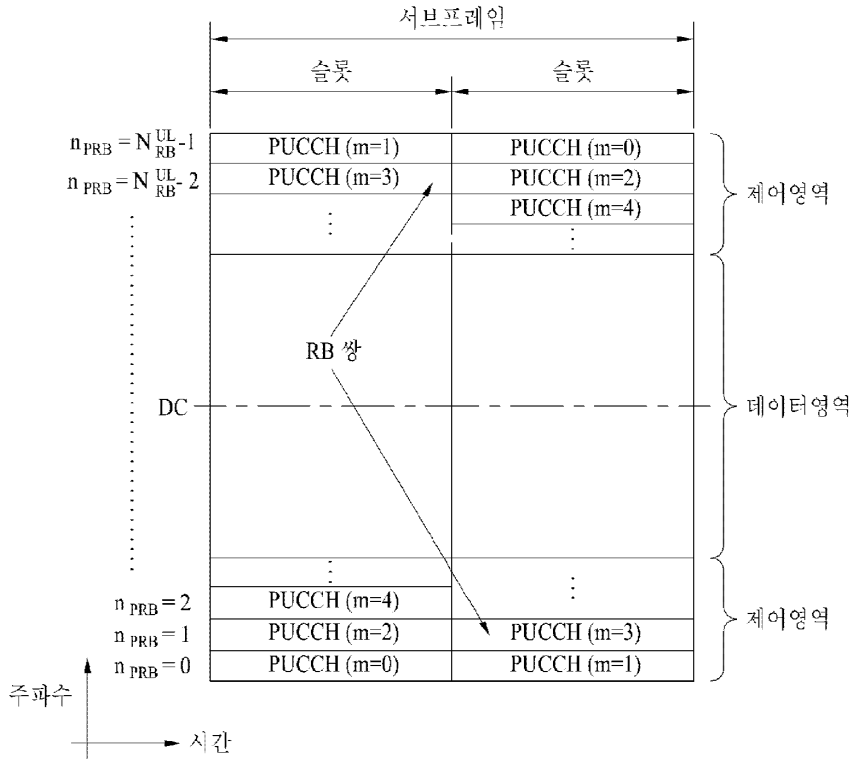
[도2]


일 DL/UL 슬롯 T_{slot}
N^{DL}_{symb} OFDM 심볼/
N^{UL}_{symb} SC-FDMA 심볼
$k=N^{DL/UL}_{RB}N^{RB}_{SC}-1$
자원블록
$N^{DL/UL}_{symb}N^{RB}_{sc}$ 자원요소
자원요소 (k,l)
$N^{DL/UL}_{RB}\times N^{RB}_{sc}$부반송파
N^{RB}_{sc}부반송파
k=0
l=0
$l=N^{DL/UL}_{symb}-1$

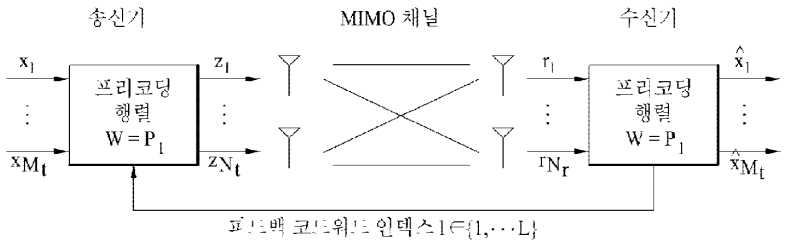
[도3]


제어 영역
데이터 영역
주파수
1번째 슬롯
2번째 슬롯
서브 프레임
시간

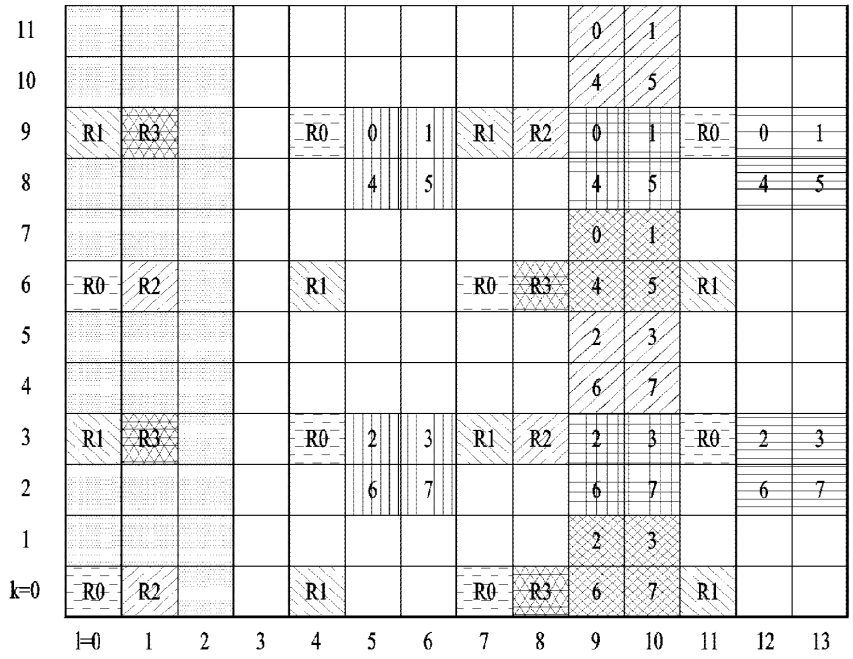
[도4]


서브프레임
슬롯
슬롯
$n_{PRB} = N_{RB}^{UL}-1$
$n_{PRB} = N_{RB}^{UL}-2$
PUCCH (m=1)
PUCCH (m=0)
PUCCH (m=3)
PUCCH (m=2)
PUCCH (m=4)
RB 쌍
DC
제어영역
데이터영역
$n_{PRB}=2$
$n_{PRB}=1$
$n_{PRB}=0$
PUCCH (m=4)
PUCCH (m=2)
PUCCH (m=0)
PUCCH (m=3)
PUCCH (m=1)
제어영역
주파수
시간

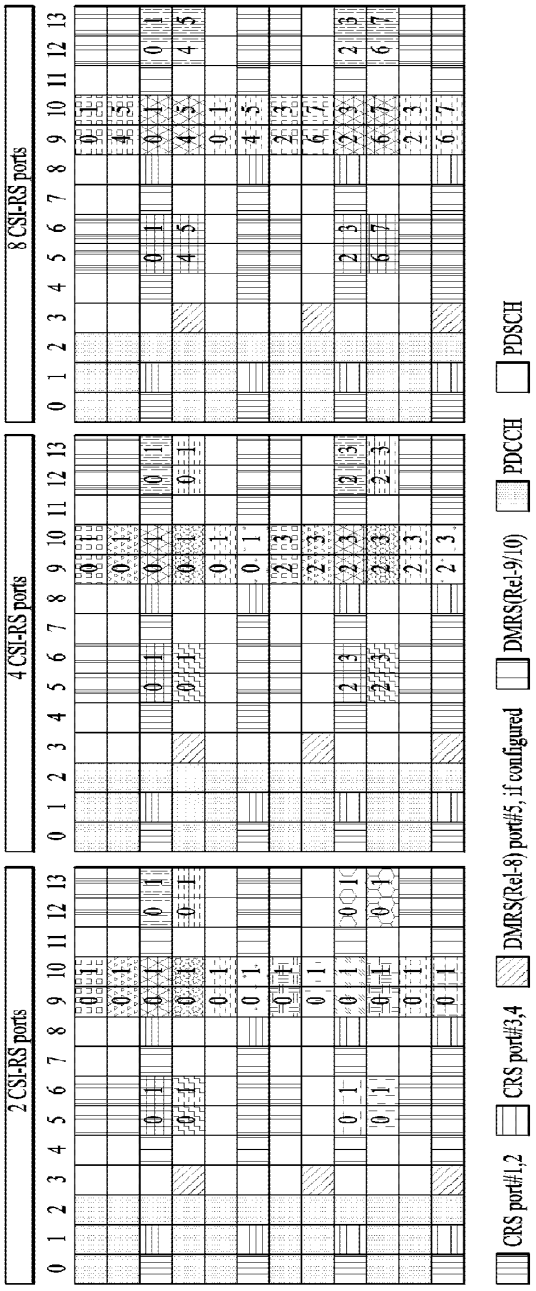
[도5]


송신기
MIMO 채널
수신기
x_1
x_{M_t}
프리코딩 행렬 W = P_l
z_1
z_{N_t}
r_1
r_{N_r}
프리코딩 행렬 W = P_l
$\hat{x}_1$
$\hat{x}_{M_t}$
피드백 코드워드 인덱스 $l \in \{1, \cdots L\}$

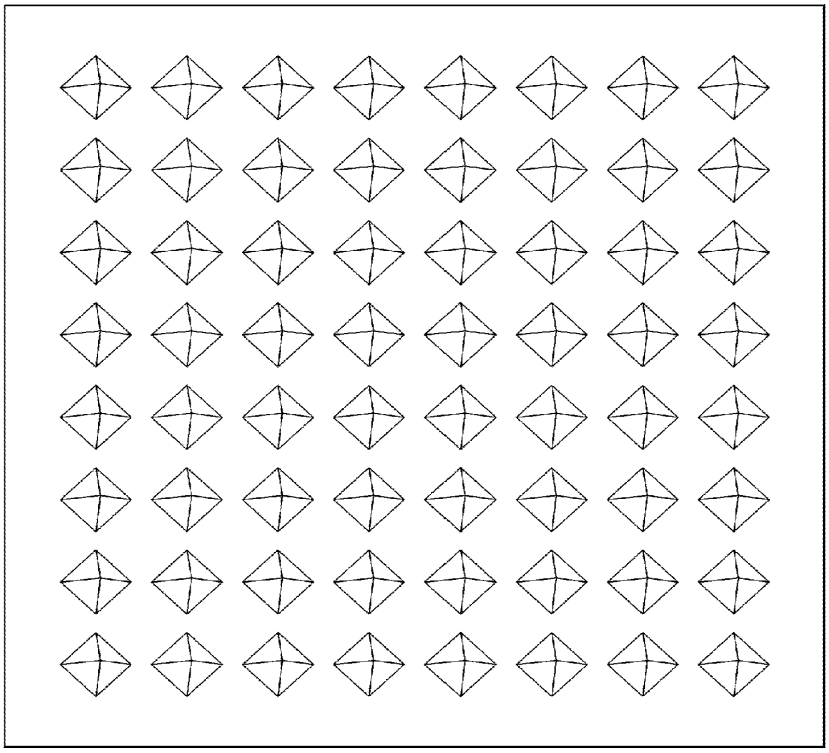
[도6]


11
10
9
8
7
6
5
4
3
2
1
k=0
l=0 1 2 3 4 5 6 7 8 9 10 11 12 13
R1 R3 R0 0 1 R1 R2 0 1 R0 0 1
4 5 4 5 4 5
0 1
R0 R2 R1 R0 R3 4 5 R1
2 3
6 7
R1 R3 R0 2 3 R1 R2 2 3 R0 2 3
6 7 6 7 6 7
2 3
R0 R2 R1 R0 R3 6 7 R1

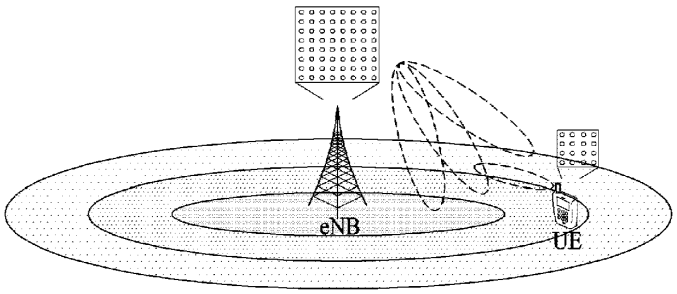
[도7]


2 CSI-RS ports
4 CSI-RS ports
8 CSI-RS ports
0 1 2 3 4 5 6 7 8 9 10 11 12 13
CRS port#1,2
CRS port#3,4
DMRS(Rel-8) port#5, if configured
DMRS(Rel-9/10)
PDCCH
PDSCH

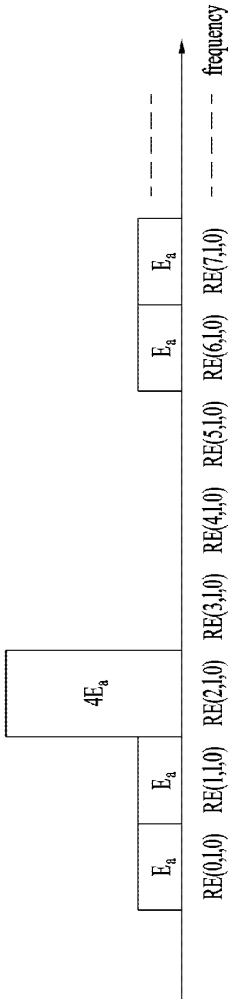
[도8]



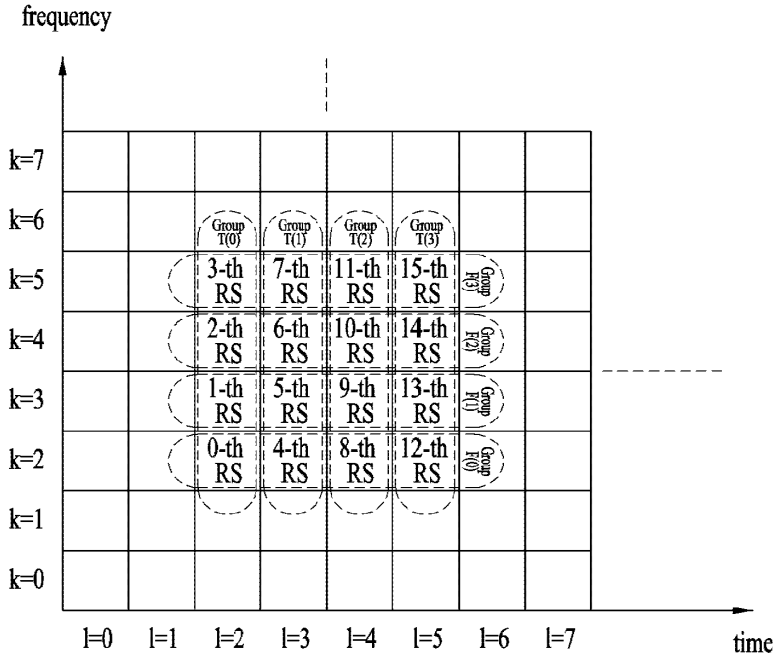
[도9]



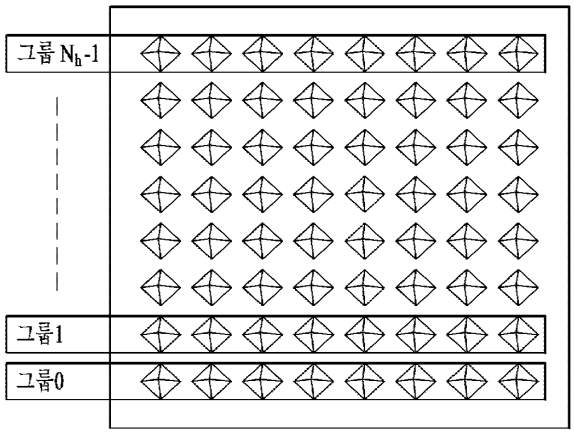
[도10]


frequency
RE(0,1,0)
RE(1,1,0)
RE(2,1,0)
RE(3,1,0)
RE(4,1,0)
RE(5,1,0)
RE(6,1,0)
RE(7,1,0)
E_a
$4E_a$

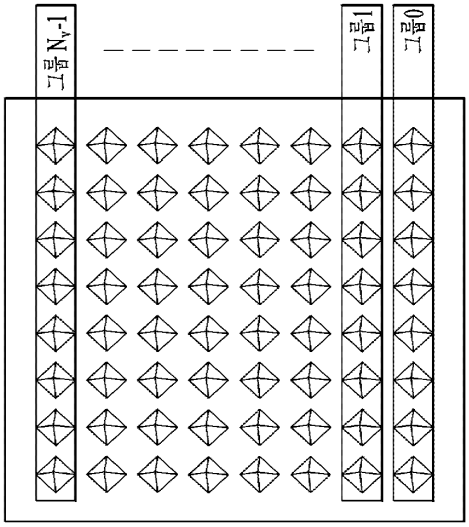
[도11]


frequency
k=7
k=6
k=5
k=4
k=3
k=2
k=1
k=0
Group T(0)
Group T(1)
Group T(2)
Group T(3)
3-th RS
7-th RS
11-th RS
15-th RS
2-th RS
6-th RS
10-th RS
14-th RS
1-th RS
5-th RS
9-th RS
13-th RS
0-th RS
4-th RS
8-th RS
12-th RS
Group F(3)
Group F(2)
Group F(1)
Group F(0)
l=0
l=1
l=2
l=3
l=4
l=5
l=6
l=7
time

[도12]

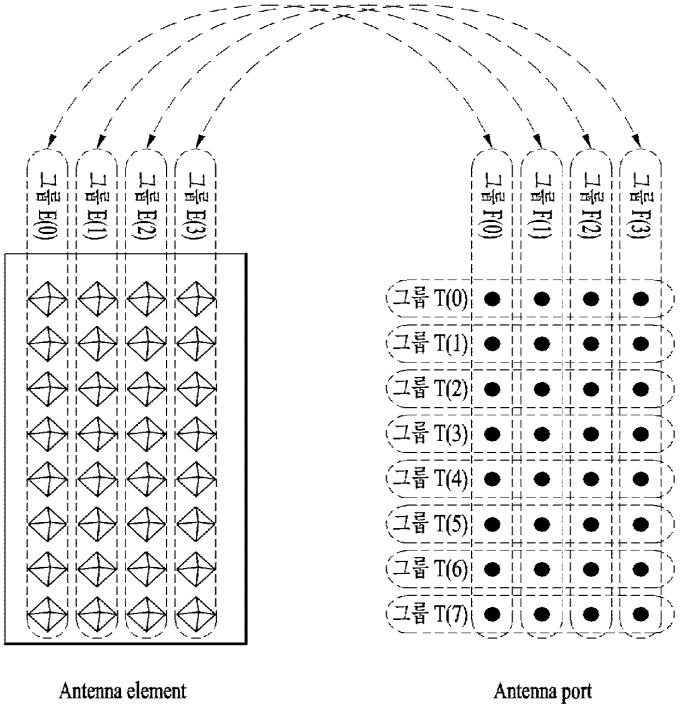


(b)

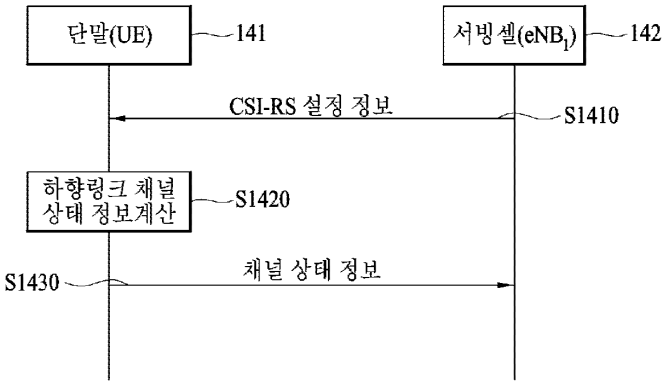


(a)

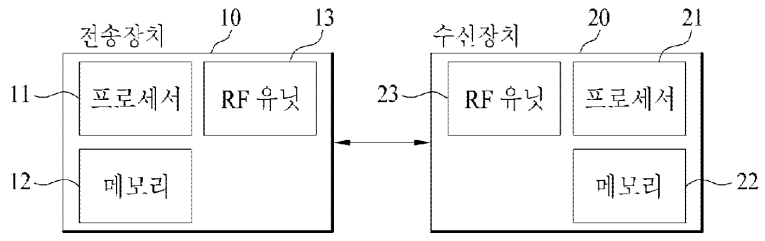
[도13]


그룹 E(0)
그룹 E(1)
그룹 E(2)
그룹 E(3)
그룹 F(0)
그룹 F(1)
그룹 F(2)
그룹 F(3)
그룹 T(0)
그룹 T(1)
그룹 T(2)
그룹 T(3)
그룹 T(4)
그룹 T(5)
그룹 T(6)
그룹 T(7)
Antenna element
Antenna port

[도14]


단말(UE)
141
서빙셀(eNB1)
142
CSI-RS 설정 정보
S1410
하향링크 채널 상태 정보계산
S1420
S1430
채널 상태 정보

[도15]


전송장치
10
13
11
프로세서
RF 유닛
12
메모리
수신장치
20
21
23
RF 유닛
프로세서
메모리
22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/007995

A. CLASSIFICATION OF SUBJECT MATTER

H04B 7/06(2006.01)i, H04L 5/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04B 7/06; H04W 72/04; H04B 7/04; H04W 24/08; H04L 5/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: 2D antenna, antenna port group, precoding, codebook, CSI-RS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2014-0057005 A (PANTECH CO., LTD.) 12 May 2014 See paragraphs [0010], [0021], [0036], [0038], [0042]-[0045]; claim 1; and figure 5.	1-3,7-9
A		4-6,10-12
Y	US 2014-0098689 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 10 April 2014 See paragraphs [0101], [0145], [0149], [0172], [0181], [0210]; and figures 1A-1E.	1-3,7-9
A	US 2012-0058791 A1 (BHATTAD, Kapil et al.) 08 March 2012 See paragraphs [0009]-[0015]; claim 1; and figure 1.	1-12
A	US 2013-0163544 A1 (SAMSUNG ELECTRONICS CO., LTD. et al.) 27 June 2013 See paragraphs [0008]-[0016]; claim 1; and figure 1.	1-12
A	US 2011-0249637 A1 (HAMMARWALL, David et al.) 13 October 2011 See paragraphs [0028]-[0036]; claim 1; and figure 1.	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 DECEMBER 2015 (15.12.2015)	**15 DECEMBER 2015 (15.12.2015)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2014-0057005 A	12/05/2014	WO 2014-069821 A1	08/05/2014
US 2014-0098689 A1	10/04/2014	EP 2901571 A1	05/08/2015
		TW 201429182 A	16/07/2014
		WO 2014-052806 A1	03/04/2014
US 2012-0058791 A1	08/03/2012	CA 2788994 A1	01/09/2011
		CN 102845011 A	26/12/2012
		EP 2540022 A2	02/01/2013
		JP 05612132 B2	22/10/2014
		JP 2013-520935 A	06/06/2013
		JP 2015-039175 A	26/02/2015
		KR 10-2012-0140247 A	28/12/2012
		KR 10-2014-0130483 A	10/11/2014
		TW 201218674 A	01/05/2012
		WO 2011-106457 A2	01/09/2011
		WO 2011-106457 A3	05/04/2012
US 2013-0163544 A1	27/06/2013	EP 2798748 A1	05/11/2014
		KR 10-2013-0075140 A	05/07/2013
		WO 2013-100565 A1	04/07/2013
US 2011-0249637 A1	13/10/2011	CN 102823153 A	12/12/2012
		CN 102823154 A	12/12/2012
		CN 102823155 A	12/12/2012
		EP 2556597 A1	13/02/2013
		EP 2556598 A1	13/02/2013
		EP 2556599 A1	13/02/2013
		RU 2012147189 A	20/05/2014
		RU 2012147235 A	27/05/2014
		US 2011-0249712 A1	13/10/2011
		US 2011-0249713 A1	13/10/2011
		US 2013-0272351 A1	17/10/2013
		US 2014-0044211 A1	13/02/2014
		US 2014-0169493 A1	19/06/2014
		US 2014-0269577 A1	18/09/2014
		US 8472547 B2	25/06/2013
		US 8582627 B2	12/11/2013
		US 8687678 B2	01/04/2014
		US 8767681 B2	01/07/2014
		US 8811524 B2	19/08/2014
		WO 2011-126445 A1	13/10/2011
		WO 2011-126446 A1	13/10/2011
		WO 2011-126447 A1	13/10/2011

국 제 조 사 보 고 서

국제출원번호
PCT/KR2015/007995

A. 발명이 속하는 기술분류(국제특허분류(IPC))

H04B 7/06(2006.01)i, H04L 5/00(2006.01)i

B. 조사된 분야

조사된 최소문헌(국제특허분류를 기재)
H04B 7/06; H04W 72/04; H04B 7/04; H04W 24/08; H04L 5/00

조사된 기술분야에 속하는 최소문헌 이외의 문헌
한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC
일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))
eKOMPASS(특허청 내부 검색시스템) & 키워드: 2차원 안테나, 안테나 포트 그룹, 프리코딩, 코드북, CSI-RS

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
Y	KR 10-2014-0057005 A (주식회사 팬택) 2014.05.12 단락 [0010], [0021], [0036], [0038], [0042]-[0045]; 청구항 1; 및 도면 5 참조.	1-3,7-9
A		4-6,10-12
Y	US 2014-0098689 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 2014.04.10 단락 [0101], [0145], [0149], [0172], [0181], [0210]; 및 도면 1A-1E 참조.	1-3,7-9
A	US 2012-0058791 A1 (KAPIL BHATTAD 등) 2012.03.08 단락 [0009]-[0015]; 청구항 1; 및 도면 1 참조.	1-12
A	US 2013-0163544 A1 (SAMSUNG ELECTRONICS CO., LTD. 등) 2013.06.27 단락 [0008]-[0016]; 청구항 1; 및 도면 1 참조.	1-12
A	US 2011-0249637 A1 (DAVID HAMMARWALL 등) 2011.10.13 단락 [0028]-[0036]; 청구항 1; 및 도면 1 참조.	1-12

☐ 추가 문헌이 C(계속)에 기재되어 있습니다.

☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2015년 12월 15일 (15.12.2015)	2015년 12월 15일 (15.12.2015)

ISA/KR의 명칭 및 우편주소
대한민국 특허청
(35208) 대전광역시 서구 청사로 189,
4동 (둔산동, 정부대전청사)
팩스 번호 +82-42-472-7140

심사관
강희곡
전화번호 +82-42-481-8264

서식 PCT/ISA/210 (두 번째 용지) (2015년 1월)

국 제 조 사 보 고 서
대응특허에 관한 정보

국제출원번호
PCT/KR2015/007995

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
KR 10-2014-0057005 A	2014/05/12	WO 2014-069821 A1	2014/05/08
US 2014-0098689 A1	2014/04/10	EP 2901571 A1	2015/08/05
		TW 201429182 A	2014/07/16
		WO 2014-052806 A1	2014/04/03
US 2012-0058791 A1	2012/03/08	CA 2788994 A1	2011/09/01
		CN 102845011 A	2012/12/26
		EP 2540022 A2	2013/01/02
		JP 05612132 B2	2014/10/22
		JP 2013-520935 A	2013/06/06
		JP 2015-039175 A	2015/02/26
		KR 10-2012-0140247 A	2012/12/28
		KR 10-2014-0130483 A	2014/11/10
		TW 201218674 A	2012/05/01
		WO 2011-106457 A2	2011/09/01
		WO 2011-106457 A3	2012/04/05
US 2013-0163544 A1	2013/06/27	EP 2798748 A1	2014/11/05
		KR 10-2013-0075140 A	2013/07/05
		WO 2013-100565 A1	2013/07/04
US 2011-0249637 A1	2011/10/13	CN 102823153 A	2012/12/12
		CN 102823154 A	2012/12/12
		CN 102823155 A	2012/12/12
		EP 2556597 A1	2013/02/13
		EP 2556598 A1	2013/02/13
		EP 2556599 A1	2013/02/13
		RU 2012147189 A	2014/05/20
		RU 2012147235 A	2014/05/27
		US 2011-0249712 A1	2011/10/13
		US 2011-0249713 A1	2011/10/13
		US 2013-0272351 A1	2013/10/17
		US 2014-0044211 A1	2014/02/13
		US 2014-0169493 A1	2014/06/19
		US 2014-0269577 A1	2014/09/18
		US 8472547 B2	2013/06/25
		US 8582627 B2	2013/11/12
		US 8687678 B2	2014/04/01
		US 8767681 B2	2014/07/01
		US 8811524 B2	2014/08/19
		WO 2011-126445 A1	2011/10/13
		WO 2011-126446 A1	2011/10/13
		WO 2011-126447 A1	2011/10/13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/112033

A. CLASSIFICATION OF SUBJECT MATTER

H04B 7/0408 (2017.01) i; H04B 7/0413 (2017.01) n; H04B 7/06 (2006.01) n
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04B; H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; CNTXT; CNKI; VEN; EPTXT; USTXT; WOTXT; 3GPP: 多天线, 多输入多输出, 参考信号, 下行信号, 无线信号, 信令, 下行链路控制信息, 指示, 确定, 时间, 时域, 资源池, 天线, 虚拟化, 端口组, multiple antenna, multiple input and multiple output, reference signal, downlink signal, wireless signal, signaling, downlink control information, indicat+, determin+, time, domain, resource pool, antenna, virtualiz+, port group, RS, MIMO, DCI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 105577318 A (SHANGHAI LANGBO COMMUNICATION TECHNOLOGY CO., LTD.) 11 May 2016 (11.05.2016), description, paragraphs [0016] and [0068]-[0089], and figures 2-5	1-3, 5, 7-11, 13, 15-20
A	CN 103687010 A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY) 26 March 2014 (26.03.2014), entire document	1-20
A	WO 2016018100 A1 (LGELECTRONICS INC.) 04 February 2016 (04.02.2016), entire document	1-20
A	US 2016094326 A1 (KOREA ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE) 31 March 2016 (31.03.2016), entire document	1-20

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 January 2018	07 February 2018
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer JIA, Jie Telephone No. (86-10) 62411405

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/112033

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	LG Electronics. RS design enhancements for supporting EB and FD-MIMO. 3GPP TSGRAN WG1 Meeting #78bis, R1-144047. http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/. 05 October 2014 (05.10.2014), entire document	1-20

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/112033

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 105577318 A	11 May 2016	None	
CN 103687010 A	26 March 2014	US 2015280875 A1	01 October 2015
		EP 2892290 A1	08 July 2015
		EP 2892290 A4	16 September 2015
		WO 2014032606 A1	06 March 2014
		US 9660779 B2	23 May 2017
		EP 2892290 B1	05 July 2017
		TW 201409961 A	01 March 2014
		CN 103687010 B	04 July 2017
WO 2016018100 A1	04 February 2016	US 2017195100 A1	06 July 2017
		EP 3185436 A1	28 June 2017
		KR 20170038759 A	07 April 2017
US 2016094326 A1	31 March 2016	None	

国际检索报告

国际申请号
PCT/CN2017/112033

A. 主题的分类

H04B 7/0408(2017.01)i; H04B 7/0413(2017.01)n; H04B 7/06(2006.01)n

按照国际专利分类(IPC)或者同时按照国家分类和IPC两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

H04B;H04L

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词（如使用）)

CNABS;CNTXT;CNKI;VEN;EPTXT;USTXT;WOTXT;3GPP:多天线，多输入多输出，参考信号，下行信号，无线信号，信令，下行链路控制信息，指示，确定，时间，时域，资源池，天线，虚拟化，端口组，multiple antenna, multiple input and multiple output, reference signal, downlink signal, wireless signal, signaling, downlink control information, indicat+, determin+, time, domain, resource pool, antenna, virtualiz+, port group, RS, MIMO, DCI

C. 相关文件

类 型*	引用文件，必要时，指明相关段落	相关的权利要求
X	CN 105577318 A (上海朗帛通信技术有限公司) 2016年 5月 11日 (2016-05-11) 说明书第[0016]、[0068]-[0089]段，图2-5	1-3, 5, 7-11, 13, 15-20
A	CN 103687010 A (电信科学技术研究院) 2014年 3月 26日 (2014-03-26) 全文	1-20
A	WO 2016018100 A1 (LG电子株式会社) 2016年 2月 4日 (2016-02-04) 全文	1-20
A	US 2016094326 A1 (韩国电子通信研究院) 2016年 3月 31日 (2016-03-31) 全文	1-20
A	LG Electronics. "RS design enhancements for supporting EB and FD-MIMO" 3GPP TSGRAN WG1 Meeting #78bis, R1-144047, http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/, 2014年 10月 5日 (2014-10-05), 全文	1-20

☐ 其余文件在C栏的续页中列出。

☑ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的当天或之后公布的在先申请或专利

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件（如具体说明的）

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触，但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
2018年 1月 29日	2018年 2月 7日
ISA/CN的名称和邮寄地址 中华人民共和国国家知识产权局(ISA/CN) 中国北京市海淀区蓟门桥西土城路6号 100088 传真号 (86-10)62019451	受权官员 贾杰 电话号码 (86-10)62411405

表 PCT/ISA/210 (第2页) (2009年7月)

国际检索报告
关于同族专利的信息

国际申请号
PCT/CN2017/112033

检索报告引用的专利文件			公布日（年/月/日）	同族专利			公布日（年/月/日）
CN	105577318	A	2016年 5月 11日	无			
CN	103687010	A	2014年 3月 26日	US	2015280875	A1	2015年 10月 1日
				EP	2892290	A1	2015年 7月 8日
				EP	2892290	A4	2015年 9月 16日
				WO	2014032606	A1	2014年 3月 6日
				US	9660779	B2	2017年 5月 23日
				EP	2892290	B1	2017年 7月 5日
				TW	201409961	A	2014年 3月 1日
				CN	103687010	B	2017年 7月 4日
WO	2016018100	A1	2016年 2月 4日	US	2017195100	A1	2017年 7月 6日
				EP	3185436	A1	2017年 6月 28日
				KR	20170038759	A	2017年 4月 7日
US	2016094326	A1	2016年 3月 31日	无			

表 PCT/ISA/210（同族专利附件）（2009年7月）

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/429,077	06/03/2019	Xiaobo ZHANG	20160089-PCT-US

CONFIRMATION NO. 2560

157297
Langbo Communication Technology Co. LTD
11422 Turtleback Ln
San Diego, CA 92127

PUBLICATION NOTICE

OC000000111252355

Title: Method and Device for Multi-Antenna Transmission in UE and Base Station

Publication No.US-2019-0288807-A1
Publication Date:09/19/2019

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16429077
Filing Date	2019-06-03
First Named Inventor	Xiaobo,ZHANG
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	20160089-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110223876	A	2011-09-15	Samsung Electronics Co Ltd	
	2	20150010106	A	2015-01-08	NOKIA SOLUTIONS AND NETWORKS OY	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	105577318	CN	X	2016-05-11	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY CO.LTD	Abstract and drawing sheets of the patent specification, paragraphs 58、67-97 of the specification,	X
	2	101567865	CN	A	2009-10-28	DINGQIAO COMMUNICATION TECHNOLOGY CO.LTD		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	Xiaobo,ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	20160089-PCT-US

If you wish to add additional Foreign Patent Document citation information please click the Add button [Add]

NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	CN Search Report in application No.201611098328.7 dated December 26, 2019	☒
	2	CN First Office Action in Application No.201611098328.7 dated January 06, 2020	☒
	3	CN Grant Notice in Application No.201611098328.7 dated April 21, 2020	☒
	4	《3GPP TSG-RAN Working Group 1 Meeting #56bis R1-091591》 Nortel Discussion on RS Design for Higher-order MIMO in LTE-A	☐
	5	《3GPP TSG-RAN WG1#79 R1-145169》 Ericsson Phasee 2 modeling of 2D Antenna Arrays	☐
	6	《3GPP TSG RAN WG1 61bis R1-103705》 Texas Instruments Remaining Issues on ULMIMO Transmission Mode and DCI Format Design	☐

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	Xiaobo,ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	20160089-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	Xiaobo ZHANG	Date (YYYY-MM-DD)	2020-07-16
Name/Print	/Xiaobo ZHANG/	Registration Number	

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	40015935
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	157297
Filer:	Qi Zhou
Filer Authorized By:	
Attorney Docket Number:	20160089-PCT-US
Receipt Date:	16-JUL-2020
Filing Date:	03-JUN-2019
Time Stamp:	09:08:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	20160089_CN_GRANT.pdf	237888 5a588bb7c47d504a01f0051aa6ff5ea138d834be	no	3

Warnings:

Information:					
2	Non Patent Literature	20160089_CN_OA1.pdf	943464 8a4a2d7ca73c9a3b53fb6fd9c7962ddd83c83a46	no	16
Warnings:					
Information:					
3	Non Patent Literature	20160089_CN_SEARCH.pdf	348875 cc0946cd68c6dbcbb4f540d1c1cc1808c68f0961	no	8
Warnings:					
Information:					
4	Non Patent Literature	R1_091591.pdf	784516 2509554322fec83768bab3e7e9c0c343a2179702	no	7
Warnings:					
Information:					
5	Non Patent Literature	R1_103705.pdf	857121 69fe129f43f69d35a43da9a81401159303ddd7d7	no	4
Warnings:					
Information:					
6	Non Patent Literature	R1_145169.pdf	1166357 5c1dfc4aaac4c92ab5d45358df03bcf00e9082c3	no	6
Warnings:					
Information:					
7	Other Reference-Patent/App/Search documents	US20110223876A1.pdf	719104 c2283057fcd2e63b3da875a7664218bb61d3c0e0	no	12
Warnings:					
Information:					
8	Other Reference-Patent/App/Search documents	US20150010106A1.pdf	809216 9c8507f0726ae34e1b5e75935e775215407a2d6f	no	11
Warnings:					
Information:					

9	Foreign Reference	CN101567865A.PDF	875751 35fe28dac888fada0bb7ed708b45dc5db3bdb624	no	16
Warnings:					
Information:					
10	Foreign Reference	CN105577318A.pdf	925448 d70e6625f236425a77b60aecf19e2defa0e7aace	no	15
Warnings:					
Information:					
11	Information Disclosure Statement (IDS) Form (SB08)	20160089_PCT_US_IDS.pdf	1038307 f23390987b5d5b6bf46c59b372830b43ca1f0fb8	no	4
Warnings:					
Information:					
		Total Files Size (in bytes):	8706047		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

US 20110223876A1

(19) **United States**

(12) **Patent Application Publication**

Kang

(10) **Pub. No.: US 2011/0223876 A1**

(43) **Pub. Date: Sep. 15, 2011**

(54) **APPARATUS AND METHOD FOR VIRTUAL ANTENNA MAPPING IN MULTI-ANTENNA SYSTEM**

(75) Inventor: **Jee-Woong Kang**, Seoul (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO.,LTD.**, Suwon-si (KR)

(21) Appl. No.: **13/048,701**

(22) Filed: **Mar. 15, 2011**

(30) **Foreign Application Priority Data**

Mar. 15, 2010 (KR) 10-2010-0022768

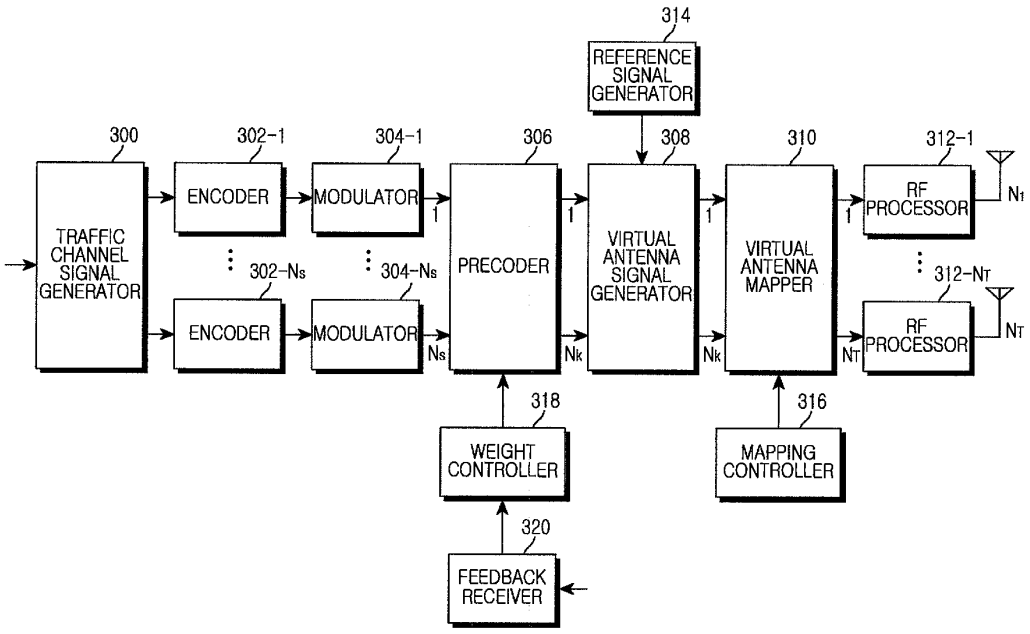
Publication Classification

(51) **Int. Cl.**
H04W 88/02 (2009.01)

(52) **U.S. Cl.** **455/129**

(57) **ABSTRACT**

An apparatus and a method for mapping virtual antennas and physical antennas in a wireless communication system. The method for mapping the virtual antennas and the physical antennas includes generating at least two virtual antenna signals for at least two virtual antennas. The method also includes generating at least two physical antenna signals by applying a corresponding matrix, which maps the at least two virtual antennas and the at least two physical antennas in many-to-many relation, to the at least two virtual antenna signals. The method further includes transmitting the at least two physical antenna signals over respective physical antennas.



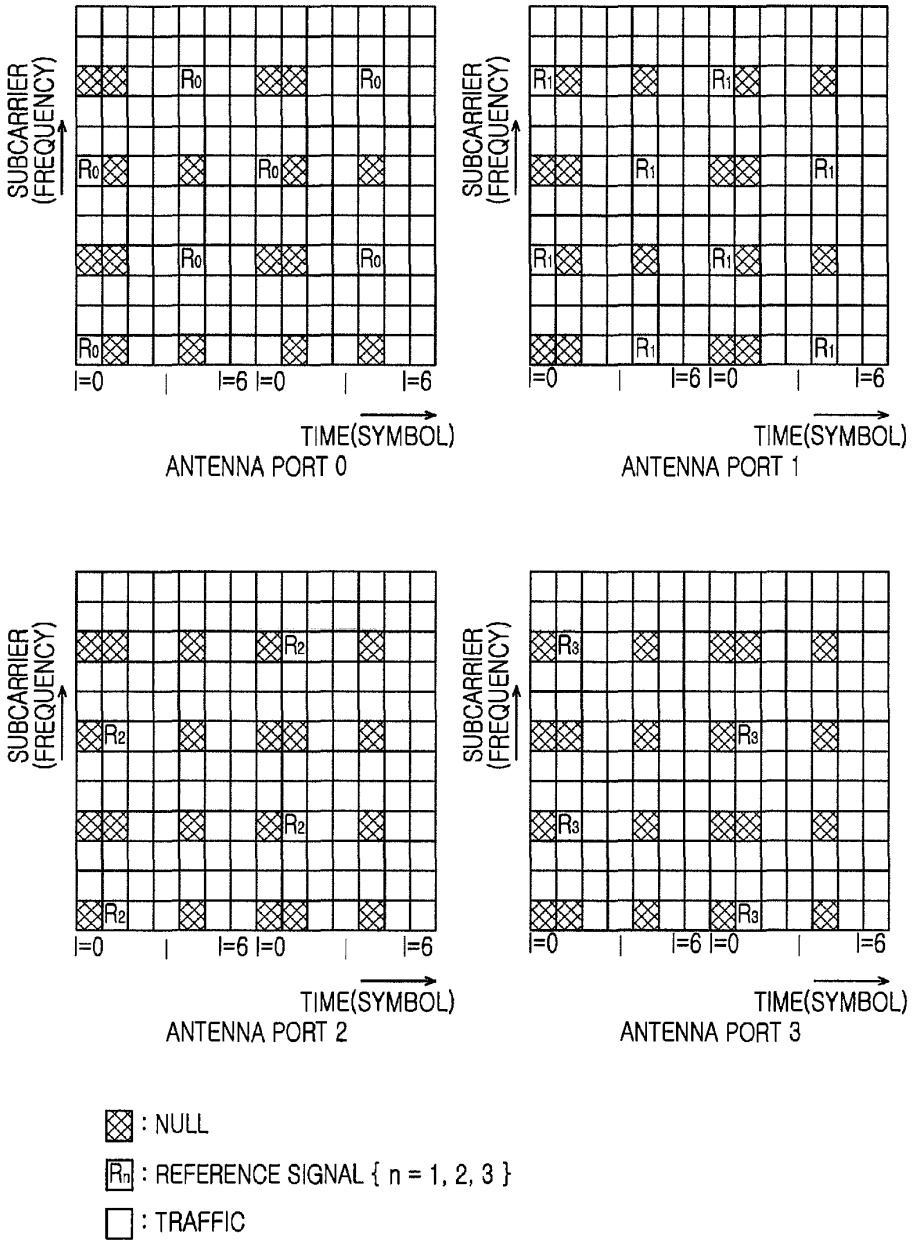


FIG.1
(PRIOR ART)

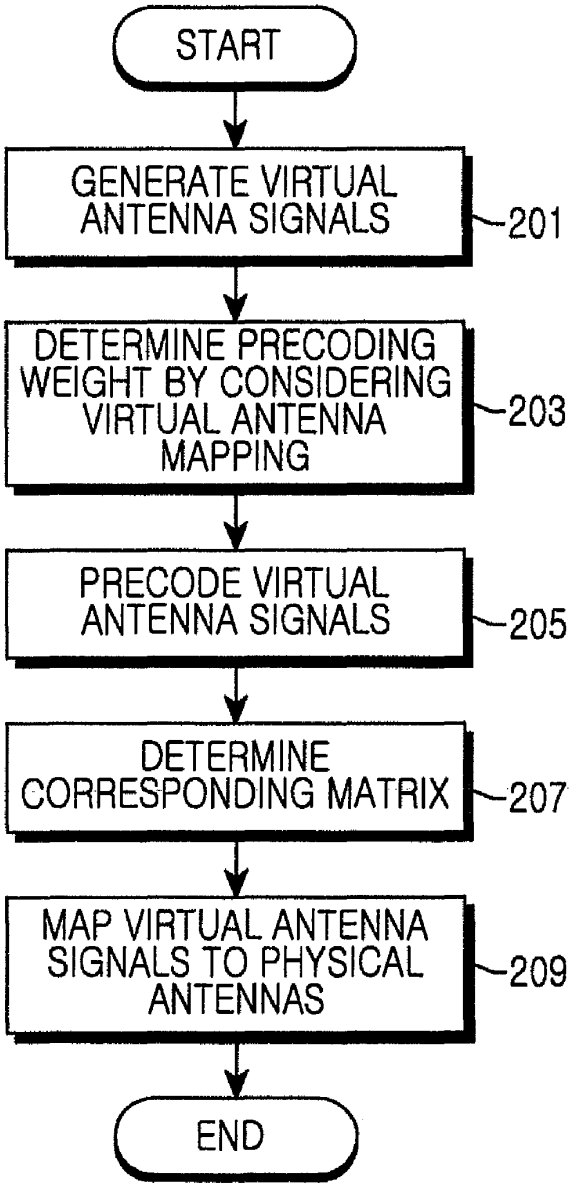

START
GENERATE VIRTUAL ANTENNA SIGNALS
201
DETERMINE PRECODING WEIGHT BY CONSIDERING VIRTUAL ANTENNA MAPPING
203
PRECODE VIRTUAL ANTENNA SIGNALS
205
DETERMINE CORRESPONDING MATRIX
207
MAP VIRTUAL ANTENNA SIGNALS TO PHYSICAL ANTENNAS
209
END

FIG.2

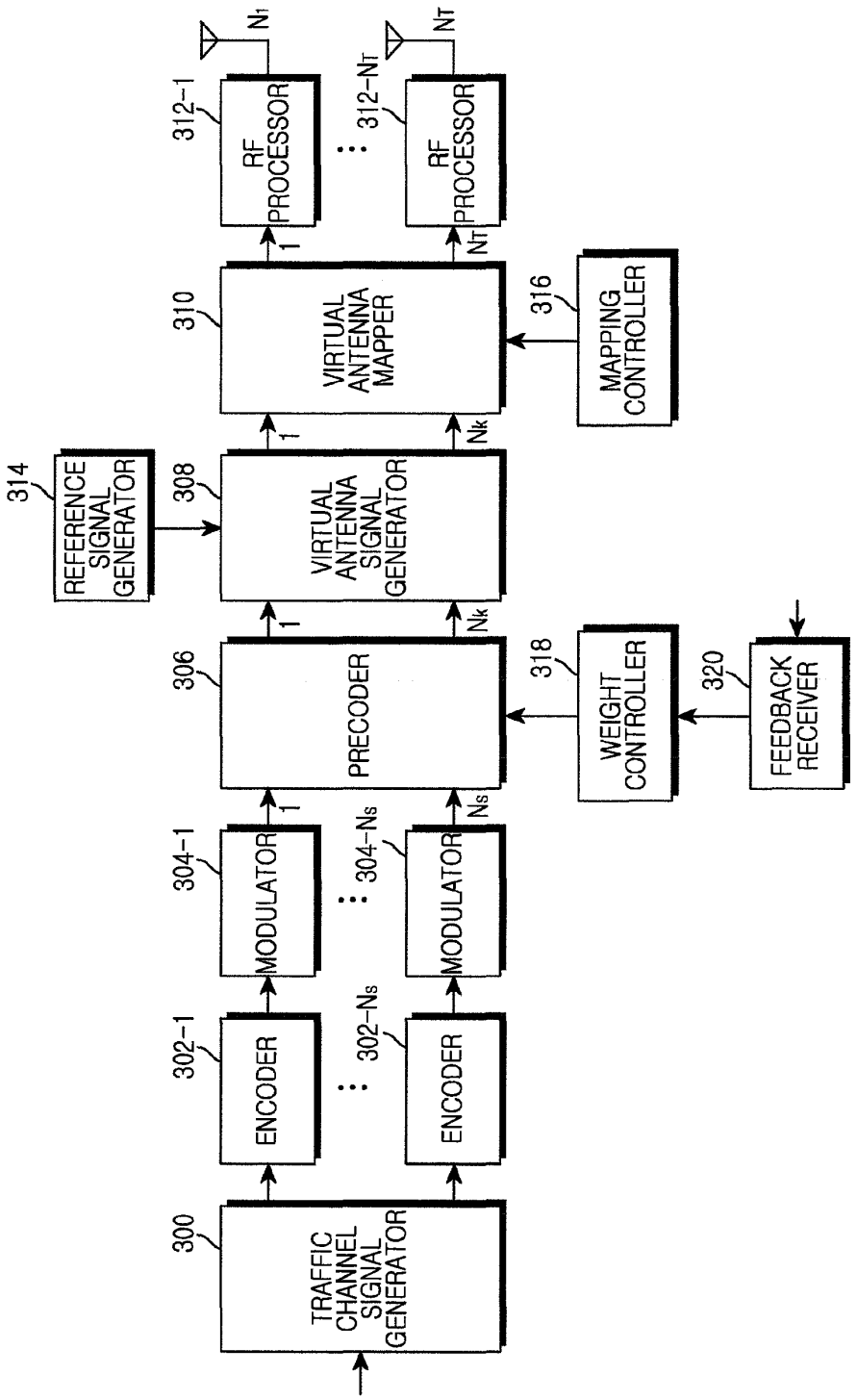

300
TRAFFIC CHANNEL SIGNAL GENERATOR
302-1
ENCODER
302-Ns
ENCODER
304-1
MODULATOR
304-Ns
MODULATOR
306
PRECODER
308
VIRTUAL ANTENNA SIGNAL GENERATOR
310
VIRTUAL ANTENNA MAPPER
312-1
RF PROCESSOR
312-NT
RF PROCESSOR
314
REFERENCE SIGNAL GENERATOR
316
MAPPING CONTROLLER
318
WEIGHT CONTROLLER
320
FEEDBACK RECEIVER
1
Ns
Nk
NT

FIG.3

APPARATUS AND METHOD FOR VIRTUAL ANTENNA MAPPING IN MULTI-ANTENNA SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION(S) AND CLAIM OF PRIORITY

[0001] The present application is related to end claims priority under 35 U.S.C. §119(a) to a Korean patent application filed in the Korean Intellectual Property Office on Mar. 15, 2010, and assigned Serial No. 10-2010-0022768, the entire disclosure of which is hereby incorporated by reference.

TECHNICAL FIELD OF THE INVENTION

[0002] The present invention relates generally to an apparatus and a method for virtual antenna mapping in a multi-antenna system. More particularly, the present invention relates to a virtual antenna mapping apparatus and method for uniform power distribution of a physical antenna in the multi-antenna system.

BACKGROUND OF THE INVENTION

[0003] Antennas of a wireless communication system are often classified as either a virtual antenna called an antenna port, or a physical antenna for actually sending and receiving signals. In general, the virtual antenna and the physical antenna of the wireless communication system correspond to each other by 1:1.

[0004] To detect a signal, a receiving stage estimates a channel between the virtual antenna of a transmitting stage and the antenna of the receiving stage, and detects a size of the transmit signal and phase modulation using the channel. The transmitting stage sends a reference signal per virtual antenna so that the receiving stage can estimate the channel of the virtual antenna.

[0005] The reference signal is allocated for the receiving stage to estimate the channel to the transmitting stage. To reject interference from a traffic channel, a resource is allocated separately from the traffic channel. For example, when the transmitting stage includes four virtual antennas, it allocates the reference signal to each virtual antenna as shown in FIG. **1**.

[0006] FIG. **1** depicts the resources of the reference signal in a conventional multi-antenna system. Hereafter, it is assumed that the multi-antenna system employs an Orthogonal Frequency Division Multiplexing (OFDM) scheme.

[0007] When the transmitting stage includes four virtual antennas as shown in FIG. **1**, it sends the reference signal over 0-th, fourth, seventh and eleventh OFDM symbols of the 0-th virtual antenna and the first virtual antenna. The transmitting stage sends the references signal over the first and eighth OFDM symbols of the second virtual antenna and the third virtual antenna. That is, the transmitting stage allocates the resources of the reference signal to send the reference signal over the same OFDM symbols of the 0-th virtual antenna and the first virtual antenna and to send the reference signal over the same OFDM symbols of the second virtual antenna and the third virtual antenna.

[0008] As sending the reference signal, the transmitting stage does not transmit any signal at the same location as the reference signal transmission location of the different virtual antennas in the resources of the virtual antennas.

[0009] As sending the reference signal per virtual antenna, the transmitting stage sends the reference signal with a transmit power four times the transmit power of the traffic per resource block. In the tone carrying the traffic, except for the reference signal, every virtual antenna of the transmitting stage sends the signal with the same transmit power.

[0010] Accordingly, the power used by the symbol carrying the reference signal per virtual antenna varies per virtual antenna. For example, when the transmit power of the traffic is set to A, over the 0-th, fourth, seventh, and eleventh OFDM symbols in FIG. **1**, the 0-th virtual antenna and the first virtual antenna consume the power of 4 A and the second virtual antenna and the third virtual antenna consume the power of 2 A.

[0011] Further, when the virtual antennas and the physical antennas correspond to each other by 1:1, the power imbalance of the virtual antennas causes imbalance in the power of the physical antennas. As a result, each physical antenna needs to be designed on different bases.

SUMMARY OF THE INVENTION

[0012] To address the above-discussed deficiencies of the prior art, it is a primary aspect of the present invention to provide an apparatus and a method for uniformly distributing power to physical antennas in a multi-antenna system.

[0013] Another aspect of the present invention is to provide an apparatus and a method for mapping virtual antennas and physical antennas in a many-to-many correspondence in a multi-antenna system.

[0014] Another aspect of the present invention is to provide an apparatus and a method for generating a corresponding matrix to map virtual antennas and physical antennas in a many-to-many correspondence in a multi-antenna system.

[0015] An aspect of the present invention is to provide an apparatus and a method for generating a corresponding matrix to map virtual antennas and physical antennas in a many-to-many correspondence by considering a precoding vector in a multi-antenna system.

[0016] According to one aspect of the present invention, a method for transmitting a signal at a transmitting stage of a wireless communication system is provided. The method includes generating at least two virtual antenna signals for at least two virtual antennas. The method also includes generating at least two physical antenna signals by applying a corresponding matrix to the at least two virtual antenna signals, the corresponding matrix mapping the at least two virtual antennas and the at least two physical antennas in a many-to-many relation. The method further includes transmitting the at least two physical antenna signals over respective physical antennas.

[0017] According to another aspect of the present invention, an apparatus method for transmitting a signal at a transmitting stage of a wireless communication system is provided. The apparatus includes at least two physical antennas. The apparatus also includes a signal generator configured to generate at least two virtual antenna signals for at least two virtual antennas. The apparatus further includes a virtual antenna mapper configured to generate at least two physical antenna signals by applying a corresponding matrix, which maps the at least two virtual antennas and the at least two physical antennas in a many-to-many relation, to the at least two virtual antenna signals. The virtual antenna mapper is also configured to provide the at least two physical antenna signals to the respective physical antennas.

[0018] Other aspects, advantages, and salient features of the invention will become apparent to those skilled in the art

from the following detailed description, which, taken in conjunction with the annexed drawings, discloses exemplary embodiments of the invention.

[0019] Before undertaking the DETAILED DESCRIPTION OF THE INVENTION below, it may be advantageous to set forth definitions of certain words and phrases used throughout this patent document: the terms "include" and "comprise," as well as derivatives thereof, mean inclusion without limitation; the term "or," is inclusive, meaning and/or; the phrases "associated with" and "associated therewith," as well as derivatives thereof, may mean to include, be included within, interconnect with, contain, be contained within, connect to or with, couple to or with, be communicable with, cooperate with, interleave, juxtapose, be proximate to, be bound to or with, have, have a property of, or the like. Definitions for certain words and phrases are provided throughout this patent document, those of ordinary skill in the art should understand that in many, if not most instances, such definitions apply to prior, as well as future uses of such defined words and phrases.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] For a more complete understanding of the present disclosure and its advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, in which like reference numerals represent like parts:

[0021] FIG. **1** illustrates resources of a reference signal in a conventional multi-antenna system;

[0022] FIG. **2** illustrates a method for sending a signal at a transmitting stage in a multi-antenna system according to an embodiment of the present invention; and

[0023] FIG. **3** illustrates the transmitting stage in the multi-antenna system according to an embodiment of the present invention.

[0024] Throughout the drawings, like reference numerals will be understood to refer to like parts, components and structures.

DETAILED DESCRIPTION OF THE INVENTION

[0025] FIGS. **1** through **3**, discussed below, and the various embodiments used to describe the principles of the present disclosure in this patent document are by way of illustration only and should not be construed in any way to limit the scope of the disclosure. Those skilled in the art will understand that the principles of the present disclosure may be implemented in any suitably arranged wireless communication system. Embodiments of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail. Terms described below, which are defined considering functions in the present invention, can be different depending on user and operator's intention or practice. Therefore, the terms should be defined on the basis of the disclosure throughout this specification.

[0026] Exemplary embodiments of the present invention provide a technique for uniformly distributing power for at least two physical antennas in a multi-antenna system.

[0027] Hereinafter, the multi-antenna system is assumed to adopt Orthogonal Frequency Division Multiplexing (OFDM)/Orthogonal Frequency Division Multiple Access (OFDMA). Note that other communication schemes are equally applicable to the multi-antenna system.

[0028] It is assumed that the multi-antenna system employs a closed-loop spatial multiplexing scheme among multi-antenna transmission schemes. Notably, the present invention is equally applicable to various multi-antenna transmission schemes.

[0029] A transmitting stage of the multi-antenna system is assumed to include N_T physical antennas and N_K virtual antennas. Herein, N_T and N_K can be of the same value or different values. Hereafter, it is assumed that N_T and N_K are four (4). That is, it is assumed that the transmitting stage includes four physical antennas and four virtual antennas.

[0030] To uniformly distribute power for the virtual antennas to the physical antennas, the transmitting stage uses a corresponding matrix having the same unitary properties with an absolute value one-half (½) of each element. For instance, the transmitting stage can map the virtual antennas and the physical antennas in many-to-many correspondence using the corresponding matrix based on Equation 1. Herein, the corresponding matrix indicates a mathematical expression of the correspondence of the virtual antennas and the physical antennas.

$$\text{DFT Matrix: } \begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \cdot \begin{bmatrix} y_0 \\ y_1 \\ y_2 \\ y_3 \end{bmatrix} \quad \text{[Eqn. 1]}$$

$$\text{Hadamard Matrix: } \begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & 1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix} \cdot \begin{bmatrix} y_0 \\ y_1 \\ y_2 \\ y_3 \end{bmatrix}$$

[0031] In Equation 1, z_i (i=0, 1, 2, 3) denotes a signal of the physical antenna, y_i (i=0, 1, 2, 3) denotes a signal of the virtual antenna, and i denotes an index of the physical antenna and the virtual antenna.

[0032] Using the corresponding matrix as stated above, the transmitting stage can address a power imbalance of symbols carrying a reference signal by mapping the virtual antennas and the physical antennas by 4:4. That is, the transmitting stage can uniformly map the signals for the virtual antennas to the four physical antennas using the corresponding matrix and thus address the power imbalance of the physical antennas in the symbols carrying the reference signal.

[0033] When the multi-antenna system rejects interference of a neighbor cell and uses a precoding scheme to raise the transmission efficiency, the transmitting stage sends the signal using a precoding matrix and the corresponding matrix together based on Equation 2. Herein, Equation 2 utilizes the DFT matrix of Equation 1 as the corresponding matrix. It is assumed that Equation 2 adopts the precoding matrix of the 0-th index of the rank 1 among 4 Tx CL-SM precode defined by 3GPP TS 36.211 of LTE standard document.

$$\begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \cdot \frac{1}{2}\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} \cdot [W_0] \quad \text{[Eqn. 2]}$$

[0034] In Equation 2, z_i (i=0, 1, 2, 3) denotes the signal of the physical antenna, i denotes the index of the physical antenna,

$$\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$

denotes the precoding matrix, and $[w_0]$ denotes a signal before the precoding.

[0035] When the precoding matrix and the corresponding matrix are used together as expressed in Equation 2, the signals of the virtual antennas fade and the signal is not delivered to the antennas other than the 0-th physical antenna. That is, the power imbalance occurs between the 0-th physical antenna and the other antennas.

[0036] Hence, the transmitting stage designs the corresponding matrix to satisfy the following conditions.

[0037] (1) The power of the physical antennas should be uniformly distributed for the un-precoded reference signal.

[0038] (2) When the precoding matrix and the corresponding matrix are applied concurrently, precoding vectors of a precoding codebook should include precoding vectors of the power uniformly distributed of the physical antennas, more than a reference number.

[0039] (3) The precoding vector satisfying the condition (2) should have an equivalent vector in the precoding codebook applied with the corresponding matrix. Herein, the equivalent vector indicates the vector of the constant phase difference between the elements in the precoding vector, for the sake of the same beamforming effect.

[0040] To meet the condition (1) and the condition (2) at the same time, the multi-antenna system designs the corresponding matrix to map two virtual antenna combinations to two physical antenna combinations. For instance, when the combination of the 0-th and second virtual antennas and the combination of the first and third virtual antennas are used, the transmitting stage can express the correspondence of the virtual antenna combinations and the physical antenna combinations as Equation 3.

$$\begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} a & 0 & b & 0 \\ 0 & e & 0 & f \\ c & 0 & d & 0 \\ 0 & g & 0 & h \end{bmatrix} \cdot \begin{bmatrix} y_0 \\ y_1 \\ y_2 \\ y_3 \end{bmatrix} \quad \text{[Eqn. 3]}$$

[0041] In Equation 3, z_i (i=0, 1, 2, 3) denotes the signal of the physical antenna, y_i (i=0, 1, 2, 3) denotes the signal of the virtual antenna, i denotes the index of the physical antenna and the virtual antenna, and a, b, c, d, e, f, g, h denote the elements of the corresponding matrix.

[0042] When the designed corresponding matrix of Equation 3 is used, the corresponding matrix should include elements which satisfy a condition of Equation 4, so as to uniformly distribute the power of the physical antennas and not to reduce the channel capacity.

$$|a| = |b| = |c| = |d| = |e| = |f| = |g| = |h| = 1 \quad \text{[Eqn. 4]}$$
$$d = -\frac{a^*}{b^*}c,\ h = -\frac{e^*}{f^*}g$$

[0043] a, b, c, d, e, f, g, h denote the elements of the corresponding matrix.

[0044] In the corresponding matrix of Equation 4, the absolute value of the elements, which are not zero, of the corresponding matrix should be the same and the unitary property should be satisfied.

[0045] To meet the condition (2), the corresponding matrix should be designed by considering characteristics of the precoding codebook. For example, when the transmitting stage designs the corresponding matrix by considering the rank 1 precoding vector of the downlink closed-loop codebook of the LTE standard, the rank 1 precoding vector can be represented as shown in Table 1.

TABLE 1

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Precoding vector	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	-j	-1	j	$\frac{1}{\sqrt{2}}(1-j)$	$\frac{1}{\sqrt{2}}(-1-j)$	$\frac{1}{\sqrt{2}}(-1+j)$	$\frac{1}{\sqrt{2}}(1+j)$	1	-j	-1	j	1	1	-1	-1
	1	-1	1	-1	-j	j	-j	j	-1	1	-1	1	1	-1	1	-1
	1	j	-1	-j	$\frac{1}{\sqrt{2}}(-1-j)$	$\frac{1}{\sqrt{2}}(1-j)$	$\frac{1}{\sqrt{2}}(1+j)$	$\frac{1}{\sqrt{2}}(-1+j)$	-1	-j	1	j	-1	1	1	-1

[0046] In Table 1, twelve precoding vectors excluding the fourth through seventh precoding vectors have the following properties.

[0047] (1) All of a 0-th weight and a second weight of the precoding vector are real numbers. That is, a phase difference between the 0-th weight and the second weight in each precoding vector is 0° or 180°.

[0048] (2) All of a first weight and a third weight of the precoding vector are real or imaginary numbers. That is, the phase difference between the first weight and the third weight in each precoding vector is 0° or 180°.

[0049] When the corresponding matrix is designed by considering the properties of the precoding vector, each element of the corresponding matrix of Equation 3 should be designed to satisfy Equation 5.

$$\text{i) } a=jb,\ c=-jd \text{ or } a=-jb,\ c=jd$$
$$\text{ii) } e=jf,\ g=-jh \text{ or } e=-jf,\ g=jh \quad \text{[Eqn. 5]}$$

[0050] The multi-antenna system can design the corresponding matrix of Equation 3 to meet the condition of Equation 4 and the condition of Equation 5. In this situation, the

corresponding matrix can uniformly distribute the power of the physical antennas even when the precoding vectors other than the fourth through seventh precoding vectors of Table 1 are used together. For example, the corresponding matrix designed based on Equation 3 to meet the condition of Equation 4 and the condition of Equation 5 is derived as Equation 6.

$$\frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & e & 0 & je \\ c & 0 & -jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & e & 0 & je \\ c & 0 & jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix} \quad \text{[Eqn. 6]}$$

$$\text{or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & -jc & 0 \\ 0 & g & 0 & jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & jc & 0 \\ 0 & g & 0 & jg \end{bmatrix}$$

where, $|a| = |c| = |e| = |g| = 1$

[0051] When a, c, e, g satisfying the condition (3) are applied in the corresponding matrix of Equation 6, the corresponding matrix can be arranged as expressed in Equation 7.

$$\frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & j & 0 & -1 \\ -j & 0 & -1 & 0 \\ 0 & 1 & 0 & -j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -j & 0 & 1 \\ -j & 0 & -1 & 0 \\ 0 & -1 & 0 & j \end{bmatrix} \quad \text{[Eqn. 7]}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & j & 0 & -1 \\ j & 0 & 1 & 0 \\ 0 & -1 & 0 & j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -j & 0 & 1 \\ j & 0 & 1 & 0 \\ 0 & 1 & 0 & -j \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -1 & 0 & -j \\ j & 0 & -1 & 0 \\ 0 & j & 0 & 1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & 1 & 0 & j \\ j & 0 & -1 & 0 \\ 0 & -j & 0 & -1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & 1 & 0 & j \\ -j & 0 & 1 & 0 \\ 0 & j & 0 & 1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -1 & 0 & -j \\ -j & 0 & 1 & 0 \\ 0 & -j & 0 & -1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & 1 & 0 & -j \\ -j & 0 & -1 & 0 \\ 0 & j & 0 & -1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -1 & 0 & j \\ -j & 0 & -1 & 0 \\ 0 & -j & 0 & 1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -1 & 0 & j \\ j & 0 & 1 & 0 \\ 0 & j & 0 & -1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & 1 & 0 & -j \\ j & 0 & 1 & 0 \\ 0 & -j & 0 & 1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & j & 0 & 1 \\ j & 0 & -1 & 0 \\ 0 & -1 & 0 & -j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -j & 0 & -1 \\ j & 0 & 1 & 0 \\ 0 & 1 & 0 & j \end{bmatrix}$$

-continued

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & j & 0 & 1 \\ -j & 0 & 1 & 0 \\ 0 & 1 & 0 & j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -j & 0 & -1 \\ -j & 0 & 1 & 0 \\ 0 & -1 & 0 & -j \end{bmatrix}$$

where $|a| = 1$

[0052] The condition (3) is that the precoding codebook with the corresponding matrix applied includes the precoding vector and the equivalent vector. That is, the precoding vector applying any one of the corresponding matrices of Equation 7 to the 0-th through third precoding vectors and the eighth through fifteenth precoding vectors of Table 1, is equivalent to any one of the precoding vectors of Table 1.

[0053] In the actual implementation, the corresponding matrix of Equation 7 increases complexity in the multiplication by

$$\frac{a}{\sqrt{2}}.$$

Accordingly, when a is set to the value of the phase 45°, 135°, 225°, and 315° such as

$$\frac{(1+j)}{\sqrt{2}}, \frac{(1-j)}{\sqrt{2}}, \frac{(-1-j)}{\sqrt{2}}, \text{ and } \frac{(-1+j)}{\sqrt{2}},$$

the transmitting stage can lower the complexity by reducing the multiplication. For example, when a is set to

$$\frac{(1+j)}{\sqrt{2}},$$

the corresponding matrix can be expressed as

Equation 8.

$$\frac{1}{2}\begin{bmatrix} 1+j & 0 & -1+j & 0 \\ 0 & -1+j & 0 & -1-j \\ 1-j & 0 & -1-j & 0 \\ 0 & 1+j & 0 & 1-j \end{bmatrix} \quad \text{[Eqn. 8]}$$

[0054] When a is set to

$$\frac{(1+j)}{\sqrt{2}}$$

in Equation 8, the complexity can be reduced by mapping the physical antennas merely with addition of the real component and the imaginary component of the virtual antenna signal.

[0055] In this embodiment, the multi-antenna system designs the corresponding matrix by considering the rank 1 precoding vector of the downlink closed-loop codebook of the LIE standard.

[0056] Alternatively, when the precoding vectors of rank 2, 3 and 4 of the downlink closed-loop codebook are considered, the multi-antenna system can design the corresponding matrix in the above-stated manner.

[0057] Now, a method of the transmitting stage for sending the signal using the virtual antenna mapping is explained.

[0058] FIG. **2** illustrates a method for sending a signal at the transmitting stage in the multi-antenna system according to an embodiment of the present invention.

[0059] In step **201**, the transmitting stage generates the virtual antenna signals. That is, the transmitting stage generates the reference signal for each virtual antenna and the signal for the traffic channel.

[0060] In step **203**, the transmitting stage determines the precoding weight determined based on the virtual antenna mapping. For example, when the closed-loop scheme is used, a base station determines the precoding weight by considering the codebook index provided from a mobile station. In so doing, when the corresponding matrix is used together, the base station instructs the mobile station not to use the precoding code which cannot uniformly distribute the power of the physical antennas. Hence, even when the corresponding matrix is used together, the base station can use only the precoding code which can uniformly distribute the power of the physical antennas.

[0061] In step **205**, the transmitting stage precodes each virtual antenna signal with the confirmed precoding weight.

[0062] In step **207**, the transmitting stage determines the corresponding matrix determined based on the precoding weight. For example, the transmitting stage confirms the corresponding matrix as expressed in Equation 3, which satisfies the conditions of Equation 4 and Equation 5.

[0063] In step **209**, the transmitting stage maps the virtual antenna signals to the physical antennas using the corresponding matrix. That is, the transmitting stage generates the physical antenna signals by linearly combining the virtual antenna signals using the corresponding matrix.

[0064] Next, the transmitting stage finishes this process. The transmitting stage sends the generated physical antenna signals over the respective physical antennas.

[0065] Although it is not illustrated here, the transmitting stage precodes the virtual antenna signals, and generates the virtual antenna signals to send over the respective virtual antennas by combining the precoded signal with the reference signal to send over the virtual antennas.

[0066] In this embodiment, the transmitting stage precodes the virtual antenna signal.

[0067] Alternatively, the transmitting stage may generate the virtual antenna signals to send over the respective virtual antennas by precoding at least one traffic channel. The transmitting stage generates the virtual antenna signals to send over the respective virtual antennas by combining the virtual antenna signals generated using the precoding and the reference signal to send over the virtual antennas.

[0068] Hereafter, a structure of the transmitting stage for mapping the virtual antennas and the physical antennas is described.

[0069] FIG. **3** is a block diagram of the transmitting stage in the multi-antenna system according to an embodiment of the present invention.

[0070] The transmitting stage of FIG. **3** includes a traffic channel signal generator **300**, encoders **302-1** through **302-**N_s, modulators **304-1** through **304-**N_s, a precoder **306**, a virtual antenna signal generator **308**, a virtual antenna mapper **310**, Radio Frequency (RF) processors **312-1** through **312-**N_T, a reference signal generator **314**, a mapping controller **316**, a weight controller **318**, and a feedback receiver **320**.

[0071] The traffic channel signal generator **300** generates N_s traffic channels having independent information. N_s denotes the number of streams spatially separated, and ranges from 1 to N_k. Herein, N_k denotes the number of the virtual antennas.

[0072] The encoders **302-1** through **302-**N_s encode the traffic channels output from the traffic channel signal generator **300** at a modulation level adequate for the channel state. Herein, the modulation level indicates a Modulation and Coding Scheme (MCS) level.

[0073] The modulators **304-1** through **304-**N_s modulate the encoded signals output from the encoders **302-1** through **302-**N_s according to the modulation level suitable for the channel state.

[0074] The precoder **306** precodes the N_s traffic channels output from the modulators **304-1** through **304-**N_s to N_k virtual antenna signals with a precode provided from the weight controller **318**.

[0075] The weight controller **318** generates the precode by taking account of the codebook index output from the feedback receiver **320**.

[0076] The weight controller **318** instructs the serviced receiving stage not to use the precoding vector which cannot be used with the corresponding matrix. For example, when the codebook of the rank 1 precoding vector of the downlink closed-loop codebook of the LIE standard is used, the weight controller **318** instructs the receiving stage not to use the fourth through seventh precoding vectors.

[0077] The feedback receiver **320** receives feedback information of the receiving stage.

[0078] The virtual antenna signal generator **308** generates the virtual antenna signals to send over the respective virtual antennas by combining the precoded traffic channel signals output from the precoder **306** and the reference signal output from the reference signal generator **314**.

[0079] The reference signal generator **314** generates the virtual antenna reference signal to send over the virtual antennas. For example, the reference signal includes a pilot.

[0080] The virtual antenna mapper **310** maps the virtual antenna signals fed from the virtual antenna signal generator **308** to the physical antennas using the corresponding matrix provided from the mapping controller **316**. More specifically, the virtual antenna mapper **310** generates the signals for the physical antennas by linearly combining the virtual antenna signals output from the virtual antenna signal generator **308** using the corresponding matrix provided from the mapping controller **316**.

[0081] The mapping controller **316** determines the corresponding matrix to map the virtual antennas and the physical antennas at the virtual antenna mapper **310**. For example, the mapping controller **316** selects any one of the corresponding matrices of Equation 7 designed based on Equation 3 which meets the conditions of Equation 4 and Equation 5. The corresponding matrices of Equation 7 are designed by taking into account the properties of the precoding codebook and to satisfy the conditions (1), (2) and (3). For example, the mapping controller **316** may generate the corresponding matrix of Equation 3 which meets the conditions of Equation 4 and Equation 5. In this situation, the mapping controller **316**

generates the corresponding matrix by taking into account the properties of the precoding codebook and to satisfy the conditions (1), (2) and (3).

[0082] The RF processors **312-1** through **312-**N_T convert the physical antenna signals output from the virtual antenna mapper **310** to analog signals. Next, the RF processors **312-1** through **312-**N_T convert the analog signals to RF signals and transmit the RF signals over the corresponding physical antenna.

[0083] As set forth above, by mapping the virtual antennas and the physical antennas in the many-to-many correspondence in the multi-antenna system, it is advantageous to uniformly distribute the power to the physical antennas.

[0084] Although the present disclosure has been described with an exemplary embodiment, various changes and modifications may be suggested to one skilled in the art. It is intended that the present disclosure encompass such changes and modifications as fall within the scope of the appended claims.

What is claimed is:

1. A method for transmitting a signal at a transmitting stage of a wireless communication system, the method comprising:

generating at least two virtual antenna signals for at least two virtual antennas;

generating at least two physical antenna signals by applying a corresponding matrix to the at least two virtual antenna signals, the corresponding matrix mapping the at least two virtual antennas and the at least two physical antennas in a many-to-many relation; and

transmitting the at least two physical antenna signals over respective physical antennas.

2. The method of claim **1**, further comprising:

after generating the at least two virtual antenna signals, precoding the at least two virtual antenna signals,

wherein the generating of the physical antenna signals comprises:

generating at least two physical antenna signals by applying the corresponding matrix to the at least two precoded virtual antenna signals.

3. The method of claim **1**, wherein the generating of the physical antenna signals comprises:

generating at least two physical antenna signals by linearly combining the at least two virtual antenna signals using the corresponding matrix.

4. The method of claim **1**, wherein the generating of the physical antenna signals comprises:

when there are four virtual antennas and four physical antennas, generating two physical antenna signals by linearly combining the 0-th virtual antenna signal and the second virtual antenna signal, and generating two different physical antenna signals by linearly combining the first virtual antenna signal and the third virtual antenna signal.

5. The method of claim **1**, wherein, when there are four virtual antennas and four physical antennas, the corresponding matrix is expressed as the following equation:

$$\frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & b & 0 \\ 0 & e & 0 & f \\ c & 0 & d & 0 \\ 0 & g & 0 & h \end{bmatrix}$$

where a, b, c, d, e, f, g, h denote elements of the corresponding matrix defined to have unitary properties of the corresponding matrix, and the elements indicate complex numbers of the same absolute value.

6. The method of claim **1**, wherein, when there are four virtual antennas and four physical antennas, the corresponding matrix is any one of corresponding matrices of the following equation:

$$\frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & e & 0 & je \\ c & 0 & -jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & e & 0 & je \\ c & 0 & jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix}$$

$$\text{or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & -jc & 0 \\ 0 & g & 0 & jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & jc & 0 \\ 0 & g & 0 & jg \end{bmatrix}$$

where, $|a| = |c| = |e| = |g| = 1$

where a, c, e, g denote elements of the corresponding matrix defined to have unitary properties of the corresponding matrix, and the elements indicate random complex numbers of the absolute number 1.

7. The method of claim **1**, wherein, when there are four virtual antennas and four physical antennas, the corresponding matrix is any one of corresponding matrices of the following equation:

$$\frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & j & 0 & -1 \\ -j & 0 & -1 & 0 \\ 0 & 1 & 0 & -j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -j & 0 & 1 \\ -j & 0 & -1 & 0 \\ 0 & -1 & 0 & j \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & j & 0 & -1 \\ j & 0 & 1 & 0 \\ 0 & -1 & 0 & j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -j & 0 & 1 \\ j & 0 & 1 & 0 \\ 0 & 1 & 0 & -j \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -1 & 0 & -j \\ j & 0 & -1 & 0 \\ 0 & j & 0 & 1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & 1 & 0 & j \\ j & 0 & -1 & 0 \\ 0 & -j & 0 & -1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & 1 & 0 & j \\ -j & 0 & 1 & 0 \\ 0 & j & 0 & 1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -1 & 0 & -j \\ -j & 0 & 1 & 0 \\ 0 & -j & 0 & -1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & 1 & 0 & -j \\ -j & 0 & -1 & 0 \\ 0 & j & 0 & -1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -1 & 0 & j \\ -j & 0 & -1 & 0 \\ 0 & -j & 0 & 1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -1 & 0 & j \\ j & 0 & 1 & 0 \\ 0 & j & 0 & -1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & 1 & 0 & -j \\ j & 0 & 1 & 0 \\ 0 & -j & 0 & 1 \end{bmatrix}$$

-continued

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & j & 0 & 1 \\ j & 0 & -1 & 0 \\ 0 & -1 & 0 & -j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -j & 0 & -1 \\ j & 0 & -1 & 0 \\ 0 & 1 & 0 & j \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & j & 0 & 1 \\ -j & 0 & 1 & 0 \\ 0 & 1 & 0 & j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -j & 0 & -1 \\ -j & 0 & 1 & 0 \\ 0 & -1 & 0 & -j \end{bmatrix}$$

where $|a| = 1$.

8. The method of claim **1**, further comprising:

when a closed-loop precoding scheme is used, instructing a receiving stage not to use at least one precoding vector that is unusable with the corresponding matrix in a codebook.

9. The method of claim **8**, wherein the at least one precoding vector comprises a precoding vector that does not satisfy all of a condition that both of a 0-th weight and a second weight of the precoding vector are real numbers, and a condition that both of a first weight and a third weight of the precoding vector are real or imaginary numbers.

10. An apparatus for transmitting a signal at a transmitting stage of a wireless communication system, the apparatus comprising:

at least two physical antennas;

a signal generator configured to generate at least two virtual antenna signals for at least two virtual antennas; and

a virtual antenna mapper configured to:

generate at least two physical antenna signals by applying a corresponding matrix to the at least two virtual antenna signals, the corresponding matrix mapping the at least two virtual antennas and the at least two physical antennas in a many-to-many relation; and

provide the at least two physical antenna signals to the respective physical antennas.

11. The apparatus of claim **10**, further comprising:

a precoder configured to precode the at least two virtual antenna signals generated by the signal generator and provide the precoded signals to the virtual antenna mapper.

12. The apparatus of claim **10**, wherein the virtual antenna mapper generates at least two physical antenna signals by linearly combining the at least two virtual antenna signals using the corresponding matrix.

13. The apparatus of claim **10**, wherein, when there are four virtual antennas and four physical antennas, the virtual antenna mapper generates two physical antenna signals by linearly combining the 0-th virtual antenna signal and the second virtual antenna signal, and generates two different physical antenna signals by linearly combining the first virtual antenna signal and the third virtual antenna signal.

14. The apparatus of claim **10**, wherein, when there are four virtual antennas and four physical antennas, the corresponding matrix is expressed as the following equation:

$$\frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & b & 0 \\ 0 & e & 0 & f \\ c & 0 & d & 0 \\ 0 & g & 0 & h \end{bmatrix}$$

where a, b, c, d, e, f, g, h denote elements of the corresponding matrix defined to have unitary properties of the corresponding matrix, and the elements indicate complex numbers of the same absolute value.

15. The apparatus of claim **10**, wherein, when there are four virtual antennas and four physical antennas, the corresponding matrix is any one of corresponding matrices of the following equation:

$$\frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & e & 0 & je \\ c & 0 & -jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & e & 0 & je \\ c & 0 & jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix}$$

$$\text{or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & -jc & 0 \\ 0 & g & 0 & jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & jc & 0 \\ 0 & g & 0 & jg \end{bmatrix}$$

where, $|a| = |c| = |e| = |g| = 1$

where a, c, e, g denote elements of the corresponding matrix defined to have unitary properties of the corresponding matrix, and the elements indicate random complex numbers of the absolute number 1.

16. The apparatus of claim **10**, wherein, when there are four virtual antennas and four physical antennas, the corresponding matrix is any one of corresponding matrices of the following equation:

$$\frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & j & 0 & -1 \\ -j & 0 & -1 & 0 \\ 0 & 1 & 0 & -j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -j & 0 & 1 \\ -j & 0 & -1 & 0 \\ 0 & -1 & 0 & j \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & j & 0 & -1 \\ j & 0 & 1 & 0 \\ 0 & -1 & 0 & j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -j & 0 & 1 \\ j & 0 & 1 & 0 \\ 0 & 1 & 0 & -j \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -1 & 0 & -j \\ j & 0 & -1 & 0 \\ 0 & j & 0 & 1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & 1 & 0 & j \\ j & 0 & -1 & 0 \\ 0 & -j & 0 & -1 \end{bmatrix}$$

-continued

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & 1 & 0 & j \\ -j & 0 & 1 & 0 \\ 0 & j & 0 & 1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -1 & 0 & -j \\ -j & 0 & 1 & 0 \\ 0 & -j & 0 & -1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & 1 & 0 & -j \\ -j & 0 & -1 & 0 \\ 0 & j & 0 & -1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -1 & 0 & j \\ -j & 0 & -1 & 0 \\ 0 & -j & 0 & 1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -1 & 0 & j \\ j & 0 & 1 & 0 \\ 0 & j & 0 & -1 \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & j & 0 \\ 0 & 1 & 0 & -j \\ j & 0 & 1 & 0 \\ 0 & -j & 0 & 1 \end{bmatrix}$$

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & j & 0 & 1 \\ j & 0 & -1 & 0 \\ 0 & -1 & 0 & -j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -j & 0 & -1 \\ j & 0 & -1 & 0 \\ 0 & 1 & 0 & j \end{bmatrix}$$

-continued

$$\text{or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & j & 0 & 1 \\ -j & 0 & 1 & 0 \\ 0 & 1 & 0 & j \end{bmatrix} \text{ or } \frac{a}{\sqrt{2}}\begin{bmatrix} 1 & 0 & -j & 0 \\ 0 & -j & 0 & -1 \\ -j & 0 & 1 & 0 \\ 0 & -1 & 0 & -j \end{bmatrix}$$

where $|a| = 1$.

17. The apparatus of claim **10**, further comprising:

a weight controller configured, when a closed-loop precoding scheme is used, to instruct a receiving stage not to use at least one precoding vector that is unusable with the corresponding matrix in a codebook.

18. The apparatus of claim **17**, wherein the weight controller recognizes a precoding vector that does not satisfy all of a condition that both of a 0-th weight and a second weight of the precoding vector are real numbers, and a condition that both of a first weight and a third weight of the precoding vector are real or imaginary numbers, as the precoding vector unusable with the corresponding matrix.

19. The apparatus of claim **10**, further comprising:

at least two encoders, each encoder configured to encode one of the at least two virtual antenna signals.

20. The apparatus of claim **10**, further comprising:

a reference signal generator configured to generate a virtual antenna reference signal that is sent over the at least two virtual antennas.

* * * * *

US 20150010106A1

(19) **United States**

(12) **Patent Application Publication**

Skov et al.

(10) **Pub. No.: US 2015/0010106 A1**

(43) **Pub. Date: Jan. 8, 2015**

(54) **VIRTUAL ANTENNA PORTS FOR FLEXIBLE CSI-RS RESOURCE DEFINITION**

(76) Inventors: **Peter Skov**, Beijing (CN); **Chun Ye Wang**, Beijing (CN); **Lilei Wang**, Beijing (CN); **Li Zhang**, Beijing (CN)

(21) Appl. No.: **14/375,148**

(22) PCT Filed: **Jan. 29, 2012**

(86) PCT No.: **PCT/CN2012/070742**

§ 371 (c)(1),
(2), (4) Date: **Jul. 29, 2014**

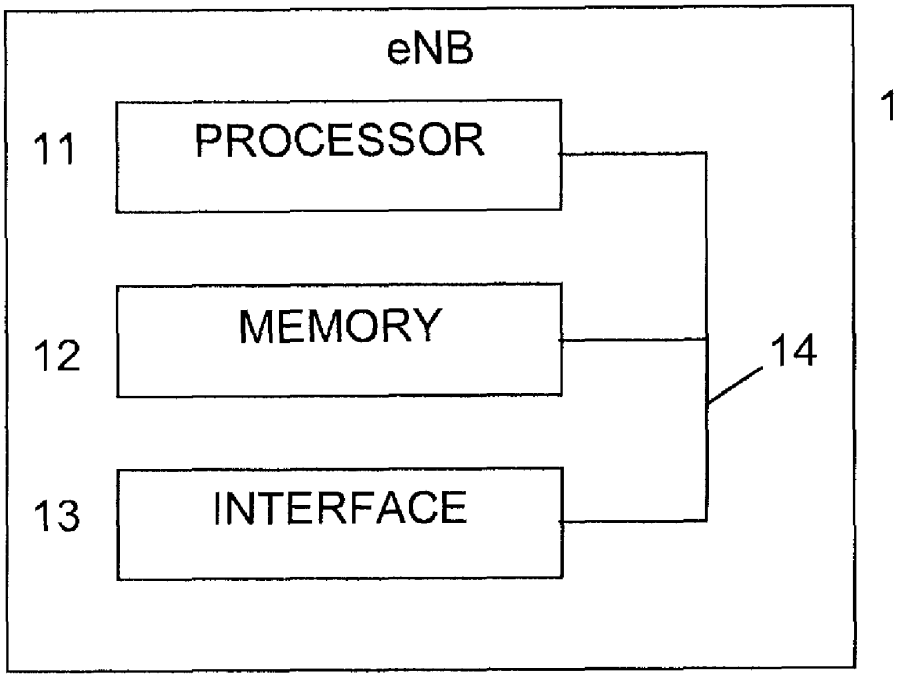
Publication Classification

(51) **Int. Cl.**
H04L 27/26 (2006.01)

(52) **U.S. Cl.**
CPC ***H04L 27/2626*** (2013.01); ***H04L 27/2646*** (2013.01)
USPC **375/295**

(57) **ABSTRACT**

An apparatus and a method are provided, by which at least one virtual antenna port is created which includes a plurality of reference signal ports defined in a physical resource block. Information regarding the at least one virtual antenna port including the definition of the reference signal ports is sent to a user equipment, and reference signals are sent on the plurality of reference signal ports to the user equipment



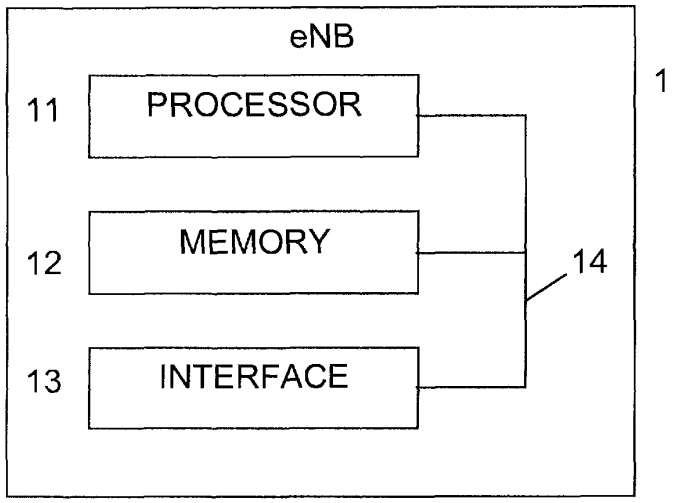

eNB
1
11
PROCESSOR
12
MEMORY
14
13
INTERFACE

Fig. 1

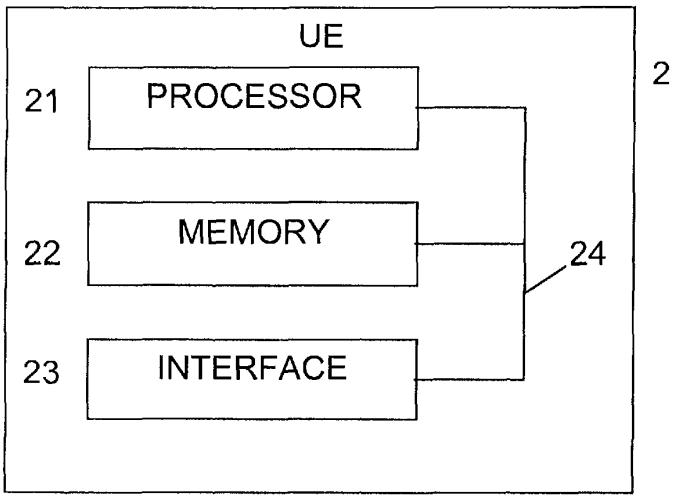

UE
2
21
PROCESSOR
22
MEMORY
24
23
INTERFACE

Fig. 2

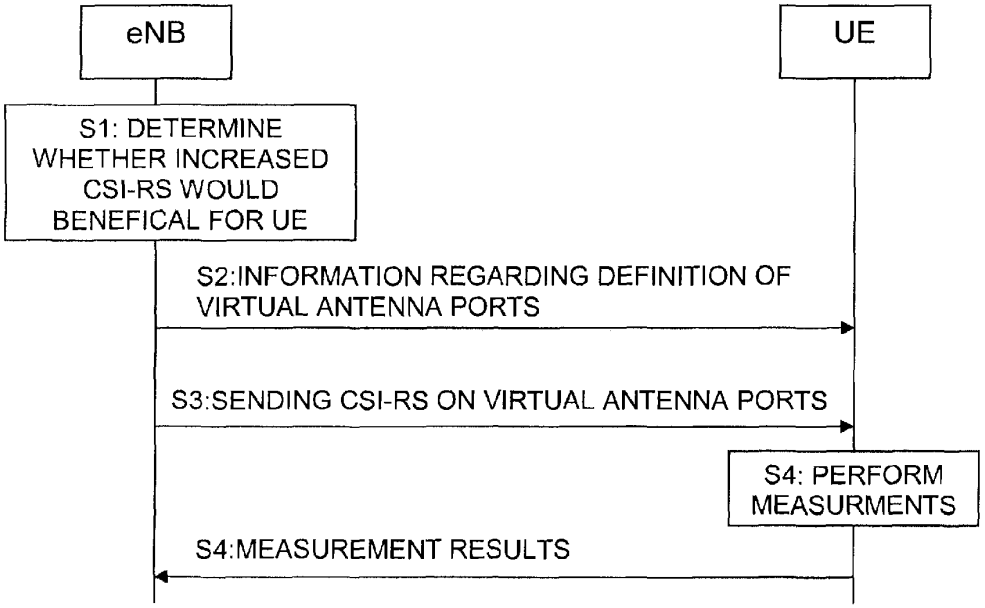

eNB
UE
S1: DETERMINE WHETHER INCREASED CSI-RS WOULD BENEFICAL FOR UE
S2:INFORMATION REGARDING DEFINITION OF VIRTUAL ANTENNA PORTS
S3:SENDING CSI-RS ON VIRTUAL ANTENNA PORTS
S4: PERFORM MEASURMENTS
S4:MEASUREMENT RESULTS

Fig. 3

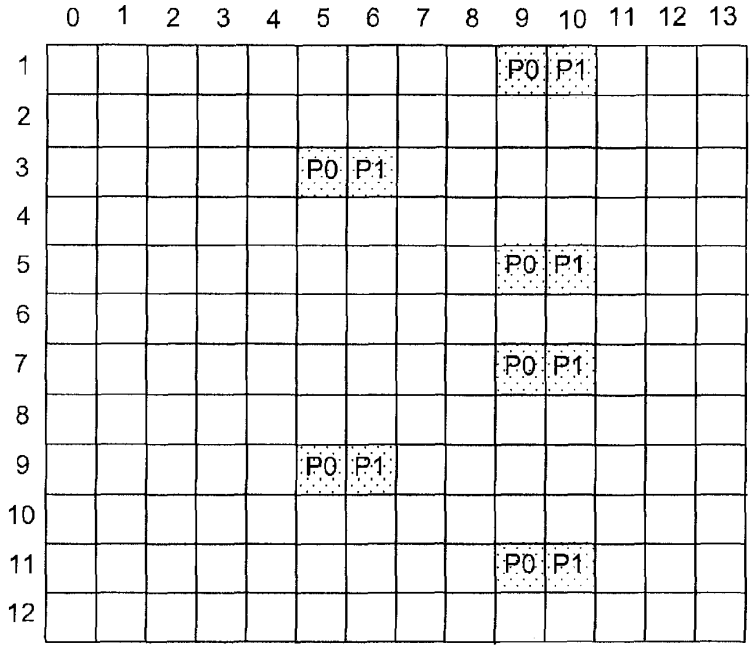

0 1 2 3 4 5 6 7 8 9 10 11 12 13
1 2 3 4 5 6 7 8 9 10 11 12
P0 P1
P0 P1
P0 P1
P0 P1
P0 P1
P0 P1
P0 P1
P0 P1

Fig. 4

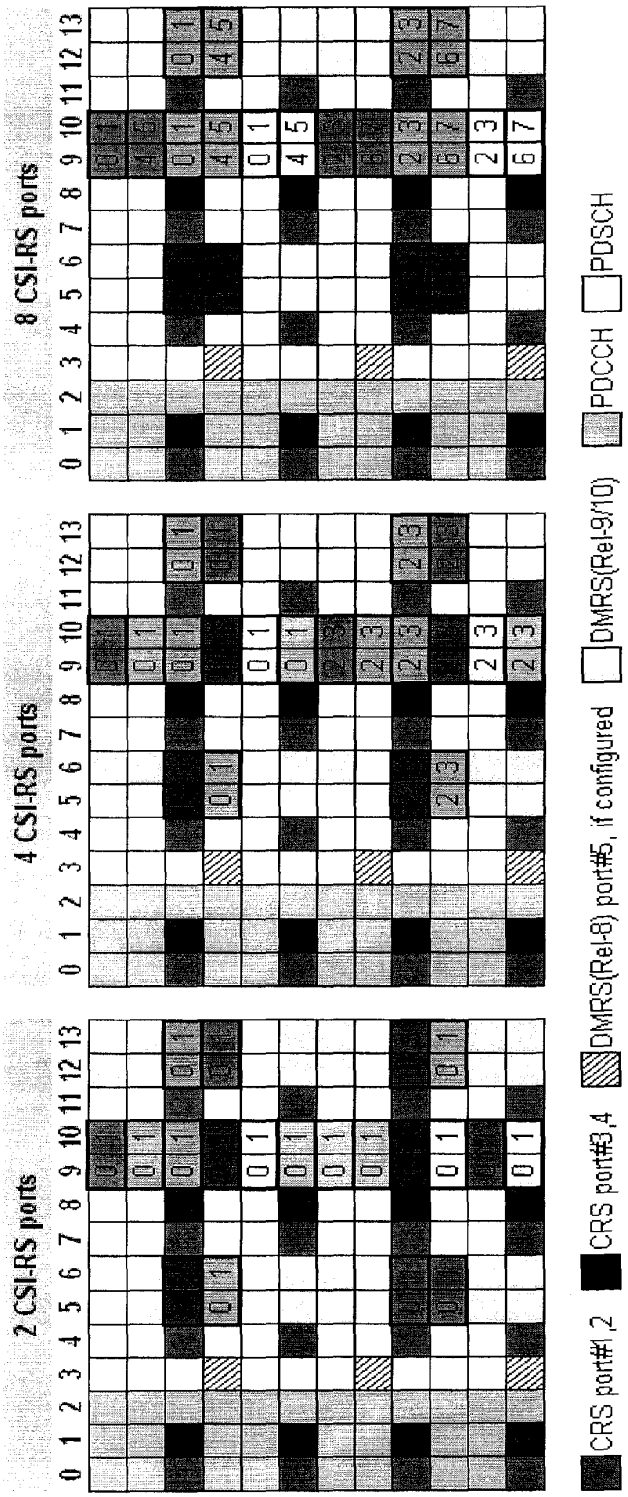

2 CSI-RS ports
4 CSI-RS ports
8 CSI-RS ports
CRS port#1,2
CRS port#3,4
DMRS(Rel-8) port#5, if configured
DMRS(Rel-9/10)
PDCCH
PDSCH

Fig. 5

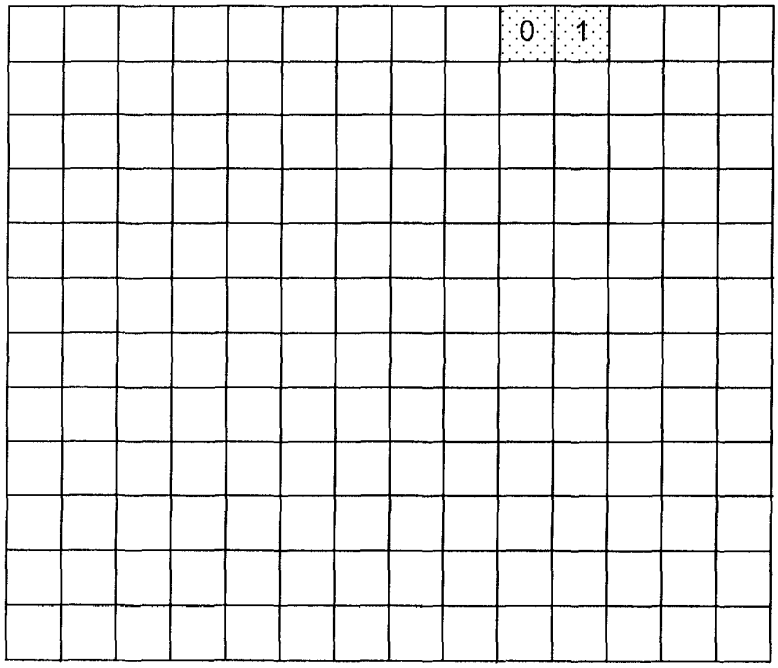


Fig. 6

VIRTUAL ANTENNA PORTS FOR FLEXIBLE CSI-RS RESOURCE DEFINITION

FIELD OF THE INVENTION

[0001] The present invention relates to apparatuses, methods and a computer program product for providing virtual antenna ports for flexible CSI-RS resource definition.

RELATED BACKGROUND ART

[0002] The following meanings for the abbreviations used in this specification apply:
[0003] 3GPP 3rd Generation Partnership Project
[0004] CDM Code Division Multiplexing
[0005] CDM-F Code Division Multiplexing-Frequency domain
[0006] CDM-T Code Division Multiplexing-Time domain
[0007] COMP Coordinated Multi-Point Transmission
[0008] CRS Common Reference Signal
[0009] CSI-RS Channel State Information Reference Signal
[0010] CP Cyclic Prefix
[0011] DL Downlink
[0012] eNB enhanced Node-B
[0013] LTE Long Term Evolution
[0014] MIMO Multiple-Input Multiple-Output
[0015] OCC Orthogonal Cover Codes
[0016] PRB Physical Resource Block
[0017] RE Resource Element
[0018] RRC Radio Resource Control
[0019] RRM Radio Resource Management
[0020] UE User Equipment
[0021] WI Work Item
[0022] Embodiments of the present invention relate to LTE, and in particular to the physical layer structure and more precisely to DL wireless channel physical resources, channel state information and reference signals. According to LTE, a channel state information reference signal (CSI-RS) already specified in 3GPP Rel. 10 standard is used for downlink channel sounding. This CSI-RS standard could be used for channel measurements and for deriving feedback on channel quality and spatial properties as needed.
[0023] Lots of physical technologies such as 8tx codebook based single-user MIMO (Re1.10 feature), coherent joint transmission (which might be an important
[0024] COMP candidate in current Re1.11 WI) rely on CSI feedback based on CSI-RS ports. Relative accurate channel estimation based on CSI-RS is critical to system performance.
[0025] FIG. **5** illustrates all possible CSI-RS resources in Rel. 10. The left figure shows possible resources for 2 CSI-RS ports, which are indicated by 0 and 1. The middle figure shows possible resources for 4 CSI-RS ports, which are indicated by 0, 1, 2 and 3. The right figure shows possible resources for 8 CSI-RS ports, which are indicated by 0, 1, 2, 3, 4, 5, 6 and 7. It is noted that also other resources are indicated, for understanding the present invention, however, only the locations of the CSI-RS resources are important.
[0026] FIG. **6** shows a simplified example for a case of 2 CSI-RS ports, which are selected from the possible resources indicated in the left figure of FIG. **5** to be used as indicated.
[0027] Thus, due to the low density, there can be problems with estimating accurately sub-band PMI using current Rel. 10 CSI-RS pattern, because of few REs available for doing this estimation (sub-band size in 10 MHz system is 6 PRB so effectively only 6 RE per antenna).
[0028] Also for some time 3GPP have been discussing the possibility of standardizing new carrier types which do not support the transmission of Rel-8 LTE common reference signal. In such carriers all UE measurements would be carried out using CSI-RS and such UEs may even use CSI-RS in legacy carriers to make these measurements. Moreover some of these new CSI-RS measurements may be done for different purposes than the measurements currently done. As an example of such a measurement the UE may measure the strength and/or quality of different geographically separated transmission points operating under the same logical cell. CSI-RS based measurements may replace in the future some or all of the existing RRM measurements or they be simply complementing existing RRM measurements.
[0029] Assuming that CSI-RS will be used also for RRM like measurements, further consideration is needed. RRM like measurements could be used for operating the cell (re) selection and handover and it is of utmost importance that such measurements are very robust and reliable.
[0030] With current Rel-10 CSI-RS design, the number of REs allocated for such UE measurement is very limited especially for 2tx operation (1 RE per antenna per PRB with minimal period of 5 ms, shown in FIG. **5** or **6**) so Rel-10 CSI-RS may not in the current form be suitable for making RRM like measurements.
[0031] On way to enhance the channel estimation could be to increase the number of RS symbols or to modify the CDM manner for each pair of REs while maintaining Rel-10 backward compatibility. However, this would lead to a complex signalling arrangement and overhead.

SUMMARY OF THE INVENTION

[0032] Embodiments of the present invention address this situation and aim to enhance channel estimation.
[0033] According to a first aspect of embodiments of the present invention, an apparatus is provided which comprises an interface configured to provide connection to at least another apparatus, and a processor. The processor is configured to create a at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block, send information regarding the at least one virtual antenna port including the definition of the reference signal ports via the interface to a user equipment, and send reference signals on the plurality of reference signal ports to the user equipment.
[0034] According to a second aspect of embodiments of the present invention, an apparatus is provided which comprises an interface configured to provide connection to at least another apparatus, and a processor. The processor is configured to receive information regarding at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block via the interface from a network control element, and receive reference signals on the plurality of reference signal ports via the interface.
[0035] According to a third aspect of embodiments of the present invention, a method is provided which comprises
[0036] creating a at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block,
[0037] sending information regarding the at least one virtual antenna port including the definition of the reference signal ports to a user equipment, and

[0038] sending reference signals on the plurality of reference signal ports to the user equipment.

[0039] According to a fourth aspect of embodiments of the present invention, a method is provided which comprises

[0040] receiving information regarding at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block via the interface from a network control element, and

[0041] receiving reference signals on the plurality of reference signal ports.

[0042] Advantageous developments are defined in the dependent claims.

[0043] Thus, according to certain embodiments, one or more virtual antenna ports are provided, each of comprises a plurality of reference signal ports on which reference signals are transmitted. In this way, channel estimation, for which the reference signals may be used, can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] These and other objects, features, details and advantages will become more fully apparent from the following detailed description of embodiments of the present invention which is to be taken in conjunction with the appended drawings, in which:

[0045] FIG. **1** shows an eNB according to an embodiment of the present invention,

[0046] FIG. **2** shows a UE according to an embodiment of the present invention,

[0047] FIG. **3** shows a signaling flow between an eNB and a UE according to an embodiment of the present invention,

[0048] FIG. **4** shows an example for a flexible CSI-RS resource configuration according to an embodiment of the present invention, and

[0049] FIG. **5** shows all possible CSI-RS resources with 2/4/8 ports per resource according to Rel. 10.

[0050] FIG. **6** shows an example of 2 tx CSI-RS resource according to Rel-10.

DETAILED DESCRIPTION OF EMBODIMENTS

[0051] In the following, description will be made to embodiments of the present invention. It is to be understood, however, that the description is given by way of example only, and that the described embodiments are by no means to be understood as limiting the present invention thereto.

[0052] As described above, according to embodiments of the present invention, downlink channel estimation by using pilot signals such as reference signals (such as CSI-RS) is to be improved. This is achieved by introducing virtual antenna ports, each of which comprises a plurality of reference signal ports defined in a physical resource block (PRB).

[0053] In the following, a general embodiment for an eNB (as an example for a corresponding apparatus or network control element) is described by referring to FIG. **1**.

[0054] In particular, a eNB **1** comprises an interface **13** configured to provide connection to at least another apparatus, and a processor **11**. The processor **11** is configured to create a at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block, to send information regarding the at least one virtual antenna port including the definition of the reference signal ports via the interface to a user equipment, and to send reference signals on the plurality of reference signal ports to the user equipment.

[0055] Optionally, the apparatus may comprise a memory **12**, in which programs for carrying out the functions according to the embodiments are stored. The processor **11**, the interface **13** and the memory **12** may be inter-connected by a suitable connection **14**, e.g., a bus or the like.

[0056] With respect to FIG. **2**, a general embodiment for an UE (as an example for a corresponding apparatus or user equipment) is described.

[0057] A UE **2** comprises an interface **23** configured to provide connection to at least another apparatus, and a processor **21**. The processor **21** is configured to receive information regarding at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block via the interface from a network control element, and to receive reference signals on the plurality of reference signal ports via the interface.

[0058] Optionally, similar as in connection with the eNB **1** described above, the UE **2** may comprise a memory **22**, in which programs for carrying out the functions according to the embodiments are stored. The processor **21**, the interface **23** and the memory **22** may be inter-connected by a suitable connection **24**, e.g., a bus or the like.

[0059] Hence, according to embodiments of the present invention, feedback can be determined based on the at least one virtual antenna port by averaging measurement over the reference signal ports with the associated weighting factor, and to send the feedback via the interface to the network control element.

[0060] A weighting factor may be applied to each reference signal port, so that a network element such as the UE **1** may carry out the measurements by taking into account different weights of the different ports.

[0061] According to more specific embodiments of the present invention, downlink channel estimation based on CSI-RS is improved by allowing what is considered in R10 LTE to be separate CSI-RS ports to be considered as a single port and thus effectively increase the number of resource elements available for the channel estimation. This is achieved by signaling to the UE which Rel-10 defined CSI-RS ports should be combined into a single virtual port, and potentially how to average the measurements on the separate CSI-RS antenna ports within a virtual port. In this way backwards compatibility is maintained as the individual CSI-RS ports aren't changed, moreover it allows UE supporting this feature to do different types of measurements with same CSI-RS ports (CQI like and RRM like) achieving optimal performance and minimal reference signal overhead.

[0062] According to certain embodiments, density of CSI-RS is made configurable (increased) in a backward compatible fashion. Basically, a UE is informed that a number of CSI-RS ports can be combined to one and this new combined virtual port can be considered as one of potentially more ports for the concerned measurement. In other words by combining a specific set of CSI-RS ports in a specific way a new set of virtual antenna ports are created and these form the basis for doing UE measurements.

[0063] It is signaled to the UE which CSI-RS antenna ports actually correspond to the single new virtual antenna port. This signaling is achieved by introducing a virtual antenna port concept/configuration.

[0064] Thus, according to embodiments of the present invention, a set of existing CSI-RS ports are mapped into new

(virtual) ones. The mapping can potentially include weighting factors allowing to control how the CSI-RS ports are combined by the UE.

[0065] Signaling according to embodiments may comprise determining (by a eNB) that a mobile would benefit from increased CSI-RS density, signaling the increased CSI-RS to the mobile (potentially along with weighting factors), and receiving feedback (e.g., RRM like measurements) based on the increased CSI-RS. Signaling from point of view of an UE may comprise receiving signaling from the eNB that an increased CSI-RS density virtual antenna port would be available for measurements (including a weighting which could be implicit), receiving the CSI-RS, determining feedback (such as RRM like) from the CSI-RS, and sending the feedback back to the eNB.)

[0066] FIG. **3** shows a signaling flow between eNB and UE a mentioned above: In S**1**, the eNB determines whether the configuration including an increased number of reference signal ports (e.g., increased number of CSI-RS ports) would be beneficial for the UE. If so, the eNB sends information regarding the definition of the virtual antenna ports to the UE. Then, in S**3** the eNB may send the reference signals (CSI-RS) on the virtual antenna ports (i.e., on the plurality of reference signal ports as defined above) to the UE. In S**4**, the UE performs measurements (e.g., RRM measurements) and sends the measurement results to the ENB in S**4**.

[0067] Thus, by embodiments of the present invention, a more robust CSI-RS based channel estimation and UE measurements are achieved.

[0068] As mentioned above, set of virtual antenna ports used for measurements is created which can have higher RE density than the R10 CSI-RS ports. A virtual antenna port is based on a specific combination of CSI-RS antenna ports as defined in the LTE R10 specification.

[0069] A virtual antenna port as proposed here is defined by

[0070] a set of CSI-RS ports

[0071] a complex valued scalar associated to each CSI-RS port

[0072] The UE creates the virtual antenna port for measurement by averaging over the indicated ports with the associated weighting factor. If the weighting factor is 1 the method reduces to simple averaging. The weighting factors could be explicitly signaled to the UE or there could be different options to select from in the spec.

[0073] FIG. **3** illustrates a flexible CSI-RS resource configuration according to an embodiment of the present invention to allow increased number of REs for RRM measurements in each PRB.

[0074] According to the example shown in FIG. **3**, 12 ports may be assigned to the UE and these may be marked as grouped to two virtual antenna ports P**0** and P**1**. These ports could be spread over the potential CSI-RS positions within one PRB. Assuming that all REs were combined to only P**0**, then there may be one virtual antenna port including 12 ports. To fit this invention into the current 3GPP discussions the virtual antenna port could be second level hierarchy in the definition of the CSI-RS resource

[0075] Old CSI-RS resource definition (e.g., according to TS 36.331, V10.4.0, chapter 6.3.2)

[0076] antennaPortsCount,

[0077] resourceConfig

[0078] subframe_config

[0079] period

[0080] New definition of CSI-RS resource: 2 port measurement with 2 REs (2tx MIMO)

[0081] virtual ports

[0082] port **1** [resourceConfig_1tx_1, resourceConfig_1tx_2], weight [1,1]

[0083] port **2** [resourceConfig_1tx_3, resourceConfig_1tx_4], weight [1,1]

[0084] subframe_config

[0085] period

[0086] An example (Example 1) is described in the following in connection with FIG. **4**. In the above case of 2 port measurement with 2 REs, only four CSI-RS ports would be present, e.g., those shown in rows 1 and 3. Thus, port **1** could be P**0**, and, resourceConfig_1tx_1 may indicate RE in row 1 and column 9, and resourceConfig_1x_2 may indicate RE in row 3, column 5.

[0087] Port **2** could be P**1**, and resourceConfig_1tx_3 may indicate RE in row 1 and column 10, and resourceConfig_1x_4 may indicate RE in row 3, column 6.

[0088] It is noted that "n" in "resourceConfig_1x_n" represents the specific RE position in the PRB.

[0089] The parameter "weight" is the weighting factor described above.

[0090] New definition of CSI-RS resource: 4port measurement with 2 REs per port (4tx MIMO)

[0091] virtual ports

[0092] port **1** [resourceConfig_1tx_1, resourceConfig_1tx_2], weight [1,1]

[0093] port **2** [resourceConfig_1tx_3, resourceConfig_1tx_4], weight [1,1]

[0094] port **3** [resourceConfig_1tx_5, resourceConfig_1tx_6], weight [1,1]

[0095] port **4** [resourceConfig_1tx_7, resourceConfig_1tx_8], weight [1,1]

[0096] subframe_config

[0097] period

[0098] New definition of CSI-RS resource: 1 port measurement with 4 REs (RRM measurement)

[0099] virtual ports

[0100] port **1** [resourceConfig_1tx_1, resourceConfig_1tx_2, resourceConfig_1tx_3, resourceConfig_1tx_4], weight [1,1,1,1]

[0101] subframe_config

[0102] period

[0103] The index resourceConfig_1tx_n is an enhanced version of the resourceConfig index according to Rel. 10 as that only distinguishes pairs of CDM codes allocated to the same pair of REs. ResourceConfig_1tx_n has double length in order to be able to index any of the in R10 defined logical CSI-RS ports.

[0104] The above signaling examples are not exhaustive and there are many other ways the exact signaling could be implemented depending on what exact level of flexibility is needed. One other example to be mentioned explicitly, which would only require minimal changes to the signaling, is defining new interpretations of resourceConfig directly in the specification. Then the eNB can simply signal to the UE which interpretation is used. In this way only one new parameter is needed, this could be called resourceConfigInterpretation

[0105] antennaPortsCount,

[0106] resourceConfig

[0107] resourceConfigInterpretation

[0108] subframe_config
[0109] period
[0110] One interpretation could then provide 2RE per port configurations (e.g. port 0-3 for 2tx measurement with port **0** and **2** combined without specific weighting) and another interpretation allowing to configure patterns optimized for RRM like measurements (ports spread out over the PRB to be combined for better diversity).
[0111] Thus, according to embodiments of the present invention, support of more robust measurements based on CSI-RS is achieved which are potentially needed for handling more advanced UE feedback (narrow band PMI) and UE mobility in R11 and beyond.
[0112] Furthermore, backward compatibility can be maintained by indicating Rel-10 UE that the REs used for new robust measurements are with zero-power CSI-RS (muted). The muting pattern and the 16-bit bitmap defined in Rel-10 can be simply re-used.
[0113] In detail, each bit in 16-bit bitmap defined in Rel. 10 indicates whether two RE pairs would be muted or not. By referring to the example 1 described above in connection with FIG. **4**, it is described in the following how a Rel. 10 UE can be informed about muting operation. For example, bit **5** and bit **8** of the 16-bit bitmap could be set as "1" (so that only the ports shown in first and the third row of FIG. **4** would be used), and the other bits could be set by "0" to mute the relevant positions. In this way, no specification modification to Rel. 10 UE would be necessary.
[0114] Thus, according to the embodiments described above, a flexible CSI-RS configuration is proposed. In this way, RRM measurement in a new carrier type without CRS based on Re1.10 CSI-RS is possible. In current Rel. 10, this is not possible due to the inflexible configuration of CSI-RS ports.
[0115] The invention is not limited to the specific examples described above.
[0116] For example, according to the embodiment described above in connection with FIG. **4**, the weighting factors for determining power of REs are sent from the eNB to the UE. However, the weighting factor (weight factor) may also be predefined in network specifications or the like, so that there is no need to specifically send this to the UE. For example: New definition of CSI-RS resource: 2 port measurement with 2 REs (2tx MIMO)
[0117] virtual ports
[0118] port **1** [resourceConfig_1tx_1, resourceConfig_1tx_2], weight [1,1]
[0119] port **2** [resourceConfig_1tx_3, resourceConfig_1tx_4], weight [1,1]
[0120] subframe_config
[0121] period
[0122] Then weight [1,1] means RE1 and RE2 have the same power. If changing weight [1,1] to weight [2,0], it means RE1 power would be doubled and RE2 will not be useful actually. When weight value is 0, in some sense it means the relevant RE is muted. This would give more flexible muting configuration instead of using 4 RE granularity of Rel.10 muting indication, which would waste the resource in some cases. For example, cell 1 has 2 tx antennas, then it does not make sense to mute 4 RE in neighbor cell 2. Using weight method as proposed above, only two RE instead of 4 RE could be muted for example by setting weight [0,0].
[0123] Furthermore, the embodiments described above refer to CSI-RS and CSI ports. However, the CSI-RS is only an example for reference signal, and other reference signals, channel related reference signals or the like can be used as well. That is, the embodiments may also applied to other reference signals and corresponding reference signal ports than CSI-RS and CSI-RS ports.
[0124] Moreover, the embodiments described above refer in particular to LTE. However, this is also only an example, and the invention can be applied to any arrangement in which reference signals can be sent in a physical resource block.
[0125] Hence, according to aspects of embodiments of the present invention, an apparatus and a method are provided, by which at least one virtual antenna port is created which comprises a plurality of reference signal ports defined in a physical resource block. Information regarding the at least one virtual antenna port including the definition of the reference signal ports is sent to a user equipment, and reference signals are sent on the plurality of reference signal ports to the user equipment.
[0126] According to a further aspect of embodiments of the present invention, an apparatus is provided which comprises
[0127] means for receiving information regarding at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block via the interface from a network control element, and
[0128] means for receiving reference signals on the plurality of reference signal ports.
[0129] According to another aspect of embodiments of the present invention, an apparatus is provided which comprises
[0130] receiving information regarding at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block via the interface from a network control element, and
[0131] receiving reference signals on the plurality of reference signal ports.
[0132] It is to be understood that any of the above modifications can be applied singly or in combination to the respective aspects and/or embodiments to which they refer, unless they are explicitly stated as excluding alternatives.
[0133] For the purpose of the present invention as described herein above, it should be noted that
[0134] method steps likely to be implemented as software code portions and being run using a processor at a network element or terminal (as examples of devices, apparatuses and/or modules thereof, or as examples of entities including apparatuses and/or modules therefore), are software code independent and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;
[0135] generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the invention in terms of the functionality implemented;
[0136] method steps and/or devices, units or means likely to be implemented as hardware components at the above-defined apparatuses, or any module(s) thereof, (e.g., devices carrying out the functions of the apparatuses according to the embodiments as described above, eNode-B etc. as described above) are hardware independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiC-

MOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components;

[0137] devices, units or means (e.g. the above-defined apparatuses, or any one of their respective means) can be implemented as individual devices, units or means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, unit or means is preserved;

[0138] an apparatus may be represented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of an apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor;

[0139] a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

[0140] It is noted that the embodiments and examples described above are provided for illustrative purposes only and are in no way intended that the present invention is restricted thereto. Rather, it is the intention that all variations and modifications be included which fall within the spirit and scope of the appended claims.

1. An apparatus comprising
an interface configured to provide connection to at least another apparatus, and
a processor, wherein
the processor is configured to
create a at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block,
send information regarding the at least one virtual antenna port including the definition of the reference signal ports via the interface to a user equipment, and
send reference signals on the plurality of reference signal ports to the user equipment.

2. The apparatus according to claim **1**, wherein the processor is configured to associate a weighting factor to each reference signal port.

3. The apparatus according to claim **2**, wherein the processor is configured to send information regarding the associated weighting factors of the reference signal ports via the interface to the user equipment.

4. The apparatus according to claim **3**, wherein the weighting factor for each reference signal indicates a factor for adjusting a power ratio among the reference signal ports.

5. (canceled)

6. The apparatus according to claim **1**, wherein the processor is configured to send information to the user equipment that some of the reference signal ports are muted.

7. The apparatus according to claim **1**, wherein the processor is configured to determine whether the user equipment would benefit from providing measurements using the plurality of reference signal ports, and to apply the at least one virtual antenna port and to send information that the plurality of reference signals would be available only in a positive determination result.

8. An apparatus comprising
an interface configured to provide connection to at least another apparatus, and
a processor, wherein
the processor is configured to
receive information regarding at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block via the interface from a network control element, and
receive reference signals on the plurality of reference signal ports via the interface.

9. The apparatus according to claim **8**, wherein a weighting factor is associated to each reference signal port.

10. The apparatus according to claim **9**, wherein the processor is configured to receive information regarding the associated weighting factors of the reference signal ports via the interface from the network control element.

11. The apparatus according to claim **9**, wherein the weighting factor for each reference signal indicates a factor for adjusting a power ratio among the reference signal ports.

12. The apparatus according to claim **10**, wherein the processor is configured to determine feedback based on the at least one virtual antenna port by averaging measurement over the reference signal ports with the associated weighting factor, and to send the feedback via the interface to the network control element.

13. The apparatus according to claim **8**, wherein the processor is configured to receive information from the network control element that the plurality of reference signals would be available.

14. (canceled)

15. A method comprising
creating a at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block,
sending information regarding the at least one virtual antenna port including the definition of the reference signal ports to a user equipment, and
sending reference signals on the plurality of reference signal ports to the user equipment.

16. The method according to claim **15**, further comprising associating a weighting factor to each reference signal port.

17. The method according to claim **16**, further comprising sending information regarding the associated weighting factors of the reference signal ports to the user equipment.

18. The method according to claim **16**, wherein the weighting factor for each reference signal indicates a factor for adjusting a power ratio among the reference signal ports.

19. (canceled)

20. The method according to claim **15**, further comprising
sending information to the user equipment that some of the reference signal ports are muted.

21. (canceled)

22. A method comprising
receiving information regarding at least one virtual antenna port which comprises a plurality of reference signal ports defined in a physical resource block via the interface from a network control element, and
receiving reference signals on the plurality of reference signal ports.

23. The method according to claim **22**, wherein a weighting factor is associated to each reference signal port.

24. The method according to claim **23**, further comprising receiving information regarding the associated weighting factors of the reference signal ports from the network control element.

25. The method according to claim **23**, wherein the weighting factor for each reference signal indicates a factor for adjusting a power ratio among the reference signal ports.

26. The method according to claim **24**, further comprising determining feedback based on the at least one virtual antenna port by averaging measurement over the reference signal ports with the associated weighting factor, and to send the feedback via the interface to the network control element.

27. (canceled)

28. (canceled)

29. A computer program product comprising code means for performing a method according to claim **15** when run on a processing means or module.

30. The computer program product according to claim **29**, wherein the computer program product is embodied on a computer-readable medium.

* * * * *

[19] 中华人民共和国国家知识产权局

[12] 发明专利申请公布说明书

[21] 申请号 200810104687.8

[51] Int. Cl.
H04L 25/03 (2006.01)
H04L 27/26 (2006.01)
H04L 1/06 (2006.01)
H04B 1/707 (2006.01)

[43] 公开日 2009 年 10 月 28 日

[11] 公开号 CN 101567865A

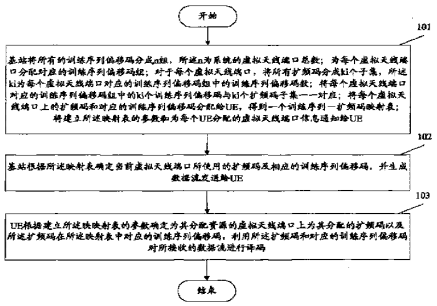
[22] 申请日 2008.4.23
[21] 申请号 200810104687.8
[71] 申请人 鼎桥通信技术有限公司
地址 100102 北京市朝阳区望京北路 9 号叶青大厦 D 座 15 层
[72] 发明人 拉盖施 范 晨 王大飞
[74] 专利代理机构 北京德琦知识产权代理有限公司
代理人 王一斌 王 琦
权利要求书 2 页 说明书 11 页 附图 2 页

[54] 发明名称

一种下行数据传输方法

[57] 摘要

本发明提出了一种下行数据传输方法，基站通过利用支持多个数据流的缺省训练序列分配方法，对每个虚拟天线端口使用的训练序列偏移码进行定义，并将每个虚拟天线端口对应的训练序列偏移码组分别与所有可用扩频码建立映射关系，然后在此基础上生成多个数据流，并通过多根天线发送给用户设备(UE)，从而实现所有可用扩频码资源在下行数据传输中的复用。 本发明能有效提高系统信道容量，发挥多入多出(MIMO)天线技术的优势。



1、一种下行数据传输方法，其特征在于，该方法包括以下步骤：

a、基站将所有的训练序列偏移码分成 n 组，所述 n 为系统的虚拟天线端口总数；为每个虚拟天线端口分配对应的训练序列偏移码组；对于每个虚拟天线端口，将所有扩频码分成 k_i 个子集，所述 k_i 为每个虚拟天线端口对应的训练序列偏移码组中的训练序列偏移码数；将每个虚拟天线端口对应的训练序列偏移码组中的 k_i 个训练序列偏移码与 k_i 个扩频码子集一一对应；将每个虚拟天线端口上的扩频码和对应的训练序列偏移码分配给用户设备 UE，得到一个训练序列—扩频码映射表；将建立所述映射表的参数和为每个 UE 分配的虚拟天线端口信息通知给 UE；

b、基站根据所述映射表确定当前虚拟天线端口所使用的扩频码及对应的训练序列偏移码，并生成数据流发送给 UE；

c、UE 根据建立所述映映射表的参数确定为其分配资源的虚拟天线端口上为其分配的扩频码以及所述扩频码在所述映射表中对应的训练序列偏移码，利用所述扩频码和对应的训练序列偏移码对所接收的数据流进行译码。

2、根据权利要求 1 所述的方法，其特征在于，所述映射表中每个虚拟天线端口对应的训练序列偏移码组中的 k_i 个训练序列偏移码与 k_i 个扩频码子集按照升序或降序一一对应。

3、根据权利要求 1 所述的方法，其特征在于，所述映射表中每个训练序列偏移码相对于同一个基本的训练序列循环移位的偏移量为 $\lfloor 128/k \rfloor$ 的整数倍，所述 k 为所有的训练序列偏移码数。

4、根据权利要求 1 所述的方法，其特征在于，所述映射表中每个虚拟天线端口使用的训练序列偏移码顺序相邻。

5、根据权利要求 1 所述的方法，其特征在于，步骤 a 中建立所述映射表的参数包括训练序列偏移码总数、每个虚拟天线端口编号、训练序列特征信息以及为每个 UE 分配的扩频码信息。

Samsung Exhibit 1003, Page 276 of 438

6、根据权利要求 5 所述的方法，其特征在于，步骤 a 中所述训练序列特征信息包括每个虚拟天线端口对应的训练序列偏移码。

7、根据权利要求 5 所述的方法，其特征在于，步骤 a 中所述训练序列特征信息包括每个虚拟天线端口对应的训练序列偏移码数。

8、根据权利要求 7 所述的方法，其特征在于，步骤 a 中所述训练序列特征信息进一步包括每个虚拟天线端口对应的训练序列偏移码组中的最大训练序列偏移码或所述最大训练序列偏移码在所有训练序列偏移码中的编号或每个虚拟天线端口对应的训练序列偏移码组中的最小训练序列偏移码或所述最小训练序列偏移码在所有训练序列偏移码中的编号。

9、根据权利要求 5 所述的方法，其特征在于，步骤 a 中所述训练序列特征信息包括每个虚拟天线端口对应的训练序列偏移码组中的最大边界训练序列和最小边界训练序列，所述最大边界训练序列为每个虚拟天线端口对应的训练序列偏移码组中的最大训练序列偏移码或所述最大训练序列偏移码在所有训练序列偏移码中的编号，所述最小边界训练序列为每个虚拟天线端口对应的训练序列偏移码组中的最小训练序列偏移码或所述最小训练序列偏移码在所有训练序列偏移码中的编号。

10、根据权利要求 7、8 或 9 所述的方法，其特征在于，步骤 a 中所述训练序列特征信息进一步包括训练序列偏移码升序或降序分配的指示信息。

11、根据权利要求 6、7、8 或 9 所述的方法，其特征在于，步骤 a 中建立所述映射表的参数和为每个 UE 分配的虚拟天线端口信息由基站通过高速共享控制信道发送给 UE，所述高速共享控制信道为所有虚拟天线端口共用的一条高速共享控制信道。

12、根据权利要求 6、7、8 或 9 所述的方法，其特征在于，步骤 a 中所述为每个 UE 分配的扩频码信息由基站通过高速共享控制信道发送给 UE，建立所述映射表的参数中除为每个 UE 分配的扩频码信息之外的其他参数以及所述为每个 UE 分配的虚拟天线端口信息由基站通过广播信道、高层信令发送给 UE，所述高速共享控制信道为每个虚拟天线端口分别配置的高速共享控制信道。

Samsung Exhibit 1003, Page 277 of 438

一种下行数据传输方法

技术领域

本发明涉及时分同步码分多址（TD-SCDMA）系统中的数据传输技术，特别是涉及一种多入多出天线（MIMO）系统中的下行数据传输方法。

背景技术

TD-SCDMA 系统中，时分双工（TDD ）模式下的物理信道是将一个突发在所分配的无线帧的特定时隙发射。一个突发由数据部分、训练序列(midamble)部分和保护间隔组成。突发的数据部分由信道码和扰码共同扩频，信道码是一个正交可变扩频因子(OVSF)码，扩频因子可以取 1，2，4，8 或 16，物理信道的速率取决于扩频因子，并在功率不变、码率不变的情况下与扩频因子的大小成正比；训练序列部分由一个基本的 midamble 循环移位产生的训练序列即训练序列偏移码（midamble shift）构成，基本的 midamble 码长度为 128 个码片，训练序列部分用于接收端进行信道估计与测量，辅助对数据部分的数据解调。一个突发的持续时间是一个时隙，发射机可以同时发射几个突发，在这种情况下，几个突发的数据部分必须使用不同的 OVSF 信道码，但应使用相同的扰码，训练序列部分必须使用同一个基本的 midamble 码，但可使用不同训练序列偏移码。

目前的 TD-SCDMA 系统中，训练序列的分配方案有两种，一种是特定分配方案，在该方案中，为每个用户设备(UE)分配一个特定的训练序列偏移码，所述特定的训练序列偏移码仅与 UE 相关，与扩频码无关；另一种是缺省分配方案，该方案中由训练序列偏移码与扩频码的映射关系给出，因此训练序列偏移码仅与扩频码相关，与 UE 无关。缺省分配方案中训练序列偏移码与扩频码的映射关系与基站可用的最大训练序列数量有关，最大训练序列

Samsung Exhibit 1003, Page 278 of 438

数量由基站确定，其有效期为一个或多个时隙、帧或子帧。假设最大训练序列数量为K，缺省分配方案通常建立k个训练序列偏移码和所有可用的扩频码（通常为16个）的对应关系。具体方法为：首先由一个基本的训练序列通过多次循环移位产生k个训练序列偏移码，其中每个训练序列偏移码相对于基本的训练序列循环移位的偏移量为$\lfloor 128/k \rfloor$的整数倍，然后将所有可用的扩频码分成k组，将k组扩频码与k个训练序列偏移码顺次建立一一映射关系。上述缺省分配方案建立的训练序列偏移码与扩频码的映射关系仅适用于单个数据流传输的情况。

当TD-SCDMA系统为了提高系统容量引入了MIMO天线技术后，利用多个虚拟天线端口在一个时隙内可以传输多个数据流，其中每个虚拟天线端口与一根或多根发射天线相对应。在这种情况下，如果按照现有的缺省分配方案分别为虚拟天线端口建立训练序列偏移码与扩频码的映射关系表，通过多个独立的映射关系来实现多个数据流传输时训练序列的分配，则是不可行的。因为，在MIMO系统中每个虚拟天线端口不能与其他虚拟天线端口使用相同的训练序列偏移码，如果多个虚拟天线端口使用相同数量的训练序列偏移码，此时按照现有的缺省分配方案为它们分别建立多个映射关系表，则会导致在这些相互独立的映射关系表中分配给这些虚拟天线端口的训练序列偏移码相同，这会导致MIMO系统无法进行正常的信道估计。另外，即使多个虚拟天线端口所使用的训练序列偏移码数量均不相同，也会存在不同数据流中相邻训练序列偏移码间隔较近的情况，这将影响此后数据接收端利用训练序列偏移码进行信道估计的准确性。上述问题，可以通过利用现有的缺省分配方案仅配置一个所有虚拟天线端口共享的训练序列偏移码与扩频码映射表的方法来克服。在该映射表中，不同虚拟天线端口上的相同扩频码被分成一组，所有扩频码组成k组，k组扩频码分别与k个不同的训练序列偏移码一一对应。因此，当用户仅在某一个虚拟天线端口被调度时，则该用户在该虚拟天线端口上使用的扩频码资源无法在其它虚拟天线端口上被

Samsung Exhibit 1003, Page 279 of 438

其它用户使用，这将降低信道的传输能力，不能发挥 MIMO 天线技术的优势。

由此可见，利用现有训练序列的缺省分配方案实现下行数据传输的方法不能直接应用于 MIMO 系统中。

发明内容

有鉴于此，本发明的主要目的在于提供一种下行数据传输方法，该方法适用于 MIMO 系统。

为了达到上述目的，本发明提出的技术方案为：

一种下行数据传输方法，包括以下步骤：

a、基站将所有的训练序列偏移码分成 n 组，所述 n 为系统的虚拟天线端口总数；为每个虚拟天线端口分配对应的训练序列偏移码组；对于每个虚拟天线端口，将所有扩频码分成 k_i 个子集，所述 k_i 为每个虚拟天线端口对应的训练序列偏移码组中的训练序列偏移码数；将每个虚拟天线端口对应的训练序列偏移码组中的 k_i 个训练序列偏移码与 k_i 个扩频码子集一一对应；将每个虚拟天线端口上的扩频码和对应的训练序列偏移码分配给 UE，得到一个训练序列—扩频码映射表；将建立所述映射表的参数和为每个 UE 分配的虚拟天线端口信息通知给 UE；

b、基站根据所述映射表确定当前虚拟天线端口所使用的扩频码及对应的训练序列偏移码，并生成数据流发送给 UE；

c、UE 根据建立所述映映射表的参数确定为其分配资源的虚拟天线端口上为其分配的扩频码以及所述扩频码在所述映射表中对应的训练序列偏移码，利用所述扩频码和对应的训练序列偏移码对所接收的数据流进行译码。

如上所述的方法中，所述映射表中每个虚拟天线端口对应的训练序列偏移码组中的 k_i 个训练序列偏移码与 k_i 个扩频码子集按照 升序或降序一一对应。

如上所述的方法中，所述映射表中每个训练序列偏移码相对于同一个基本的训练序列循环移位的偏移量为 $\lfloor 128/k \rfloor$ 的整数倍，所述 k 为所有的训练序列偏

Samsung Exhibit 1003, Page 280 of 438

移码数。

如上所述的方法中，所述映射表中每个虚拟天线端口使用的训练序列偏移码顺序相邻。

如上所述的方法中，步骤 a 中建立所述映射表的参数包括训练序列偏移码总数、每个虚拟天线端口编号、训练序列特征信息以及为每个 UE 分配的扩频码信息。

如上所述的方法中，步骤 a 中所述训练序列特征信息包括每个虚拟天线端口对应的训练序列偏移码。

如上所述的方法中，步骤 a 中所述训练序列特征信息包括每个虚拟天线端口对应的训练序列偏移码数。

如上所述的方法中，步骤 a 中所述训练序列特征信息进一步包括每个虚拟天线端口对应的训练序列偏移码组中的最大训练序列偏移码或所述最大训练序列偏移码在所有训练序列偏移码中的编号或每个虚拟天线端口对应的训练序列偏移码组中的最小训练序列偏移码或所述最小训练序列偏移码在所有训练序列偏移码中的编号。

如上所述的方法中，步骤 a 中所述训练序列特征信息包括每个虚拟天线端口对应的训练序列偏移码组中的最大边界训练序列和最小边界训练序列，所述最大边界训练序列为每个虚拟天线端口对应的训练序列偏移码组中的最大训练序列偏移码或所述最大训练序列偏移码在所有训练序列偏移码中的编号，所述最小边界训练序列为每个虚拟天线端口对应的训练序列偏移码组中的最小训练序列偏移码或所述最小训练序列偏移码在所有训练序列偏移码中的编号。

如上所述的方法中，步骤 a 中所述训练序列特征信息进一步包括训练序列偏移码升序或降序分配的指示信息。

如上所述的方法中，步骤 a 中建立所述映射表的参数和为每个 UE 分配的虚拟天线端口信息由基站通过高速共享控制信道发送给 UE，所述高速共享控制信道为所有虚拟天线端口共用的一条高速共享控制信道。

如上所述的方法中，步骤 a 中所述为每个 UE 分配的扩频码信息由基站

Samsung Exhibit 1003, Page 281 of 438

通过高速共享控制信道发送给 UE，建立所述映射表的参数中除为每个 UE 分配的扩频码信息之外的其他参数以及所述为每个 UE 分配的虚拟天线端口信息由基站通过广播信道、高层信令发送给 UE，所述高速共享控制信道为每个虚拟天线端口分别配置的高速共享控制信道。

综上所述，本发明提出的下行数据传输方法中基站通过利用支持多个数据流的缺省训练序列分配方法，对每个虚拟天线端口使用的训练序列偏移码进行了定义，并将每个虚拟天线端口对应的训练序列偏移码组分别与所有可用扩频码建立映射关系，然后在此基础上生成多个数据流，并通过多根天线发送给 UE，从而实现所有可用扩频码资源在下行数据传输中的复用，进而有效提高了系统信道容量，发挥 MIMO 天线技术的优势，因此本发明适用于 MIMO 系统。

附图说明

图 1 为本发明方法的流程图；

图 2 为本发明实施例一的方法流程图。

具体实施方式

为使本发明的目的、技术方案和优点更加清楚，下面将结合附图及具体实施例对本发明作进一步地详细描述。

图 1 为本发明方法的流程图。如图 1 所示，本发明方法主要包括：

步骤 101、基站将所有的训练序列偏移码分成 n 组，所述 n 为系统的虚拟天线端口总数；为每个虚拟天线端口分配对应的训练序列偏移码组；对于每个虚拟天线端口，将所有扩频码分成 k_i 个子集，所述 k_i 为每个虚拟天线端口对应的训练序列偏移码组中的训练序列偏移码数；将每个虚拟天线端口对应的训练序列偏移码组中的 k_i 个训练序列偏移码与 k_i 个扩频码子集一一对应；将每个虚拟天线端口上的扩频码和对应的训练序列偏移码分配给 UE，得到一个训练序列—扩频码映射表；将建立所述映射表的参数和为每个 UE 分配的虚拟天线端口

Samsung Exhibit 1003, Page 282 of 438

信息通知给 UE。

本步骤中得到的所述训练序列—扩频码映射表具体为:

假设所有可以使用的扩频码数为 z，相应的所有扩频码的集合为 $\{c_1,c_2,c_3,.....c_z\}$，虚拟天线端口总数为 n，所有虚拟天线端口所需的训练序列偏移码总数为 k，训练序列偏移码集合为 $\{m_1,m_2,m_3,.....m_k\}$，其中 $m_x \neq m_y$，$1 \leqslant x \leqslant k$，$1 \leqslant y \leqslant k$，且 $x \neq y$，将集合 $\{m_1,m_2,m_3,.....m_k\}$ 分为 n 个训练序列偏移码组，分别与 n 个虚拟天线端口一一对应，具体的，第 i 个虚拟天线端口使用第 i 个训练序列偏移码组，第 i 个训练序列偏移码组的训练序列偏移码数为 k_i，且 $k_1+.....+k_i+.....+k_n=k$；对于第 i 个虚拟天线端口，将扩频码集合 $\{c_1,c_2,c_3,.....c_z\}$ 划分为 k_i 个子集，使第 j 个扩频码子集与该第 i 个虚拟天线端口的第 j 个训练序列偏移码建立一一对应关系，其中 $1 \leqslant j \leqslant k_i$。

这里需要说明的是，在实际应用中 k 值的有效期为一个或多个时隙、帧或子帧。通过采用上述建立映射表的方法，可以根据基站的调度需求为每个虚拟天线端口分配适当的训练序列偏移码数 k_i，并将这 k_i 个训练序列偏移码子集与系统所有可用扩频码建立映射关系，从而实现扩频码资源在多个虚拟天线端口上的复用，从而提高系统容量，另外，由于多个虚拟天线端口所使用的训练序列偏移码均为同一个训练序列偏移码集合中的不同元素,因此，可以确保不同的虚拟天线端口使用不同的训练序列偏移码。

本步骤中，建立所述映射表的参数主要包括：建立所述映射表的参数包括训练序列偏移码总数、每个虚拟天线端口编号、训练序列特征信息以及为每个 UE 分配的扩频码信息。在实际应用中，所述参数还可以包括训练序列偏移码升序或降序分配的指示信息，需要说明的是，该指示信息也可以作为系统的默认信息预设于 UE 中，而不需要在进行数据传输时通知给 UE。所述参数中，所述训练序列特征信息可以为每个虚拟天线端口对应的训练序列偏移码组中的训练序列偏移码数。根据训练序列偏移码总数、虚拟天线端口编号、每个虚拟天线端口使用的训练序列偏移码数以及训练序列偏移码升序或降序分配的指示信息，UE 可以按照建立所述映射表的方法获得每个虚拟

Samsung Exhibit 1003, Page 283 of 438

天线端口使用的训练序列偏移码，其方法在具体应用中有多种。例如，若建立所述映射表时，按照升序依次为每个虚拟天线端口分配训练序列偏移码，且每个训练序列偏移码相对于基本的训练序列循环移位的偏移量为$\lfloor 128/k \rfloor$的整数倍，则第 i 个虚拟天线端口使用的训练序列偏移码为在（$k_1+\ldots+k_{i-1}$）*128/k 至（$k_1+\ldots+k_i$）*128/k 区间上 k_i 个不同偏移量所分别对应的训练序列偏移码，该方法中每个虚拟天线端口的训练序列偏移码的确定与其他虚拟天线端口的训练序列偏移码的数量有关，如果某一虚拟天线端口的训练序列偏移码数量信息出错，则会影响对其后虚拟天线端口的训练序列偏移码的计算，使错误扩散，因此对指令信息的准确性要求高，但该方法具备信令开销小的优点。为了克服上述方法的缺点，在实际应用中，还可以将每个虚拟天线端口对应的训练序列偏移码作为所述训练序列特征信息直接通知给 UE，另外，也可以将每个虚拟天线端口对应的训练序列偏移码组中的最大边界训练序列和最小边界训练序列作为所述训练序列特征信息通知给 UE，其中，所述最大边界训练序列为每个虚拟天线端口对应的训练序列偏移码组中的最大训练序列偏移码或所述最大训练序列偏移码在所有训练序列偏移码中的编号，所述最小边界训练序列为每个虚拟天线端口对应的训练序列偏移码组中的最小训练序列偏移码或所述最小训练序列偏移码在所有训练序列偏移码中的编号。此时，UE 可以根据最大边界训练序列和最小边界训练序列，并结合系统预设的相邻训练序列偏移码间隔$\lfloor 128/k \rfloor$推算出每个虚拟天线端口使用的所有训练序列偏移码。这样，UE 在确定每个虚拟天线端口所使用的训练序列偏移码时，不需要依赖于其它虚拟天线端口的训练序列偏移码数量，但是该方法将增大信令的开销，实际应用中，系统可以根据实际需要对上述两种方法进行取舍。这里需要说明的是，同样也可以将每个虚拟天线端口对应的训练序列偏移码组中的训练序列偏移码数和所述最大边界训练序列作为所述训练序列特征信息，或者，将每个虚拟天线端口对应的训练序列偏移码组中的训练序列偏移码数和所述最小边界训练序列作为所述训练序

Samsung Exhibit 1003, Page 284 of 438

列特征信息，此时，UE 也可以根据所述训练序列特征信息和预设的相邻训练序列偏移码间隔推算出每个虚拟天线端口所使用的训练序列偏移码，而不需要依赖于其它虚拟天线端口的训练序列偏移码数量。

在实际应用中，为每个 UE 分配的虚拟天线端口信息可以通过高速共享控制信道（HS－SCCH）以调度消息的方式或广播信道、高层信令的方式发送给 UE，建立所述映射表的参数中除了为每个 UE 分配的扩频码信息需要在 HS－SCCH 以调度消息的方式发送给 UE 外，其它参数信息均可以在广播信道、高层信令或 HS－SCCH 信道以调度消息的方式发送给 UE。

步骤 102、基站根据所述映射表确定当前虚拟天线端口所使用的扩频码及相应的训练序列偏移码，并生成数据流发送给 UE。

本步骤中，具体的如何生成数据流并发送给 UE，为现有技术，此处不再赘述。

步骤 103、UE 根据建立所述映映射表的参数确定为其分配资源的虚拟天线端口上为其分配的扩频码以及所述扩频码在所述映射表中对应的训练序列偏移码，利用所述扩频码和对应的训练序列偏移码对所接收的数据流进行译码。

本步骤中，UE 根据建立所述映射表的参数确定基站在为其分配资源的虚拟天线端口上分配给自己的扩频码，以及各虚拟天线端口使用的训练序列偏移码，根据建立所述映射表的方法，UE 可以确定与其扩频码相对应的训练序列偏移码，即每个虚拟天线端口为该 UE 分配的训练序列偏移码，然后再利用所述训练序列偏移码进行信道估计，辅助扩频码对所接收的数据流进行译码。这里需要说明的是，与现有非 MIMO 系统中数据传输方法相比，本步骤的不同之处在于，如何根据建立所述映射表的参数确定各数据流使用的训练序列偏移码，前文已对其方法进行了说明。至于如何利用所述扩频码确定相对应的训练序列偏移码，以及如何利用所述训练序列偏移码进行信道估计，辅助扩频码对所接收的数据流进行译码，这些内容均与现有非 MIMO 系统中采用的方法相同，此处不再赘述。

下面通过本发明的较佳实施例对本发明的方法进行详细说明。

Samsung Exhibit 1003, Page 285 of 438

图 2 为本发明实施例一的流程图。简单起见，实施例一中的 MIMO 系统采用二入二出天线技术，假设虚拟天线端口总数为 2，可用的扩频码总数为 16，可用的训练序列偏移码总数为 8，每个训练序列偏移码相对于基本的训练序列循环移位的偏移量设置为 128/8 的整数倍即 16 的整数倍，系统所需承载的 UE 数为 8。基于上述条件，如图 2 所述，实施例一包括以下步骤：

步骤 201、基站将 8 个训练序列偏移码分成 2 组，每个训练序列偏移码组中包含 4 个训练序列偏移码；为每个虚拟天线端口分配对应的训练序列偏移码组；对于每个虚拟天线端口，将所有扩频码分成 4 个子集；将每个虚拟天线端口对应的训练序列偏移码组中的 4 个训练序列偏移码与 4 个扩频码子集一一对应；将两个虚拟天线端口上的扩频码和对应的训练序列偏移码分配给 8 个 UE，得到一个训练序列—扩频码映射表；

本实施例中，按照每个训练序列偏移码相对于基本的训练序列循环移位的偏移量为 16 的整数倍，可计算出所有训练序列偏移码的偏移量分别为 0、16、32、48、64、80、96 和 112，其对应的训练序列偏移码为：m1、m2、m3、m4、m5、m6、m7、m8，由此可建立如表 1 所示的训练序列—扩频码映射表：

第一个虚拟天线端口				第二个虚拟天线端口			
m1	m2	m3	m4	m5	m6	m7	m8
{c1 ~ c4}	{c5 ~ c8}	{c9 ~ c12}	{c13 ~ c16}	{c1 ~ c4}	{c5 ~ c8}	{c9 ~ c12}	{c13 ~ c16}
UE1	UE2	UE2	UE3	UE4	UE5	UE6	UE3

表 1

表 1 中 c_i 表示第 i 个扩频码，其中 $1 \leqslant i \leqslant 16$。由表 1 中可知，第一个虚拟天线端口配置了四个训练序列偏移码即 m1、m2、m3 和 m4，承载了三个用户即 UE1，UE2 和 UE3，并与 16 个扩频码建立了映射关系，第二个虚拟天线端口配置了四个训练序列偏移码即 m5、m6、m7 和 m8，承载了四个用户即 UE3、UE4、UE5 和 UE6，并与 16 个扩频码建立了映射关系。通过上述分析可以看出，表 1 实现了 16 个扩频码资源在两个虚拟天线端口上的复

Samsung Exhibit 1003, Page 286 of 438

用。

步骤 202、基站在 HS-SCCH 信道发送调度信息给 UE，所述调度信息中包含为每个 UE 分配的扩频码信息、训练序列偏移码总数、每个虚拟天线端口编号、每个虚拟天线端口使用的训练序列偏移码和为每个 UE 分配的虚拟天线端口信息。

这里，需要说明的是，在实际应用中，所述 HS-SCCH 信道可以是所有虚拟天线端口共用的一条 HS-SCCH 信道，也可以是每个虚拟天线端口分别配置的 HS-SCCH 信道。如果是前者则所述调度信息包含了所有虚拟天线端口的调度信息，且需要在调度信息中增加标志信息，以指示各调度信息所对应的虚拟天线端口；如果是后者，则所述调度信息仅包含其对应虚拟天线端口的调度信息，另外，系统还需要以广播信道或高层信令的方式告知 UE 各虚拟天线端口信息及各虚拟天线端口使用的 HS-SCCH 信息。

步骤 203、基站根据所述映射表确定生成当前虚拟天线端口所使用的扩频码及对应的训练序列偏移码，并生成数据流发送给 UE;

步骤 204、UE 根据调度信息确定基站为其分配资源的虚拟天线端口上为其分配的扩频码以及所述扩频码在所述映射表中对应的训练序列偏移码，利用所述扩频码和对应的训练序列偏移码对所接收的数据流进行译码。

上述技术方案中，步骤 201 和 202 实现了本发明的步骤 101，步骤 203 实现了本发明的步骤 102，步骤 204 实现了本发明的步骤 103。

通过上述技术方案可以看出，本发明中基站利用支持多个数据流的缺省训练序列分配方法，仅通过建立一个训练序列—扩频码映射表为所有虚拟天线端口分配了不同的训练序列偏移码，并将每个虚拟天线端口对应的训练序列偏移码组分别与所有可用扩频码建立映射关系，然后在此基础上生成多个数据流通过多个发射天线发送给 UE，从而实现所有可用扩频码资源在下行数据传输中的复用，进而有效提高系统信道容量，发挥 MIMO 天线技术的优势，因此本发明适用于 MIMO 系统。

综上所述，以上仅为本发明的较佳实施例而已，并非用于限定本发明的

Samsung Exhibit 1003, Page 287 of 438

保护范围。凡在本发明的精神和原则之内，所作的任何修改、等同替换、改进等，均应包含在本发明的保护范围之内。

Samsung Exhibit 1003, Page 288 of 438

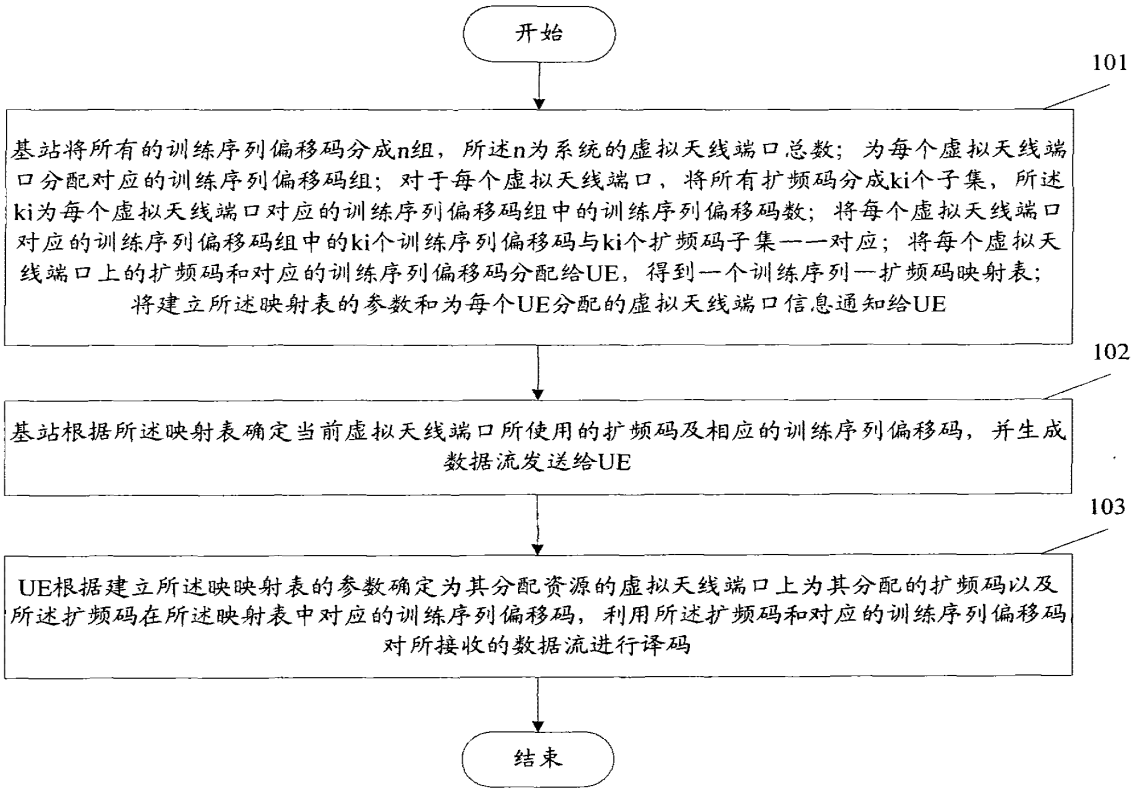


图 1

Samsung Exhibit 1003, Page 289 of 438

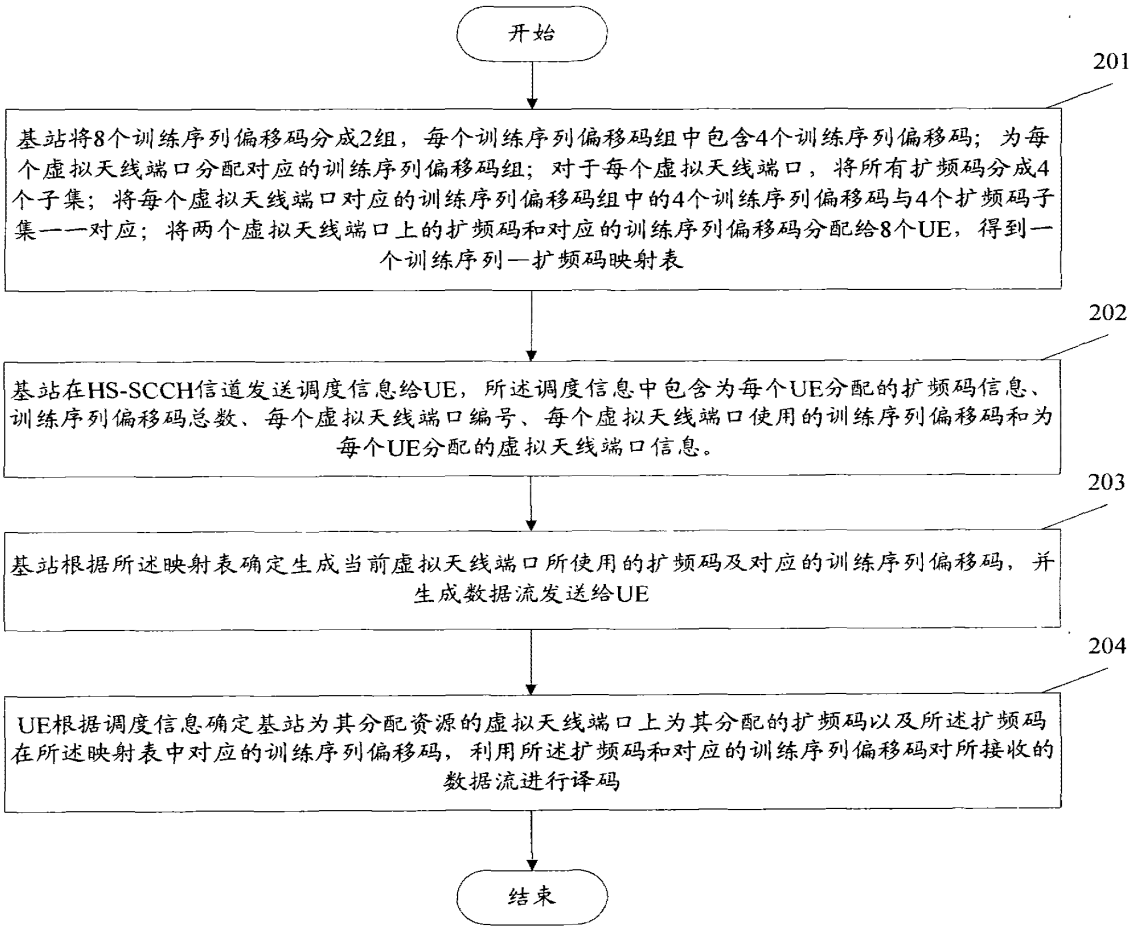


图 2

Samsung Exhibit 1003, Page 290 of 438

Espacenet

Bibliographic data: CN105577318 (A) — 2016-05-11

CSI feedback method and apparatus in FD-MIMO transmission

Inventor(s): ZHANG XIAOBO ± (ZHANG XIAOBO, ; 张晓博)

Applicant(s): LONGBO COMMUNICATION TECHNICAL CO LTD ± (LONGBO COMMUNICATION TECHNICAL CO., LTD, ; 上海朗帛通信技术有限公司)

Classification: - international: ***H04L1/00; H04L1/16***
- cooperative:

Application number: CN201410545497 20141015 Global Dossier

Priority number(s): CN201410545497 20141015

Also published as: CN105577318 (B)

Abstract of CN105577318 (A)

The invention provides a channel status information (CSI) feedback method and apparatus in full-dimension multiple-input-multiple-output (FD-MIMO) transmission. User equipment (UE) receives a downlink reference signal at a first reference signal (RS) resource at a step one and receives a downlink signalling at the step one to obtain a first precoding vector index (PVI). The first RS resource includes N RS ports and the vector of the first PVI index includes M elements; each RS port of the first RS resource in a target sub-frame set is generated by M antenna unit groups based on an antenna virtualization scheme; and the corresponding antenna virtualization vector is indicated by the first PVI, wherein the N is a positive integer lager than 1, the M is a positive integer larger than 1. The sub-frame set includes F subframes, wherein the F is a positive integer. According to the method provided by the invention, the US utilizes limited air interface resources to measure and feed back the CSI effectively, so that the costs of the air interface resources are saved.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 105577318 A
(43)申请公布日 2016.05.11

(21)申请号 201410545497.5

(22)申请日 2014.10.15

(71)申请人 上海朗帛通信技术有限公司
地址 200240 上海市闵行区东川路555号乙楼A2117室

(72)发明人 张晓博

(51)Int.Cl.
H04L 1/00(2006.01)
H04L 1/16(2006.01)

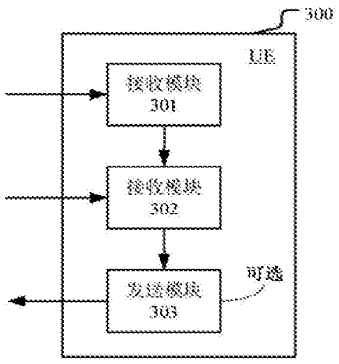
权利要求书2页 说明书8页 附图3页

(54)发明名称

一种FD-MIMO传输中的CSI反馈方法和装置

(57)摘要

本发明提出了一种FD-MIMO传输中的CSI反馈方法和装置。UE在步骤一中在第一RS资源上接收下行参考信号，在步骤一中接收下行信令获得第一PVI。其中，第一RS资源包括N个RS端口。第一PVI索引的向量包括M个元素。第一RS资源中的每一个RS端口在目标子帧集合中都是分别由M个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量都由第一PVI指示。所述N是大于1的正整数，所述M是大于1的正整数。所述子帧集合包括F个子帧，所述F是正整数。本发明的方法使得UE利用有限的空口资源有效的测量并反馈CSI，节省了空口资源的开销。



CN 105577318 A

1. 一种 UE 中的方法，其中，包括如下步骤：

- 步骤 A. 在第一 RS 资源上接收下行参考信号

- 步骤 B. 接收下行信令获得第一 PVI。

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

2. 根据权利要求 1 所述的方法，其特征在于，所述步骤 A 还包括：

- 步骤 A1. 在第二 RS 资源上接收下行参考信号。

所述方法还包括：

- 步骤 C. 发送 { 第一 PMI，第二 PMI，上行 RS} 中的至少一种以及第一 CQI。

其中，第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

3. 根据权利要求 1，2 所述的方法，其特征在于，所述步骤 B 还包括：

- 步骤 B1. 根据接收的第一 RS 资源上的 K 个所述子帧集合上的下行参考信号以及相应的 K 个 PVI 恢复出每个所述 RS 端口对应的 M 个天线单元组的信道信息。所述 K 是不小于 M 的正整数。

4. 根据权利要求 1-3 所述的方法，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

5. 一种基站中的方法，其中，包括如下步骤：

- 步骤 A. 在第一 RS 资源上发送下行参考信号

- 步骤 B. 发送下行信令指示第一 PVI。

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

6. 根据权利要求 5 所述的方法，其特征在于，所述步骤 A 还包括：

- 步骤 A1. 在第二 RS 资源上发送下行参考信号。

所述方法还包括：

- 步骤 C. 接收 { 第一 PMI，第二 PMI，上行 RS} 中的至少一种以及第一 CQI。

其中，第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

7. 根据权利要求 5，6 所述的方法，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

8. 一种用户设备，其特征在于，该设备包括：

第一模块：用于在第一 RS 资源上接收下行参考信号

第二模块：用于接收下行信令获得第一 PVI。

Samsung Exhibit 1003, Page 293 of 438

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

9. 根据权利要求 8 所述的设备，其特征在于，该设备还包括：

第三模块：用于发送｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。

其中，第一模块还用于在第二 RS 资源上接收下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

10. 一种基站设备，其特征在于，该设备包括：

第一模块：用于在第一 RS 资源上发送下行参考信号

第二模块：用于发送下行信令指示第一 PVI。

其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

11. 根据权利要求 10 所述的设备，其特征在于，该设备还包括：

第三模块：用于接收｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。

其中，第一模块还用于在第二 RS 资源上发送下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

Samsung Exhibit 1003, Page 294 of 438

一种 FD-MIMO 传输中的 CSI 反馈方法和装置

技术领域

[0001] 本发明涉及移动通信技术领域中信道信息反馈的方案，特别是涉及采用了FD(Full Dimension，全维度)MIMO(Multiple Input Multiple Output，多输入输出）技术的移动通信系统中的CSI(Channel Status Information，信道状态信息）反馈方案。

背景技术

[0002] 传统的3GPP(3rd Generation Partner Project，第三代合作伙伴项目)LTE(Long Term Evolution，长期演进）系统中，MIMO信道的CSI反馈主要有两种方式

[0003] ●反馈隐式CSI

[0004] UE(User Equipment，用户设备）通过检测CRS(Cell specific Reference Signal，小区特定的参考信号）或者是CSI-RS(CSI Reference Signal，信道状态指示参考信号）得到CIR(Channel Impulse Response，信道冲激响应）并映射为隐式CSI。隐式CSI包括PMI(Precoding Matrix Indicator，预编码矩阵指示)，CQI(Channel Quality Indicator，信道质量指示）等信息。系统侧通过UE反馈的隐式CSI获得MIMO下行信道参数。

[0005] 附图1是一个现有LTE系统中基于正常CP(Cyclic Prefix，循环前缀）的在PRBP(Physical Resource Block Pair，物理资源块）内CSI-RS图案－同时标示出了CRS和DMRS(Demodulation Reference Signal，解调参考信号)，其中一个小方格是LTE的最小资源单位-RE(Resource Element，资源粒子）。斜线标示的RE可以用于发送CSI-RS。LTE系统采用端口的概念定义RS资源：一个RS端口可能由一个天线单元发送，也有可能是多个天线单元通过天线虚拟化技术形成。LTE定义了4种CSI-RS端口数量：1，2，4，8。

[0006] 隐式CSI适用于FDD(Frequency Duplex Division，频分双工）系统和TDD(Time Duplex Division，时分双工）系统。

[0007] ●反馈上行SRS(Sounding Reference Signal，侦听参考信号）

[0008] UE发送上行SRS，系统侧通过解调SRS获得上行信道CSI，再根据链路对称性获得下行CSI。该方法主要适用于TDD系统。

[0009] 3GPP R(Release，版本)12制定了3D(Dimension，维)MIMO信道模型。在RAN(Radio Access Network，无线接入网)#65次会议上，FD-MIMO被批准为3GPP R13的研究课题。FD-MIMO研究最多达到64个物理天线的场景。FD-MIMO所面临的一个挑战是如何确保基站设备准确的获得下行CSI。目前关于Massive MIMO主要的研究是基于TDD系统，即利用SRS和链路对称性是系统侧获得下行CSI。考虑到SRS的局限性（例如FDD很难采用，射频链路的非对称性，SRS导频污染，SRS资源受限等)，隐式CSI在Massive MIMO传输中可能依然扮演重要角色。

[0010] 对于FD-MIMO，如果UE直接反馈针对所有物理天线的CSI，所带来的空口开销在天线数量较多时几乎是不可接受的。针对上述问题，本发明提出了一种FD MIMO系统中的CSI反馈方法和装置。

Samsung Exhibit 1003, Page 295 of 438

发明内容

[0011] 本发明公开了一种UE中的方法，其中，包括如下步骤：

[0012] -步骤A. 在第一RS资源上接收下行参考信号

[0013] -步骤B. 接收下行信令获得第一PVI(Precoding Vector Index，预编码向量索引)

[0014] 其中，第一RS资源包括N个RS端口。第一PVI索引的向量包括M个元素。第一RS资源中的每一个RS端口在目标子帧集合中都是分别由M个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一PVI索引的向量。所述N是大于1的正整数，所述M是大于1的正整数。所述子帧集合包括F个子帧，所述F是正整数。

[0015] 上述方法中，针对每一个RS端口，所述UE收集M个彼此不平行的PVI(即M个PVI对应的向量组成的矩阵是满秩的)之后，能够根据相应M个PVI各自的目标子帧集合中接收到的下行RS信号恢复出M个天线单元组的下行信道信息(只要M个天线单元组在所述UE收集所述M个彼此不平行的PVI期间到RS端口的映射没有变化，并且下行信道信息在此期间是相关的)，因此所述UE能够利用(第一RS资源的)N个RS端口恢复出MN个天线单元组的下行信道信息。此外，上述方法提供了一种机制，即基站能够根据当前小区中UE的统计下行信道信息自适应的调整第一RS资源的天线虚拟化向量以提高UE侧信道估计的精度，或者支持低频度的发送第一RS资源。

[0016] 作为一个实施例，一个所述天线单元组对应一个TXRU(Transceiver Unit，收发器单元)。作为一个实施例，一个所述天线单元组包括1个天线单元。作为一个实施例，所述下行信令是高层信令，所述目标子帧集合是所述下行信令的有效期。作为一个实施立，所述下行信令是用于配置第一RS资源的CSI-RS-Config IE(Information Element，信息单元)。作为一个实施例，所述下行信令是物理层信令。作为一个实施例，所述F为1，所述下行信令是下行调度DCI(Downlink Control Information，下行控制信息)即用于调度下行物理层数据发送的DCI，所述目标子帧集合是所述下行信令的调度子帧。作为一个实施例，所述RS端口在子帧内的图案对应一个CSI-RS端口的图案。作为一个实施例，所述RS端口在子帧内的图案对应一个CRS端口的图案。

[0017] 作为一个实施例，第一PVI指示的向量中第m个元素是$\exp(2\pi(m-1)/M)$，m从1到M。

[0018] 具体的，根据本发明的一个方面，其特征在于，所述步骤A还包括：

[0019] -步骤A1. 在第二RS资源上接收下行参考信号。

[0020] 所述方法还包括：

[0021] -步骤C. 发送{第一PMI，第二PMI，上行RS}中的至少一种以及第一CQI。

[0022] 其中，第二RS资源包括M个RS端口。如果第一PMI存在，第一PMI的参考RS是第一RS资源，第一CQI的计算假定第一PMI被基站采用。如果第二PMI存在，第二PMI的参考RS是第二RS资源，第一CQI的计算假定第二PMI被基站采用。

[0023] 第二PMI的参考RS是第二RS资源是指：第二PMI所指示的CSI参考资源上的PDSCH(Physical Downlink Shared Channel，物理下行共享信道)所采用的发送天线端口分别和第二RS资源的M个RS端口一一对应。所述CSI参考资源的详细描述参考TS36.213。第一PMI的参考RS是第一RS资源的含义同上。

Samsung Exhibit 1003, Page 296 of 438

[0024] 作为一个实施例，第一 RS 资源和第二 RS 资源属于同一个 CSI-RS 子帧集 (CSI subframe set)。作为一个实施例，第一 PMI 和第二 PMI 都是宽带 PMI。作为一个实施例，所述上行 RS 是 SRS。

[0025] 作为一个实施例，第二 RS 资源中的 RS 端口在给定子帧集合中都是由 N 个天线单元组采用天线虚拟化方案生成。

[0026] 具体的，根据本发明的一个方面，其特征在于，所述步骤 B 还包括：

[0027] -步骤 B1. 根据接收的第一 RS 资源上的 K 个所述子帧集合上的下行参考信号以及相应的 K 个 PVI 恢复出每个所述 RS 端口对应的 M 个天线单元组的信道信息。所述 K 是不小于 M 的正整数。

[0028] 作为一个实施例，所述 K 个 PVI 组成的矩阵的秩等于 M。

[0029] 具体的，根据本发明的一个方面，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

[0030] 所述 CSI-RS 配置参考 TS36.211 中的表格 6.10.5.2-1。

[0031] 本发明公开了一种基站中的方法，其中，包括如下步骤：

[0032] -步骤 A. 在第一 RS 资源上发送下行参考信号

[0033] -步骤 B. 发送下行信令指示第一 PVI。

[0034] 其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

[0035] 作为一个实施例，所述下行信令是 RRC(Radio Resource Control，无线资源控制)层信令，所述目标子帧集合是所述下行信令的生效子帧到下一次 RRC 信令的生效子帧的前一子帧。作为一个实施例，所述 F 为 1，所述下行信令是下行调度 DCI，所述目标子帧集合是所述下行信令的调度子帧。作为一个实施例，所述 RS 端口在子帧内的图案对应一个 CSI-RS 端口的图案。作为一个实施例，所述 RS 端口在子帧内的图案对应一个 CRS 端口的图案。

[0036] 具体的，根据本发明的一个方面，其特征在于，所述步骤 A 还包括：

[0037] -步骤 A1. 在第二 RS 资源上发送下行参考信号。

[0038] 所述方法还包括：

[0039] -步骤 C. 接收{第一 PMI，第二 PMI，上行 RS}中的至少一种以及第一 CQI。

[0040] 其中，第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

[0041] 作为一个实施例，第一 RS 资源和第二 RS 资源属于同一个 CSI-RS 子帧集。

[0042] 具体的，根据本发明的一个方面，其特征在于，第一 RS 资源和第二 RS 资源在一个子帧内的图案分别是一组 CSI-RS 配置所对应的 CSI-RS 在一个子帧内的图案。

[0043] 本发明公开了一种用户设备，其特征在于，该设备包括：

[0044] 第一模块：用于在第一 RS 资源上接收下行参考信号

[0045] 第二模块：用于接收下行信令获得第一 PVI

[0046] 其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一

Samsung Exhibit 1003, Page 297 of 438

RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

[0047] 作为一个实施例，上述设备的特征在于，该设备还包括：

[0048] 第三模块：用于发送{第一 PMI，第二 PMI，上行 RS}中的至少一种以及第一 CQI。

[0049] 其中，第一模块还用于在第二 RS 资源上接收下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

[0050] 作为一个实施例，上述设备的特征在于，第二模块还用于根据接收的第一 RS 资源上的 K 个所述子帧集合上的下行参考信号以及相应的 K 个 PVI 恢复出每个所述 RS 端口对应的 M 个天线单元组的信道信息。所述 K 是不小于 M 的正整数。

[0051] 本发明公开了一种基站设备，其特征在于，该设备包括：

[0052] 第一模块：用于在第一 RS 资源上发送下行参考信号

[0053] 第二模块：用于发送下行信令指示第一 PVI

[0054] 其中，第一 RS 资源包括 N 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。

[0055] 作为一个实施例，上述设备的特征在于，该设备还包括：

[0056] 第三模块：用于接收{第一 PMI，第二 PMI，上行 RS}中的至少一种以及第一 CQI。

[0057] 其中，第一模块还用于在第二 RS 资源上发送下行参考信号。第二 RS 资源包括 M 个 RS 端口。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。

[0058] 针对 FD MIMO 系统中测量 RS 以及 UE 所反馈的 CSI 占用过多的空口开销这一问题，本发明公开了一种 CSI-RS 配置和相应的 CSI 反馈的方法和装置。根据本发明的方法，UE 能够利用较少的 RS 端口恢复出较多的天线单元组的下行信道信息。此外，基站能够根据当前小区中 UE 的统计下行信道信息自适应的调整第一 RS 资源的天线虚拟化向量以提高 UE 侧信道估计的精度。本发明的方法使得 UE 利用有限的空口资源有效的测量并反馈 CSI，节省了空口资源的开销。

附图说明

[0059] 通过阅读参照以下附图所作的对非限制性实施例所作的详细描述，本发明的其它特征、目的和优点将会变得更加明显：

[0060] 图 1 示出了现有 LTE 系统的下行 RS 图案的一个示例；

[0061] 图 2 示出了根据本发明的一个实施例的 RS 资源配置以及 CSI 反馈的流程图；

[0062] 图 3 示出了根据本发明的一个实施例的第一 RS 资源和第二 RS 资源在 PRBP 内的图案；

Samsung Exhibit 1003, Page 298 of 438

[0063] 图 4 示出了根据本发明的一个实施例的基站侧的 4X8 垂直极化天线阵到 RS 端口的映射图；

[0064] 图 5 示出了根据本发明的一个实施例的用于 UE 中的处理装置的结构框图；

[0065] 图 6 示出了根据本发明的一个实施例的用于基站中的处理装置的结构框图；

具体实施方式

[0066] 下文将结合附图对本发明的技术方案作进一步详细说明，需要说明的是，在不冲突的情况下，本申请的实施例和子实施例中的特征可以任意相互组合。

[0067] 实施例 1

[0068] 实施例 1 是 RS 资源配置以及 CSI 反馈的流程图，如附图 2 所示。附图 2 中，基站 E1 维持的一个小区是 UE U2 的服务小区。步骤 S210 是可选步骤。

[0069] 对于基站 E1，在步骤 S10 中，在第一 RS 资源和第二 RS 资源上发送下行参考信号；在步骤 S11 中，发送下行信令指示第一 PVI；在步骤 S12 中，接收上行 CSI。

[0070] 对于 UE U2，在步骤 S20 中，在第一 RS 资源和第二 RS 资源上接收下行参考信号；在步骤 S21 中，接收下行信令获得第一 PVI；在步骤 S22 中，发送上行 CSI。

[0071] 实施例 1 中，第一 RS 资源包括 N 个 RS 端口。第二 RS 资源包括 M 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。所述上行 CSI 包括{第一 PMI，第二 PMI，上行 RS}中的至少一种以及第一 CQI。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 也被基站 E1 采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 也被基站 E1 采用。所述上行 RS 是传统的 SRS 或者是扩展 SRS，所述扩展 SRS 是指出现在正常子帧（即非 TDD 特殊子帧）内的非最后一个 SC-FDMA(Single Carrier Frequency Division Multiple Access，单载波频分多址）符号上的 SRS，所述扩展 SRS 的 RS 序列以及在 SC-FDMA 符号内的图案重用传统的 SRS 方案。

[0072] 作为实施例 1 的子实施例 1，UE U2 在步骤 S210 中，根据接收的第一 RS 资源上的最近的 M 个所述子帧集合上的下行参考信号以及相应的 M 个 PVI 恢复出第一 RS 资源上每个 RS 端口对应的 M 个天线单元组的信道信息。其中，所述下行信令是物理层信令，所述 F 为 1。

[0073] 作为实施例 1 的子实施例 2，所述上行 CSI 包括{第一 PMI，上行 RS，第二 PMI，第一 CQI}。

[0074] 作为实施例 1 的子实施例 3，所述上行 CSI 包括{第一 PMI，第二 PMI，第一 CQI}。

[0075] 作为实施例 1 的子实施例 4，所述上行 CSI 包括{第一 PMI，上行 RS，第一 CQI}。

[0076] 实施例 2

[0077] 实施例 2 示例了本发明中的第一 RS 资源和第二 RS 资源在 PRBP 内的图案，如附图 3 所示，其中数字 x 标识的 RE 对应 RS 端口的索引，时域相邻的相同子载波上的两个 RE 采用 OCC(Orthogonal Covering Code，正交覆盖码）。附图 3 中，第一 RS 资源和第二 RS 资源在子帧内分别重用 LTE 中的一个 CSI-RS 配置对应的 CSI-RS- 第一 RS 资源包括 RS 端口 {1,2,

Samsung Exhibit 1003, Page 299 of 438

3,4,5,6,7,8}，第二 RS 资源包括 RS 端口 {9,10,11,12}。所述 RS 端口对应 LTE 中的一个 CSI-RS 端口的时、频、码域资源。

[0078] 实施例 3

[0079] 实施例 3 是基站侧配置的 4X8 垂直极化天线阵到 RS 端口的映射图，如附图 4 所示。附图 4 中，一个小方格表示一个物理天线单元，其中的数字表示该物理天线对应的 RS 端口索引（一根天线单元上有两个数字意味着一根天线单元映射到 2 个 RS 端口 - 发送两个 RS 端口的信号）。

[0080] 如附图 4 所示，同一列的 4 根发送天线采用天线虚拟化的方式映射到同一个 RS 端口（即 4 根发送天线分别发送同一个经过天线虚拟化向量预编码的信号，在接收机侧形成一根虚拟天线）- 对应 RS 端口 {1-8}。 类似的，同一行的 4 根发送天线采用天线虚拟化的方式映射到同一个 RS 端口 - 对应 RS 端口 {9-12}。

[0081] 首先基站在第一 RS 资源和第二 RS 资源上发送下行参考信号到 UE；然后基站发送下行信令给 UE 以第一 PVI；然后 UE 发送上行 CSI 到基站。

[0082] 实施例 3 中，第一 RS 资源包括 RS 端口 {1-8}，第二 RS 资源包括 RS 端口 {9-12}。第一 PVI 索引的向量 $w_{4\times1}$ 是 4 行 1 列。在目标子帧集合中，对于 RS 端口 {1} 是由附图 4 中数字 1 标识的 4 个天线单元采用天线虚拟化方案生成，对应的天线虚拟化向量是 $w_{4\times1}$。对于 RS 端口 {2-8}，也是通过类似的操作生成 - 对应的天线虚拟化向量也是 $w_{4\times1}$。所述子帧集合包括 F 个子帧，所述 F 是正整数。所述上行 CSI 包括 { 第一 PMI，第二 PMI，第一 CQI}。第一 CQI 的计算假定第一 PMI 和第二 PMI 被基站采用。

[0083] 作为实施例 3 的子实施例 1，第一 CQI 的计算采用如下方法：

[0084] - 测量第一 RS 资源的 RS 端口 {1-8} 得到下行信道 $h^1_{r\times8}$ ~ r 行 8 列，测量第二 RS 资源的 RS 端口 {9-12} 得到下行信道 $h^2_{r\times4}$ ~ r 行 4 列，r 是 UE 接收天线数

[0085] - 假定基站使用 RS 端口 {9-12} 在第一 CQI 的 CSI 参考资源上通过预编码的方法发送 PDSCH(Physical Downlink Shared Channel，物理下行共享信道）信号。如果对应的预编码矩阵是第二 PMI 索引的矩阵 $w^2_{4\times1}$，UE 计算 PDSCH 上的预编码信道 $h^2_{r\times4}\cdot w^2_{4\times1}$ 的等效信道容量 C_1；如果对应的预编码矩阵是第一 PVI 索引的向量 $w_{4\times1}$，UE 计算 PDSCH 上的预编码信道 $h^2_{r\times4}\cdot w_{4\times1}$ 的等效信道容量 C_2

[0086] - 假定基站使用 RS 端口 {1-8} 在第一 CQI 的 CSI 参考资源上通过预编码的方法发送 PDSCH(Physical Downlink Shared Channel，物理下行共享信道）信号。对应预编码矩阵是第一 PMI 索引的矩阵 $w^1_{8\times1}$，UE 计算 PDSCH 上的预编码信道 $h^1_{r\times8}\cdot w^1_{8\times1}$ 的等效信道容量 C_3

[0087] - 假定第一 PMI 和第二 PMI 被基站采用，实际等效信道容量是 C_1-C_2+C_3，根据所述实际等效信道容量查表确定第一 CQI

[0088] 上述等效信道容量的计算可以采用 {SINR(Signal Interference Noise Ratio，信干噪比），EESM(Exponential Effective SINR Mapping，指数有效 SINR 映射），RBIR(Received Block mean mutual Information Ratio，块平均互信息率）} 准则中的任

Samsung Exhibit 1003, Page 300 of 438

意一种。

[0089] 作为实施例 3 的子实施例 2，UE 根据接收的第一 RS 资源上的 4 个所述子帧集合上的下行参考信号以及相应的 4 个 PVI（采用矩阵求逆运算）恢复出第一 RS 资源上的每个所述 RS 端口对应的 4 个天线单元的信道信息。所述 4 个 PVI 对应的向量是彼此非平行的。UE 能够获得全部 32 个物理天线单元的下行信道信息 $H_{r\times 32}$-r 行 32 列。第一 CQI 的计算采用如下方法：

[0090] - 根据（基站和 UE 都知道的）预定义的方法，UE 利用第一 PMI 索引的矩阵 $W_{8\times 1}^{1}$ 和第二 PMI 索引的矩阵 $W_{4\times 1}^{2}$ 重构总的预编码矩阵 $W_{32\times b}$，b 是预编码层数

[0091] - 根据预编码信道 $H_{r\times 32}\cdot W_{32\times b}$ 计算等效信道容量，进而查表确定第一 CQI。

[0092] 实施例 4

[0093] 实施例 4 是用于 UE 中的处理装置的结构框图，如附图 5 所示。附图 5 中，UE 装置 300 由接收模块 301，接收模块 302 和发送模块 303 构成。发送模块 303 是可选模块。

[0094] 接收模块 301 用于在第一 RS 资源上接收下行参考信号，接收模块 302 用于接收下行信令获得第一 PVI，发送模块 303 用于发送｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。当发送模块 303 存在时，接收模块 301 还用于在第二 RS 资源上接收下行参考信号

[0095] 实施例 4 中，第一 RS 资源包括 N 个 RS 端口。第二 RS 资源包括 M 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的计算假定第一 PMI 被基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被基站采用。

[0096] 作为实施例 4 的子实施例 1，所述下行信令是 RRC 层信令。

[0097] 作为实施例 4 的子实施例 2，第一 PVI 指示的 RS 资源是由高层信令配置的。

[0098] 实施例 5

[0099] 实施例 5 是用于基站（eNB）中的处理装置的结构框图，如附图 6 所示。附图 6 中，eNB 装置 400 由发送模块 401，发送模块 402 和接收模块 403 构成。接收模块 403 是可选模块。

[0100] 发送模块 401 用于在第一 RS 资源上发送下行参考信号，发送模块 402 用于发送下行信令指示第一 PVI，接收模块 403 用于接收｛第一 PMI，第二 PMI，上行 RS｝中的至少一种以及第一 CQI。当接收模块 403 存在时，发送模块 401 还用于在第二 RS 资源上发送下行参考信号。

[0101] 实施例 5 中，第一 RS 资源包括 N 个 RS 端口。第二 RS 资源包括 M 个 RS 端口。第一 PVI 索引的向量包括 M 个元素。第一 RS 资源中的每一个 RS 端口在目标子帧集合中都是分别由 M 个天线单元组采用天线虚拟化方案生成，对应的天线虚拟化向量是由第一 PVI 索引的向量。所述 N 是大于 1 的正整数，所述 M 是大于 1 的正整数。所述子帧集合包括 F 个子帧，所述 F 是正整数。如果第一 PMI 存在，第一 PMI 的参考 RS 是第一 RS 资源，第一 CQI 的

Samsung Exhibit 1003, Page 301 of 438

计算假定第一 PMI 被所述基站采用。如果第二 PMI 存在，第二 PMI 的参考 RS 是第二 RS 资源，第一 CQI 的计算假定第二 PMI 被所述基站采用。。

[0102] 作为实施例 5 的子实施例 1，所述下行信令是用于调度下行发送的物理层信令，所述 F 为 1。

[0103] 作为实施例 5 的子实施例 2，第一 PVI 指示的 RS 资源是预定义的，即不需要专有信令显示配置。作为所述预定义的一个实施例，第一 PVI 指示的 RS 资源是第一 RS 资源和第二 RS 资源中对应（虚拟化之后）垂直方向天线单元的 RS 资源。

[0104] 本领域普通技术人员可以理解上述方法中的全部或部分步骤可以通过程序来指令相关硬件完成，所述程序可以存储于计算机可读存储介质中，如只读存储器，硬盘或者光盘等。可选的，上述实施例的全部或部分步骤也可以使用一个或者多个集成电路来实现。相应的，上述实施例中的各模块单元，可以采用硬件形式实现，也可以由软件功能模块的形式实现，本申请不限于任何特定形式的软件和硬件的结合。

[0105] 以上所述，仅为本发明的较佳实施例而已，并非用于限定本发明的保护范围。凡在本发明的精神和原则之内，所做的任何修改，等同替换， 改进等，均应包含在本发明的保护范围之内。

Samsung Exhibit 1003, Page 302 of 438

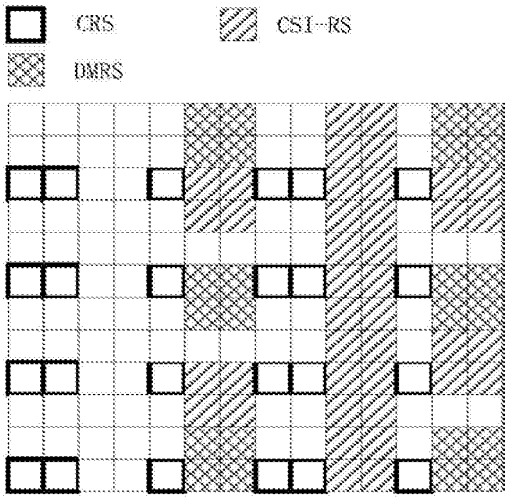


图 1

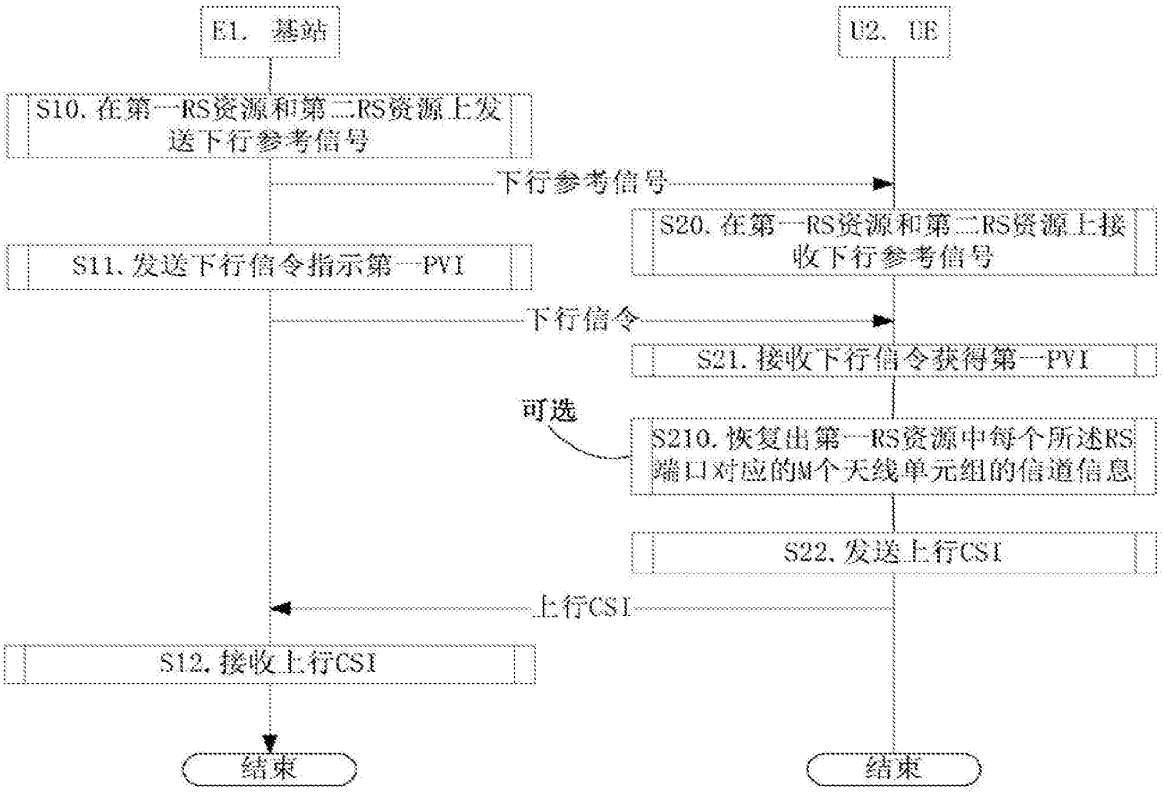


图 2

Samsung Exhibit 1003, Page 303 of 438

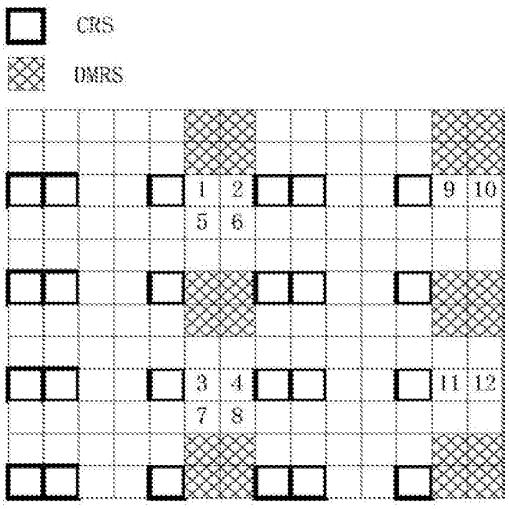


图 3



图 4

Samsung Exhibit 1003, Page 304 of 438

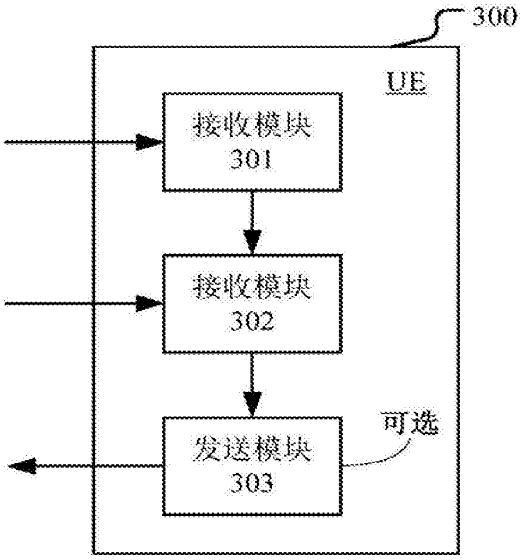


图 5

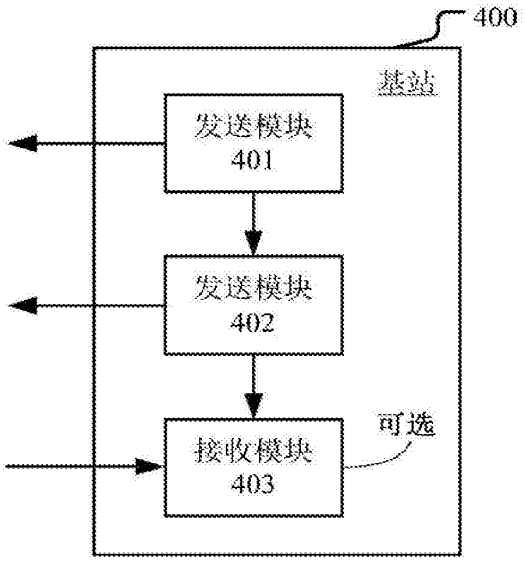


图 6

Samsung Exhibit 1003, Page 305 of 438

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/429,077	06/03/2019	Xiaobo ZHANG	20160089-PCT-US	2560

157297 7590 07/20/2020

Langbo Communication Technology Co. LTD
11422 Turtleback Ln
San Diego, CA 92127

EXAMINER
BELUR, DEEPA

ART UNIT	PAPER NUMBER
2472	

NOTIFICATION DATE	DELIVERY MODE
07/20/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patent@langbomobile.com

Office Action Summary	Application No. 16/429,077	Applicant(s) ZHANG, Xiaobo	
	Examiner DEEPA BELUR	Art Unit 2472	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 6/3/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 6/3/2019 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☑ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

2. This action is in response to the application filed on 6/3/2019.

3. Claims 1-20 have been examined and rejected.

Double Patenting

4. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a

result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

5. Claim 1 together with claim 2 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claim 1 of co-pending Application No. 16/398,207 (reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because claims 1-2 are generic to all that is recited in claim 1 of the reference application. That is, claims 1-2 are anticipated by claim 1 of the reference application.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Firstly, the underlined limitation of claim 1 of the instant application is used to determine first resource pool for both the first antenna vector and the second antenna vector. The underlined limitation of claim 1 of the reference application is used to determine first information of first antenna port set (equivalent to first resource pool for first antenna vector), and the same first resource pool is used to determine a second information (equivalent to first resource pool for second antenna vector).

Secondly the italicized limitations in claim 2 of the instant application map to the italicized limitations in claim 1 of the reference application, with the second signaling is used to determine at least one of occupied frequency domain resources representing the scheduling information of claim 1 of the reference application..

Claim Number	**16429077 (instant application)**	**16/398,207 (reference application)**
1	A method for multi-antenna transmission in a user equipment, comprising: receiving a first radio signal; and receiving a first signaling; wherein the first radio signal is transmitted by K antenna port groups; the antenna port group includes a positive integer number of the antenna port(s); a first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first	A method in a User Equipment (UE) for dynamic scheduling, comprising: receiving first information; receiving second information; and operating a first radio signal; wherein the first information comprises Q field(s), the Q field(s) corresponds(correspond) to Q target receiver(s) respectively, the UE is a target receiver out of the Q target receiver(s); a first field out of the Q field(s) corresponds to the UE, the first field is used to determine a first antenna port set, the first field is one of the Q field(s); the first antenna port set comprises a positive integer number of antenna port(s), the

	time resource pool; at least one first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; the K is a positive integer greater than 1.	second information is transmitted by an antenna port within the first antenna port set; the first information and the second information are both dynamically configured; the Q is a positive integer; *the operating is receiving, or the operating is transmitting; the second information is used to determine scheduling information of the first radio signal, the scheduling information comprises at least one of time-frequency resources occupied, a transmitting antenna port set, a power control parameter, MCS, RV, NDI, or a HARQ Process Number; the transmitting antenna port set comprises a positive integer number of antenna port(s).*
2	The method of claim 1, further comprising: receiving a second signaling; and operating a second radio signal in a first time resource sub-pool; wherein *the operating is receiving, or the operating is transmitting; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and the second*	

	signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.	

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

> (a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 1-20 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventor(s), at the time the application was filed, had possession of the claimed invention.

The specification fails to provide description of the subject matter recited in claims 1, 6, 11, and 16. These claims recite: "… ***the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment or the target receiver… in the first time resource pool***…"; **however, the specification (detailed description) fails to provide description for this limitation.**

Dependent claims 2-5, 7-10, 12-15 and 17-20 are also rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, by virtue of their dependency and for the same reasons stated above.

The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

7. Claims 1-20 rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claims 1 and 11 recite in part: "…***receiving a first radio signal….receiving a first signaling… first radio signal is transmitted by K antenna port groups… the first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool***". It is not clear

whether 1) the UE is receiving or transmitting the first radio signal and a first signaling, since the next limitation says that the first radio signal is transmitted by K antenna port groups; 2) who is the "transmitter of the first signaling in the first time resource pool", and 3) the "K antenna ports" belong to the UE or the base station, making these claims unclear and hence indefinite. The Applicant could change these claims to system claims, and clearly indicate who is transmitting and who is receiving.

Dependent claims 2-5 and 12-15 are also rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, by virtue of their dependency and for the same reasons stated above.

Additionally, claims 2 and 12 recite in part: "…***operating a second radio signal… operating is receiving, or the operating is transmitting***…".It is not clear what the limitation "operating" is for, making these claims unclear and hence indefinite.

Additionally claims 3 and 13 recite in part: "…***the second time resource pool includes a positive integer number of the time resource block(s)***…" The underlined claim limitation is unclear and indefinite.

Additionally claims 4 and 14 recite in part: "…***receiving the first information….or; transmitting the second information***…". It is unclear whether the UE is supposed to receive the first information or transmit the second information, making these claims unclear and hence indefinite.

Claims 6 and 16 recite in part: "…***transmitting a first radio signal…. transmitting a first signaling… first radio signal is transmitted by K antenna port groups… the***

first antenna virtualization vector is an antenna virtualization vector available to a transmitter of the first signaling in the first time resource pool". It is not clear whether 1) the base station is receiving or transmitting the first radio signal and a first signaling, since the next limitation says that the first radio signal is transmitted by K antenna port groups; 2) who is the "transmitter of the first signaling in the first time resource pool", and 3) the "K antenna ports" belong to the UE or the base station, making these claims unclear and hence indefinite. The Applicant could change these claims to system claims, and clearly indicate who is transmitting and who is receiving. Dependent claims 7-10 and 17-20 are also rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, by virtue of their dependency and for the same reasons stated above.

Additionally, claims 7 and 17 recite in part: "…***performing a second radio signal… performing is transmitting, or the performing is receiving***…".It is not clear what the limitation "***performing***" is for, making these claims unclear and hence indefinite.

Additionally claims 8 and 18 recite in part: "…***the second time resource pool includes a positive integer number of the time resource block(s)***…" The underlined claim limitation is unclear and indefinite.

Additionally claims 9 and 19 recite in part: "…***transmitting the first information….or; receiving the second information***…". It is unclear whether the base station is supposed to receive the first information or transmit the second information, making these claims unclear and hence indefinite.

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to DEEPA BELUR whose telephone number is (571)270-3722. The examiner can normally be reached on M-F 8 am - 4:30 pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hassan Kizou can be reached on 571-272-3088. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DEEPA BELUR/
Examiner, Art Unit 2472

Notice of References Cited	Application/Control No. 16/429,077	Applicant(s)/Patent Under Reexamination ZHANG, Xiaobo	
	Examiner DEEPA BELUR	Art Unit 2472	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20180269949-A1	09-2018	KIM; Hyungtae	H04L5/005	1/1
*	B	US-20170195100-A1	07-2017	KIM; Kijun	H04L5/0053	1/1
*	C	US-20190191396-A1	06-2019	Sun; Yanliang	H04W72/04	1/1
*	D	US-20120008577-A1	01-2012	Han; Seung Hee	H04B7/0686	370/329
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

CPC - Searched*		
Symbol	Date	Examiner
H04L5/005.cpc.	07/13/2020	DB
H04B7/0408.cpc.	07/13/2020	DB

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
H04L5/005.cpc. in combination with text search, see search history printout	07/13/2020	DB
H04B7/0408.cpc. in combination with text search, see search history printout	07/13/2020	DB
Inventor and Assignee search in EAST - see search history printout	07/14/2020	DB

/D.B/ Examiner, Art Unit 2472	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/D.B/ Examiner, Art Unit 2472	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	**Art Unit**
	DEEPA BELUR	2472

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant						☐ CPA		☐ T.D.		☐ R.1.47
CLAIM		**DATE**								
Final	Original	07/15/2020								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

/D.B./ /D.B./ /D.B./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	307	((("ZHANG") near3 ("Xiaobo"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2020/07/13 08:50
S3	17,744	H04L5/005.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/13 08:53
S4	236	H04L5/005.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/13 12:24
S5	114	H04B7/0408.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/13 12:25
S6	52	H04B7/0408.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/13 13:01
S12	3	("20160094326").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/13 13:19
S13	148	((("ZHANG") near3 ("Xiaobo"))).INV. and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2020/07/13 13:21
S14	112	((antenna port$1) near2 (group$1)(reference near2 signal near2 group$1)) same (resource with pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2020/07/14 09:13

			DERWENT; IBM_TDB			
S15	112	((antenna port$1) near2 (group$1)(reference near2 signal near2 group$1)) same (resource with pool$1 sub$1pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:14
S16	110	((antenna port$1) near2 (group$1)) same (resource with pool$1 sub$1pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:14
S17	83	((antenna array layer) near2 (group$1)) same (resource with pool$1 sub$1pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:16
S18	63	((antenna array) near2 (group$1)) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:17
S19	90	((antenna array) near2 (group$1) MU$1MIMO) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:18
S20	164	(SHANGHAI near2 LANGBO near2 COMMUNICATION near2 TECHNOLOGY near2 COMPANY near2 LIMITED).as,aanm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:42
S21	56	S19 and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:42
S22	32	((antenna array) near3 (virtual$7) near3 (vector) MU$1MIMO) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2020/07/14 09:46

			DERWENT; IBM_TDB			
S23	4	("20110222485" | "20160212735").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 09:51
S24	104	((antenna array) near3 (virtual$7) near3 (vector)) same (resource$1 symbol$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 10:17
S25	89	((antenna array) near3 (virtual$7) near3 (vector)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 10:17
S26	208	((antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 17:22
S27	169	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 17:23
S28	169	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1 (resource) near2 (block$1 element$1 pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 17:25
S29	5	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (first) near2 (resource$1 symbol$1 (resource) near2 (block$1 element$1 pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/14 18:03
S30	5	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2020/07/14 18:04

		PVI)) same (first) near2 (resource$1 symbol$1 (resource) near2 (pool$1 sub$1pool$1)) and (@ad < "20161203")	EPO; JPO; DERWENT; IBM_TDB			
S31	10	(first "same") with (resource near3 pool) same (UE with antenna) same (base near2 station with antenna)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/15 08:44
S32	5	(first "same") with (virtual) with (resource near3 pool) same (UE) same (base near2 station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/15 08:44
S33	13	(resource near3 pool) same (UE with antenna) same (base near2 station with antenna)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/15 08:56
S34	17	((resource) near3 (pool group$1 set$1 sub$1set$1)) same (UE with (multi$1antenna massive near2 mimo)) same (base near2 station with (multi$1antenna massive near2 mimo))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/15 09:00
S35	6	"20140098761"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/15 10:05

7/15/2020 1:41:08 PM
C:\Users\dbelur\Documents\EAST\Workspaces\16429077\16429077.wsp

Bibliographic Data

Application No: 16/429,077

Foreign Priority claimed: ◉ Yes ○ No

35 USC 119 (a-d) conditions met: ☑ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /DEEPA BELUR/ (Examiner's Signature) | (Initials)

Title: Method and Device for Multi-Antenna Transmission in UE and Base Station

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/03/2019	370	2472	20160089-PCT-US
RULE			

APPLICANTS

INVENTORS

Xiaobo ZHANG, Shanghai, CHINA

CONTINUING DATA

This application is a CON of PCT/CN2017/112033 11/21/2017

FOREIGN APPLICATIONS

CHINA 201611098328.7 12/03/2016

IF REQUIRED, FOREIGN LICENSE GRANTED**

06/10/2019

**** SMALL ENTITY ****

STATE OR COUNTRY

CHINA

ADDRESS

Langbo Communication Technology Co. LTD
11422 Turtleback Ln
San Diego, CA 92127
UNITED STATES

FILING FEE RECEIVED

$1,015

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16429077
Filing Date	2019-06-03
First Named Inventor	XiaoBo ZHANG
Art Unit	2464
Examiner Name	NGO, RICKY QUOC
Attorney Docket Number	20160089-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20160094326	A1	2016-03-31	KOREA ELECTRONICS TELECOMM	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	105577318	CN	A	2016-05-11	LONGBO COMMUNICATION TECHNICAL CO., LTD	English Abstract	☒
	2	103687010	CN	A	2014-03-26	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY	English Abstract	☒
	3	2016018100	WO	A1	2016-02-04	LG ELECTRONICS INC		☐

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	XiaoBo ZHANG
	Art Unit	2464
	Examiner Name	NGO, RICKY QUOC
	Attorney Docket Number	20160089-PCT-US

If you wish to add additional Foreign Patent Document citation information please click the Add button [Add]

NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ISR received in application no. PCT/CN2017/112033 dated February 7, 2018	
	2	RS design enhancements for supporting EB and FD-MIMO, LG Electronics, 3GPP TSG RAN WG1 Meeting #78bis , R1-144047, October 5, 2014	

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/DEEPA BELUR/ (07/10/2020)	Date Considered	07/10/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	XiaoBo ZHANG
	Art Unit	2464
	Examiner Name	NGO, RICKY QUOC
	Attorney Docket Number	20160089-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/XiaoBo ZHANG/	Date (YYYY-MM-DD)	2019-08-19
Name/Print	XiaoBo ZHANG	Registration Number	

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number	16/429,077		
Filing Date	June 3, 2019		
First Named Inventor	Xiaobo Zhang		
Title	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION		
Art Unit	2472		
Examiner Name	Deepa Belur		
Attorney Docket Number	S3876.10063US01		
SIGNATURE of Applicant or Patent Practitioner			
Signature	/R. Burns Israelsen/	**Date**	September 30, 2020
Name	R. Burns Israelsen	**Telephone**	(435) 252-1360
Registration Number	42685		

MASCHOFF BRENNAN, PLLC
1389 Center Drive, SUITE 300
PARK CITY, UTAH 84098, USA

POWER OF ATTORNEY BY APPLICANT

[Assignee, Legal Representative or Person with Proprietary Interest]

I hereby revoke all previous powers of attorney given in the application identified in the attached Transmittal for Power of Attorney form.

■ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter:

97149

Please recognize or change the correspondence address for the above-identified patent to:

■ The address associated with the above-mentioned Customer Number.

I am the Applicant:

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor

☐ Person Who Otherwise Shows Sufficient *Proprietary* Interest (*e.g.*, a petition under 37 CFR 1.46 (b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

The individual whose signature and title is supplied below is authorized to act on behalf of the Applicant

Signature	Xiaobo ZHANG	Date	January 23, 2019
Name	Xiaobo ZHANG	Telephone	
Company	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED	Title	CTO

NOTE: Signature - This form must be signed by the applicant or applicant's representative in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below*.

*Total of forms are submitted.

MASCHOFF BRENNAN, PLLC
1389 Center Drive, SUITE 300
PARK CITY, UTAH 84098, USA

Doc Code: R46C.REQ
Document Description: Request under 37 CFR 1.46(c) to correct, update or change the applicant.

PTO/AIA/41 (04-15)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

REQUEST TO CORRECT OR UPDATE THE NAME OF THE APPLICANT UNDER 37 CFR 1.46(c)(1), OR CHANGE THE APPLICANT UNDER 37 CFR 1.46(c)(2)

(FOR USE ONLY IN APPLICATIONS FILED ON OR AFTER SEPTEMBER 16, 2012)

Application Number	16/429,077
Filing Date	June 3, 2019
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	Deepa Belur
Practitioner Docket Number	S3876.10063US01

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant hereby **requests that the name of the applicant be corrected or updated under 37 CFR 1.46(c)(1), or that the applicant be changed under 37 CFR 1.46(c)(2),** in the above-identified application. **Requests under 37 CFR 1.46(c)(1) or (c)(2) cannot be submitted after payment of the issue fee or if the application has been patented.**

Please check the applicable box(es) below.

☐ 1. This request is to **correct or update the name of the applicant** (**under 37 CFR 1.46(c)(1)**) and includes:

☐ An application data sheet (ADS) in accordance with 37 CFR 1.76(c) with the corrected or updated information shown with markings (*e.g.*, underlining for insertions, strikethrough for deletions). A Corrected Web-based ADS may be used.

Note: Requests under 37 CFR 1.46(c)(1) may be filed to correct typographical errors in the name of the § 1.46 applicant, or for updating the name of the § 1.46 applicant (*i.e.*, where there is no change in the applicant itself but just in the applicant's name). See the Manual of Patent Examining Procedure (MPEP) section 605.01.

☒ 2. This request is to **change the applicant** (**under 37 CFR 1.46(c)(2)**) and includes:

☒ An application data sheet (ADS) in accordance with 37 CFR 1.76(c) that identifies the changes with proper markings (underlining for insertions and strikethrough for deletions). A Corrected Web-based ADS may be used.

☒ A Statement Under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent). See MPEP 325.

I am the

☐ applicant* ☒ attorney or agent of record Registration number 42685 ☐ attorney or agent acting under 37 CFR 1.34 Registration number _____

Signature /R. Burns Israelsen/

Typed or printed name R. Burns Israelsen

Date September 30, 2020

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. *Juristic entities must be represented by a patent practitioner (See 37 CFR 1.31, applicable to any paper filed on or after September 16, 2012 that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below**.

☐ ** Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.36. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xiaobo		ZHANG	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Shanghai	Country of Residence i	CN

Mailing Address of Inventor:

Address 1	Room 210, 2nd Floor, No. 2088, Xietu Road		
Address 2	Xuhui District		
City	Shanghai	**State/Province**	OT
Postal Code	200032	**Country** i	CN

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	~~157297~~ 97149		
Email Address	docket@mabr.com	Add Email	Remove Email

Application Information:

Title of the Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station		
Attorney Docket Number	20160089-PCT-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	15	**Suggested Figure for Publication (if any)**	12

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	~~157297~~ 97149		

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					
Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/CN2017/112033	2017-11-21

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country	Filing Date (YYYY-MM-DD)	Access Code (if applicable)
201611098328.7	CN	2016-12-03	0727

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED		
Mailing Address Information For Applicant:			
Address 1	Room 210, 2nd Floor, No. 2088, Xietu Road		
Address 2	Xuhui District		
City	Shanghai	**State/Province**	
Country	CN	Postal Code	200032
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	Shanghai Langbo Communication Technology Company Limited

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	Room 210, 2nd Floor, No. 2088, Xietu Road		
Address 2	Xuhui District		
City	Shanghai	**State/Province**	~~OT~~
Country i	CN	Postal Code	200032
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e. g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	~~/Xiaobo ZHANG/~~ /R. Burns Israelsen/			Date (YYYY-MM-DD)	2020-09-30
First Name	~~Xiaobo~~ R. Burns	Last Name	~~ZHANG~~ Israelsen	Registration Number	42685

Additional Signature may be generated within this form by selecting the Add button.

Electronic Acknowledgement Receipt

EFS ID:	40723762
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	157297
Filer:	Robert Burns Israelsen/Vanessa Mangum
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	20160089-PCT-US
Receipt Date:	30-SEP-2020
Filing Date:	03-JUN-2019
Time Stamp:	16:23:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Assignee showing of ownership per 37 CFR 3.73	S3876-10063US01_373.pdf	118033 757e4ddb13322cdfb455b7994d63e8c73f29afb1	no	3

Warnings:

Information:					
2	Power of Attorney	S3876-10063US01_POA.pdf	1201773 6ff62972a4cbb45af4f6df025b81353ece5dd219	no	2
Warnings:					
Information:					
3	Request for Corrected Filing Receipt	S3876-10063US01_Req_Change_Applicant.pdf	391081 569385715f45dc8ec517e845e495c614014f6d73	no	2
Warnings:					
Information:					
4	Application Data Sheet	S3876-10063US01_Supp_ADS.pdf	596253 e94bcc6fe96ac0b7c2d0f20366153dade49b44ac	no	7
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
			Total Files Size (in bytes):	2307140	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Xiaobo ZHANG

Application No./Patent No.: 16/429,077 Filed/Issue Date: June 3, 2019

Titled: Method and Device for Multi-Antenna Transmission in UE and Base Station

SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 049341, Frame 0156, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/R. Burns Israelsen/	September 30, 2020
Signature	Date
R. Burns Israelsen	42685
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/429,077	06/03/2019	Xiaobo ZHANG	S3876.10063US01

CONFIRMATION NO. 2560

97149
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

POA ACCEPTANCE LETTER

OC000000120347839

Date Mailed: 10/02/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 09/30/2020.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ggasgedom/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/429,077	06/03/2019	2472	1015	S3876.10063US01	20	4

CONFIRMATION NO. 2560

CORRECTED FILING RECEIPT

97149
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

OC000000120347852

Date Mailed: 10/02/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Xiaobo ZHANG, Shanghai, CHINA;

Applicant(s)

SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, Shanghai, CHINA;

Assignment For Published Patent Application

Shanghai Langbo Communication Technology Company Limited, Shanghai, CHINA

Power of Attorney: The patent practitioners associated with Customer Number 97149

Domestic Priority data as claimed by applicant

This application is a CON of PCT/CN2017/112033 11/21/2017

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
CHINA 201611098328.7 12/03/2016 Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to Retrieve Electronic Priority Application(s)** (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 06/10/2019
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/429,077**
Projected Publication Date: Not Applicable
Non-Publication Request: No
Early Publication Request: No
**** SMALL ENTITY ****
Title

Method and Device for Multi-Antenna Transmission in UE and Base Station

Preliminary Class

370

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative,

this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo ZHANG	
Application No.:	16/429,077	Art Unit 2472
Filed:	June 3, 2019	
Conf. No.:	2560	
For:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION	
Examiner:	Deepa Belur	
Customer No.:	97149	
Attorney Docket No.:	S3876.10063US01 (20160089-PCT-US)	

AMENDMENT AND RESPONSE TO NON-FINAL OFFICE ACTION DATED JULY 20, 2020

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Non-Final Office Action dated July 20, 2020, please consider the following:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 9 of this paper.

Electronic Acknowledgement Receipt

EFS ID:	40844465
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Brian Lance Jensen/Debbie Evans
Filer Authorized By:	Brian Lance Jensen
Attorney Docket Number:	S3876.10063US01
Receipt Date:	14-OCT-2020
Filing Date:	03-JUN-2019
Time Stamp:	17:28:39
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		S387610063US01_Response_101420.pdf	84081 b69dd9e1e32b7fe2d56fc7666002ab36c8da1899	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	9	11
	Claims	2	8
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	84081	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

REMARKS

Applicants respectfully request reconsideration of the application in view of the above amendments to the claims and the following remarks. Unless otherwise stated herein, amendments to the claims have been made at the discretion of the Applicants and not necessarily for reasons related to patentability.

Applicants reserve the right to pursue any previously pending claims or other claims that capture any subject matter supported by the present disclosure. Additionally, Applicants reserve the right, both during and after prosecution of this case, to modify or revoke the views expressed with regard to any cited reference.

The following remarks are not intended to exhaustively identify all distinctions between any cited reference and the claims. The term "Applicants" is used herein to refer to any entity with authority to prosecute this application.

Obviousness Type Double Patenting Rejections

The Office Action rejects claims 1 and 2 under the judicially created doctrine of obviousness-type double patenting in view of Application Serial No. 16/398,207. Applicants submit herewith a terminal disclaimer relative to Application Serial No. 16/398,207, rendering the rejections moot. Applicants therefore respectfully request that Examiner withdraw the obviousness-type double patenting rejections of claims 1 and 2.

Rejections Under 35 U.S.C. § 112(a)

The Office Action rejects claims 1-20 under 35 U.S.C. § 112(a) as failing to comply with the written description requirement. In particular, the Office Action contends that the specification fails to provide a description for the limitation of "the first antenna virtualization vector is an antenna virtualization vector available a transmitter of the first signaling in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the target receiver [or user equipment] of the first signaling in the first time resource pool."

Applicants respectfully traverse these rejections for at least the reason that the specification, including the drawings, the detailed description, and the original claims provide adequate written description. First, Applicants have amended claims 1, 6, 11, and 16 to provide better clarification as to which devices are at play in this limitation. Further, Applicants

respectfully submit that the specification provides ample discussion in paragraphs [0021], [0047], and [0073] – [0085] regarding what antenna virtualization vectors entail, how they are generally used, and how they may be specifically used by a base station and a user equipment. Further, one having ordinary skill in the art of wireless and cellular communication understands that different time slots (also referred to commonly as "time resources") are grouped together into "pools" and selected for certain transmissions. Therefore, the specification provides more than sufficient description as to the meaning of the above-recited claim elements to indicate possession of the claimed invention. Because the specification adequately supports claims 1-20, Applicants respectfully request that the Examiner withdraw the rejections of claims 1-20 under 35 U.S.C. § 112(a).

Rejections Under 35 U.S.C. § 112(b)

The Office Action rejects claims 1-4, 6-9, 11-14, and 16-19 as being indefinite under 35 U.S.C. § 112(b). Applicants respectfully submit that the amendments to the claims render these rejections moot.

Further, with respect to the rejections of claims 3, 7, 13, and 17 regarding the second time resource pool including a positive integer number of time resource blocks, Applicants note that such a limitation is used to indicate that the number of time resource blocks in the second time resource pool is a positive integer. Removal of the word "the" helps clarify this meaning.

In addition, with respect to the rejections of claims 4 and 14 and claims 9 and 19 regarding the use of "or", Applicants note that such a use does not make such claims indefinite. The use of "or" merely indicates that if either the transmitting or the receiving is performed, the claim limitation is satisfied. In other words, it merely indicates that both do not have to be performed, but one or the other, in order to infringe the claim. This is not indefinite but merely broad.

For at least the reasons discussed above, Applicants respectfully submit that the claims are not indefinite. Applicants therefore respectfully request that the Examiner withdraw the rejections of claims 1-20 under 35 U.S.C. § 112(b).

Charge Authorization

The Commissioner is hereby authorized to charge payment of any of the following fees that may be applicable to this communication, or credit any overpayment, to Deposit Account No.

50-5394: (1) any filing fees required under 37 C.F.R. § 1.16; (2) any patent application and reexamination processing fees under 37 C.F.R. § 1.17; and/or (3) any post issuance fees under 37 C.F.R. § 1.20. In addition, if any additional extension of time is required, which has not otherwise been requested, please consider this a petition therefor and charge any additional fees that may be required to Deposit Account No. 50-5394.

CONCLUSION

In view of the foregoing, Applicants submit that the pending claims are allowable. In the event that Examiner finds remaining impediment to a prompt allowance of this application that may be clarified through a telephone interview or overcome by an Examiner's Amendment, Examiner is requested to contact the undersigned attorney.

Dated this 14th day of October, 2020.

Respectfully submitted,

/B. Lance Jensen/

B. Lance Jensen
Registration No. 68,022
Attorney for Applicants
Customer No. 97149
Telephone No. (435) 252-1360
Maschoff Brennan

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions and listings of claims in the application:

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

receiving a first radio signal from a base station; and

receiving a first signaling from the base station;

wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of [[the]] antenna port(s); a first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to the base station ~~a transmitter of the first signaling~~ in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and the K is a positive integer greater than 1.

2. (Currently Amended) The method of claim 1, further comprising:

receiving a second signaling; and

operating a second radio signal in a first time resource sub-pool;

wherein the operating is receiving from the base station, or the operating is transmitting to the base station; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.

3. (Currently Amended) The method of claim 2, comprising;

monitoring the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the

second time resource pool includes a positive integer number of [[the]] time resource block(s); or[[,]]

monitoring the second signaling in a second time resource pool and monitoring the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of [[the]] time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of [[the]] time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

4. (Currently Amended) The method of claim 1, further comprising:

receiving first information, wherein the first information is used to determine the first antenna port group; or[[,]]

transmitting second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

5. (Original) The method of claim 1, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

6. (Currently Amended) A method for multi-antenna transmitting in a base station, comprising:

transmitting a first radio signal <u>to a target receiver</u>; and

transmitting a first signaling <u>to the target receiver</u>;

wherein the first radio signal is transmitted by K antenna port groups <u>of the base station</u>; the antenna port group includes a positive integer number of [[the]] antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one of a first antenna virtualization vector and a second antenna

virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to the base station ~~a transmitter of the first signaling~~ in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to [[a]] the target receiver of the first signaling in the first time resource pool; and the K is a positive integer greater than 1.

7. (Currently Amended) The method of claim 6, further comprising:

transmitting a second signaling; and

performing a second radio signal in a first time resource sub-pool;

wherein the performing is transmitting to the target receiver, or the performing is receiving from the target receiver; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.

8. (Currently Amended) The method of claim 7, comprising:

transmitting the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of [[the]] time resource block(s); or[[,]]

transmitting the second signaling in a second time resource pool and transmitting the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of [[the]] time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of [[the]] time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

9. (Currently Amended) The method of claim 6, further comprising:

transmitting first information, wherein the first information is used to determine the first antenna port group; or[[,]]

receiving second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

10. (Original) The method of claim 6, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

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

a first transceiver, receiving a first radio signal from a base station; and

a second receiver, receiving a first signaling from the base station;

wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of [[the]] antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to the base station ~~a transmitter of the first signaling~~ in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and the K is a positive integer greater than 1.

12. (Currently Amended) The UE of claim 11, comprising:

a third receiver, receiving a second signaling; and

a second transceiver, operating a second radio signal in a first time resource sub-pool;

wherein the operating is receiving from the base station, or the operating is transmitting to the base station; the second signaling is used to determine the first time resource sub-pool from

the first time resource pool; and the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.

13. (Currently Amended) The UE of claim 12, the third receiver further monitors the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of [[the]] time resource block(s); or[[,]]

the third receiver further monitors the second signaling in a second time resource pool, and the second receiver further monitors the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of [[the]] time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of [[the]] time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

14. (Currently Amended) The UE of claim 11, wherein:

the second receiver further receives first information, wherein the first information is used to determine the first antenna port group; or

the first transceiver further transmits second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

15. (Original) The UE of claim 11, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

16. (Currently Amended) A base station equipment for multi-antenna transmission, comprising:

a third transceiver, transmitting a first radio signal to a target receiver; and

a second transmitter, transmitting a first signaling to the target receiver;

wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of [[the]] antenna port(s); the first antenna port group is one of the K antenna port groups; the first signaling is used to determine a first time resource pool; at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to the base station ~~a transmitter of the first signaling~~ in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to [[a]] the target receiver of the first signaling in the first time resource pool; and the K is a positive integer greater than 1.

17. (Original) The base station equipment of claim 16, further comprising:

a third transmitter, transmitting a second signaling; and

a fourth transceiver, performing a second radio signal in a first time resource sub-pool;

wherein the performing is transmitting, or the performing is receiving; the second signaling is used to determine the first time resource sub-pool from the first time resource pool; the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.

18. (Currently Amended) The base station equipment of claim 17, wherein:

the third transmitter further transmits the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of [[the]] time resource block(s); or

the third transmitter further transmits the second signaling in a second time resource pool, and the second transmitter further transmits the first signaling in a third time resource pool, wherein

the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of [[the]] time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of [[the]] time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.

19. (Currently Amended) The base station equipment of claim 16, wherein:

the second transmitter further transmits first information, wherein the first information is used to determine the first antenna port group; or

the third transceiver further receives second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.

20. (Original) The base station equipment of claim 16, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/25 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION**
Application Number	16429077
Filing Date	03-Jun-2019
First Named Inventor	Xiaobo ZHANG
Attorney Docket Number	S3876.10063US01
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED	100%

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

16398207 filed on 04/29/2019

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.	
Applicant claims the following fee status: ◉ Small Entity ○ Micro Entity ○ Regular Undiscounted I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application Registration Number 68022 ○ A sole inventor ○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ○ A joint inventor; all of whom are signing this request	
Signature	/B. Lance Jensen/
Name	B. Lance Jensen

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16429077
Filing Date:	03-Jun-2019
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Filer:	Brian Lance Jensen/Debbie Evans
Attorney Docket Number:	S3876.10063US01

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	2814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**170**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16429077

Filing Date: 03-Jun-2019

Applicant/Patent under Reexamination: ZHANG

Electronic Terminal Disclaimer filed on October 14, 2020

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt	
EFS ID:	40844355
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Brian Lance Jensen/Debbie Evans
Filer Authorized By:	Brian Lance Jensen
Attorney Docket Number:	S3876.10063US01
Receipt Date:	14-OCT-2020
Filing Date:	03-JUN-2019
Time Stamp:	17:30:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$170
RAM confirmation Number	E20200DH30327094
Deposit Account	505394
Authorized User	Debbie Evans
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	34070 2e9f8d30b85fc6ef8e80909d83d41dc7ae46e6c4	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30543 e12af37b0f692d78a62e20777ae0216a40c8b64c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	64613		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

97149 7590 11/17/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

EXAMINER
BELUR, DEEPA

ART UNIT	PAPER NUMBER
2472	

DATE MAILED: 11/17/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/429,077	06/03/2019	Xiaobo ZHANG	S3876.10063US01	2560

TITLE OF INVENTION: METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/17/2021

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

97149 7590 11/17/2020
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/429,077	06/03/2019	Xiaobo ZHANG	S3876.10063US01	2560

TITLE OF INVENTION: METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/17/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
BELUR, DEEPA	2472	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1_____
2_____
3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/429,077	06/03/2019	Xiaobo ZHANG	S3876.10063US01	2560

97149 7590 11/17/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

EXAMINER	
BELUR, DEEPA	
ART UNIT	PAPER NUMBER
2472	

DATE MAILED: 11/17/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/429,077	Applicant(s) ZHANG, Xiaobo	
	Examiner DEEPA BELUR	Art Unit 2472	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to TD and Applicant arguments filed on 10/14/2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-20 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/DEEPA BELUR/
Examiner, Art Unit 2472

Examiners Comment

1. The double patenting rejection has been withdrawn, since a Terminal Disclaimer has been filed and approved on 10/14/2020.

2. The 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph rejection has been withdrawn, based on Applicant arguments.

3. The 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph rejection has been withdrawn, based on claim amendments.

Reason for Allowance

4. The following underlined claim limitation is not disclosed by any prior art:

"...A method for multi-antenna transmission in a user equipment, comprising:

receiving a first radio signal from a base station; and

receiving a first signaling from the base station;

wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of antenna port(s);

a first antenna port group is one of the K antenna port groups;

the first signaling is used to determine a first time resource pool;

at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;

the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and the K is a positive integer greater than 1."

5. Closest prior art:

Kim (US20170195100A1) discloses at paragraphs 113 and FIG. 9, the FDM (frequency division multiplexing)+TDM (time division multiplexing) scheme may

group antenna ports of reference signals (RSs) transmitted to the same OFDM symbol, and may group physical antenna elements, such that the respective antenna ports contained in the antenna port group can transmit signals through the plurality of antenna elements of different antenna element groups… further at paragraphs 119-120: the antenna port may be referred to as a virtual antenna, and the antenna element may be referred to as a physical antenna. The method for mapping each logical antenna port to the physical antenna element is of importance to the entire MIMO system design. As the antenna mapping scheme, not only the one-to-one mapping scheme in which a single antenna port is mapped to a single antenna element, but also the one-to-multiple mapping scheme in which a single antenna port is mapped to a plurality of antenna ports may be considered. The mapping from the antenna port to the antenna element may be denoted by a virtualization matrix (B)… x may be a transmission signal at the antenna port, and z may be a Tx signal at the antenna element. Whereas the number of antenna ports may be less than the number of antenna elements, the number of antenna ports may be denoted by Nt. bn is a virtualization vector for indicating the relationship in which the n-th antenna port is mapped to the antenna elements...

However, Kim does not disclose: ***"…*** ***the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool…"***

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to DEEPA BELUR whose telephone number is (571)270-3722. The examiner can normally be reached on M-F 8 am - 4:30 pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hassan Kizou can be reached on 571-272-3088. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DEEPA BELUR/
Examiner, Art Unit 2472

Notice of References Cited	Application/Control No. 16/429,077	Applicant(s)/Patent Under Reexamination ZHANG, Xiaobo	
	Examiner DEEPA BELUR	Art Unit 2472	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20170195100-A1	07-2017	KIM; Kijun	H04L5/0053	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	**Art Unit**
	DEEPA BELUR	2472

CPC						
Symbol					**Type**	**Version**
H04L	/	5	/	005	F	2013-01-01
H04B	/	7	/	0413	I	2013-01-01
H04B	/	7	/	0617	I	2013-01-01
H04L	/	1	/	0003	I	2013-01-01
H04L	/	1	/	1819	I	2013-01-01
H04L	/	5	/	0082	I	2013-01-01
H04W	/	88	/	02	I	2013-01-01
H04B	/	7	/	06	I	2013-01-01
H04B	/	7	/	0408	I	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

None		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/DEEPA BELUR/ Examiner, Art Unit 2472	01 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9

U.S. Patent and Trademark Office — Part of Paper No.: 20201101

Samsung Exhibit 1003, Page 383 of 438

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	**Art Unit**
	DEEPA BELUR	2472

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04L	/	5	/	00

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

None		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/DEEPA BELUR/ Examiner, Art Unit 2472	01 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9

U.S. Patent and Trademark Office — Part of Paper No.: 20201101

Samsung Exhibit 1003, Page 384 of 438

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	**Art Unit**
	DEEPA BELUR	2472

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19										
	2		11		20										
	3		12												
	4		13												
	5		14												
	6		15												
	7		16												
	8		17												
	9		18												

None		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/DEEPA BELUR/ Examiner, Art Unit 2472	01 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9

U.S. Patent and Trademark Office — Part of Paper No.: 20201101

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

CPC - Searched*		
Symbol	Date	Examiner
H04L5/005.cpc.	07/13/2020	DB
H04B7/0408.cpc.	07/13/2020	DB

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
H04L5/005.cpc. in combination with text search, see search history printout	07/13/2020	DB
H04B7/0408.cpc. in combination with text search, see search history printout	07/13/2020	DB
Inventor and Assignee search in EAST - see search history printout	07/14/2020	DB
Search updated	11/02/2020	DB
searched IP.COM and google scholar	11/02/2020	DB

/D.B/ Examiner, Art Unit 2472	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/429,077	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	see Interference_SearchHistory.Printout.pdf	11/02/2020	DB

/D.B/ Examiner, Art Unit 2472	

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16429077
Filing Date	2019-06-03
First Named Inventor	Xiaobo,ZHANG
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	20160089-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110223876	A	2011-09-15	Samsung Electronics Co Ltd	
	2	20150010106	A	2015-01-08	NOKIA SOLUTIONS AND NETWORKS OY	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	105577318	CN	X	2016-05-11	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY CO.LTD	Abstract and drawing sheets of the patent specification, paragraphs 58、67-97 of the specification,	X
	2	101567865	CN	A	2009-10-28	DINGQIAO COMMUNICATION TECHNOLOGY CO.LTD		☐

EFS Web 2.1.18

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	Xiaobo,ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	20160089-PCT-US

If you wish to add additional Foreign Patent Document citation information please click the Add button [Add]

NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	CN Search Report in application No.201611098328.7 dated December 26, 2019	X
	2	CN First Office Action in Application No.201611098328.7 dated January 06, 2020	☒
	3	CN Grant Notice in Application No.201611098328.7 dated April 21, 2020	☒
	4	《3GPP TSG-RAN Working Group 1 Meeting #56bis R1-091591》 Nortel Discussion on RS Design for Higher-order MIMO in LTE-A	☐
	5	《3GPP TSG-RAN WG1#79 R1-145169》 Ericsson Phasee 2 modeling of 2D Antenna Arrays	☐
	6	《3GPP TSG RAN WG1 61bis R1-103705》 Texas Instruments Remaining Issues on ULMIMO Transmission Mode and DCI Format Design	☐

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/DEEPA BELUR/ (11/01/2020)	Date Considered	11/01/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16429077
	Filing Date	2019-06-03
	First Named Inventor	Xiaobo,ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	20160089-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	Xiaobo ZHANG	Date (YYYY-MM-DD)	2020-07-16
Name/Print	/Xiaobo ZHANG/	Registration Number	

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

Bibliographic Data

Application No: 16/429,077

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /DEEPA BELUR/ Examiner's Signature [ ] Initials

Title: Method and Device for Multi-Antenna Transmission in UE and Base Station

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/03/2019	370	2472	S3876.10063US01
RULE			

APPLICANTS

SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, Shanghai, CHINA

INVENTORS

Xiaobo ZHANG, Shanghai, CHINA

CONTINUING DATA

This application is a CON of PCT/CN2017/112033 11/21/2017

FOREIGN APPLICATIONS

CHINA CN201611098328.7 12/03/2016

IF REQUIRED, FOREIGN LICENSE GRANTED**

06/10/2019

**** SMALL ENTITY ****

STATE OR COUNTRY

CHINA

ADDRESS

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098
UNITED STATES

FILING FEE RECEIVED

$1,015

PE2E SEARCH - Search History (Prior Art)

There are no Prior Art searches to show.

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	1	((antenna port) near3 (virtualization map mapping) near3 (vector) SAME (time WITH resource$1)).clm.	US-PGPUB; USPAT	OR	ON	ON	2020/11/02 06:01 PM

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L2	8	"105577318"	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/07/13 10:40 AM
L3	1473787	((antenna near2 groups)(reference near2 signal near2 groups)) SAME virtualiz$5 WITH vector SAME resource pool	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/07/13 12:23 PM
L5	148	L3 AND H04B7/0408.cpc.	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/07/13 12:59 PM
L6	68	L3 AND H04B7/0408.cpc. AND @ad < "20161203"	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/07/13 01:00 PM
L7	307	((("ZHANG") near3 ("Xiaobo"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	OFF	2020/07/13 08:50 AM
L8	17744	H04L5/005.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 08:53 AM
L9	236	H04L5/005.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 12:24 PM
L10	114	H04B7/0408.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 12:25 PM
L11	52	H04B7/0408.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 01:01 PM

		pool) and (@ad < "20161203")					
L13	0	(((antenna near2 groups)(reference near2 signal near2 groups)) same (virtualiz$5 with vector) same (resource with pool)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 01:03 PM
L14	0	((antenna near2 groups)(reference near2 signal near2 groups)) same (virtualiz$5 with vector) same (resource with pool) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 01:03 PM
L15	0	((antenna reference near2 signal) with (group$1)) same (virtualiz$5 with vector) same (resource with pool) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 01:04 PM
L16	0	((antenna reference near2 signal) with (group$1)) same (virtual$7 with vector) same (resource with pool) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 01:05 PM
L17	3	("20160094326").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/13 01:19 PM
L18	148	((("ZHANG") near3 ("Xiaobo"))).INV. and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	OFF	2020/07/13 01:21 PM
L19	112	((antenna port$1) near2 (group$1)(reference near2 signal near2 group$1)) same (resource with pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:13 AM
L20	112	((antenna port$1) near2 (group$1)(reference near2 signal near2 group$1)) same (resource with pool$1 sub$1pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:14 AM
L21	110	((antenna port$1) near2 (group$1)) same (resource with pool$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	OFF	2020/07/14 09:14 AM

Samsung Exhibit 1003, Page 395 of 438

		sub$1pool$1)	IBM_TDB				
L22	83	((antenna array layer) near2 (group$1)) same (resource with pool$1 sub$1pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:16 AM
L23	63	((antenna array) near2 (group$1)) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:17 AM
L24	90	((antenna array) near2 (group$1) MU$1MIMO) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:18 AM
L25	164	(SHANGHAI near2 LANGBO near2 COMMUNICATION near2 TECHNOLOGY near2 COMPANY near2 LIMITED).as,aanm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:42 AM
L26	56	L25 and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:42 AM
L27	32	((antenna array) near3 (virtual$7) near3 (vector) MU$1MIMO) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:46 AM
L28	4	("20110222485"|"20160212735").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 09:51 AM
L29	104	((antenna array) near3 (virtual$7) near3 (vector)) same (resource$1 symbol$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 10:17 AM
L30	89	((antenna array) near3 (virtual$7) near3 (vector)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 10:17 AM
L31	208	((antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 05:22 PM

L32	169	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 05:23 PM
L33	169	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1 (resource) near2 (block$1 element$1 pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 05:25 PM
L34	5	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (first) near2 (resource$1 symbol$1 (resource) near2 (block$1 element$1 pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 06:03 PM
L35	5	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (first) near2 (resource$1 symbol$1 (resource) near2 (pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/14 06:04 PM
L36	10	(first "same") with (resource near3 pool) same (UE with antenna) same (base near2 station with antenna)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/15 08:44 AM
L37	5	(first "same") with (virtual) with (resource near3 pool) same (UE) same (base near2 station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/15 08:44 AM
L38	13	(resource near3 pool) same (UE with antenna) same (base near2 station with antenna)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/15 08:56 AM
L39	17	((resource) near3 (pool	US-PGPUB; USPAT;	OR	OFF	OFF	2020/07/15

Samsung Exhibit 1003, Page 397 of 438

		group$1 set$1 sub$1set$1)) same (UE with (multi$1antenna massive near2 mimo)) same (base near2 station with (multi$1antenna massive near2 mimo))	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB				09:00 AM
L40	6	"20140098761"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/07/15 10:05 AM
L41	22	"49385412".FMID.	US-PGPUB; USPAT; FPRS; JPO	OR	OFF	OFF	2020/07/15 11:41 AM
L43	18	("20120008577"|"20190191396"|"20110223876"|"20170195100"|"20150010106"|"20160094326"|"20180269949").PN.	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/01 12:18 PM
L44	417	(antenna port) near3 (virtual$7) WITH (resource$1) near3 (pool set collection plural$3 many)	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 09:34 AM
L45	21	((antenna port) near3 (virtual$7) WITH (time) near3 (resource$1) near3 (pool set collection plural$3 many))	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 09:35 AM
L46	10	"59962635".fmid.	US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO); FPRS; JPO	OR	ON	ON	2020/11/02 10:02 AM
L47	8	"105577318"	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 11:04 AM
L48	1500141	((antenna near2 groups)(reference near2 signal near2 groups)) SAME virtualiz$5 WITH vector SAME resource pool	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 11:04 AM
L49	161	L3 AND H04B7/0408.cpc.	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 11:04 AM
L50	75	L3 AND H04B7/0408.cpc. AND	US-PGPUB; USPAT; USOCR; FIT (CN, FR,	OR	ON	ON	2020/11/02 11:04 AM

		@ad < "20161203"	WO); FPRS; EPO; JPO; DERWENT; IBM_TDB				
L51	372	((("ZHANG") near3 ("Xiaobo"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	OFF	2020/11/02 11:04 AM
L52	18571	H04L5/005.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L53	257	H04L5/005.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L54	118	H04B7/0408.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L55	50	H04B7/0408.cpc. and (((antenna near2 groups)(reference near2 signal near2 groups)) same virtualiz$5 with vector same resource pool) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L61	3	("20160094326").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L62	149	((("ZHANG") near3 ("Xiaobo"))).INV. and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	OFF	2020/11/02 11:04 AM
L63	76	((antenna port$1) near2 (group$1)(reference near2 signal near2 group$1)) same (resource with pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L64	78	((antenna port$1) near2 (group$1)(reference near2 signal near2 group$1)) same (resource with pool$1 sub$1pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L65	75	((antenna port$1) near2	US-PGPUB; USPAT;	OR	OFF	OFF	2020/11/02

		(group$1)) same (resource with pool$1 sub$1pool$1)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB				11:04 AM
L66	66	((antenna array layer) near2 (group$1)) same (resource with pool$1 sub$1pool$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L67	65	((antenna array) near2 (group$1)) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L68	97	((antenna array) near2 (group$1) MU$1MIMO) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L69	217	(SHANGHAI near2 LANGBO near2 COMMUNICATION near2 TECHNOLOGY near2 COMPANY near2 LIMITED).as,aanm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L70	24	L25 and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L71	37	((antenna array) near3 (virtual$7) near3 (vector) MU$1MIMO) same ((resource$1 symbol$1) with (pool$1 sub$1pool$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L72	4	("20110222485"|"20160212735").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L73	38	((antenna array) near3 (virtual$7) near3 (vector)) same (resource$1 symbol$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L74	23	((antenna array) near3 (virtual$7) near3 (vector)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L75	111	((antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM

		(resource$1 symbol$1) and (@ad < "20161203")					
L76	93	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L77	93	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (resource$1 symbol$1 (resource) near2 (block$1 element$1 pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L78	5	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (first) near2 (resource$1 symbol$1 (resource) near2 (block$1 element$1 pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L79	5	((first second) with (antenna array) near3 (virtual$7) near3 (vector) (precoding near2 vector near2 index PVI)) same (first) near2 (resource$1 symbol$1 (resource) near2 (pool$1 sub$1pool$1)) and (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L80	10	(first "same") with (resource near3 pool) same (UE with antenna) same (base near2 station with antenna)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L81	5	(first "same") with (virtual) with (resource near3 pool) same (UE) same (base near2 station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L82	11	(resource near3 pool) same (UE with antenna) same (base near2 station	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	OFF	2020/11/02 11:04 AM

		with antenna)	IBM_TDB				
L83	11	((resource) near3 (pool group$1 set$1 sub$1set$1)) same (UE with (multi$1antenna massive near2 mimo)) same (base near2 station with (multi$1antenna massive near2 mimo))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L84	6	"20140098761"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:04 AM
L85	20	"49385412".FMID.	US-PGPUB; USPAT; FPRS; JPO	OR	OFF	OFF	2020/11/02 11:04 AM
L86	18	("20120008577"|"20190191396"|"20110223876"|"20170195100"|"20150010106"|"20160094326"|"20180269949").PN.	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 11:04 AM
L87	417	(antenna port) near3 (virtual$7) WITH (resource$1) near3 (pool set collection plural$3 many)	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 11:04 AM
L88	21	((antenna port) near3 (virtual$7) WITH (time) near3 (resource$1) near3 (pool set collection plural$3 many))	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 11:04 AM
L89	10	"59962635".fmid.	US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO); FPRS; JPO	OR	ON	ON	2020/11/02 11:04 AM
L92	8	((antenna WITH virtualiz$5 WITH (vector map$4)) SAME ((resource$1) WITH (pool set group))) AND (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 11:18 AM
L94	13	(((port antenna) WITH virtualiz$5 WITH (vector map$4)) AND ((resource$1) near3 (time) near3 (pool set group))) AND (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	OFF	2020/11/02 05:24 PM
L96	11	(((port antenna) WITH	US-PGPUB; USPAT;	OR	OFF	OFF	2020/11/02

		(virtualiz$5 vector map$4)) WITH ((resource$1) near3 (time) near3 (pool set group))) AND (@ad < "20161203")	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB				05:37 PM
L98	16	(antenna) near3 (virtualization map mapping) near3 (vector) SAME (time WITH resource$1)	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 05:46 PM
L99	5	"62069756".fmid.	US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO); FPRS; JPO	OR	ON	ON	2020/11/02 05:50 PM
L100	16	(antenna port) near3 (virtualization map mapping) near3 (vector) SAME (time WITH resource$1)	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 05:56 PM
L101	310	((("SHANGHAI") near3 ("LANGBO") near3 ("COMMUNICATION") near3 ("TECHNOLOGY") near3 ("COMPANY") near3 ("LIMITED"))).AS,AANM.	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 05:59 PM
L102	4	L100 AND L101	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/02 05:59 PM
L105	4	"201611098328"	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/03 12:16 PM
L107	8	"105577318"	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/03 01:43 PM
L108	45	(antenna port) near3 (virtualization map mapping) near3 (vector) SAME ((time$1frequency WITH resources) (resource near2 blocks) (ofdm near2 symbols symbols ofdm sub$1frames)) AND (@ad < "20161203")	US-PGPUB; USPAT; USOCR; FIT (CN, FR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	ON	2020/11/05 09:34 AM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Samsung Exhibit 1003, Page 404 of 438

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo ZHANG	
Application No.:	16/429,077	Art Unit
Filed:	06/03/2019	2472
Conf. No.:	2560	
For:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION	
Examiner:	BELUR, DEEPA	
Attorney Docket No.:	S3876.10063US01	

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sirs,

Applicant acknowledges Examiner's statements of Reasons for Allowance of the above-referenced patent application and agrees that the claimed subject matter is patentable. However, Applicant takes no position regarding the Reasons for Allowance presented by the Examiner other than the position Applicant may have previously taken during prosecution. Therefore, the Examiner's Reasons for Allowance should not be attributed to Applicant as an indication of the basis for Applicant's belief that the claims are patentable. Furthermore, Applicant respectfully asserts that there may also be additional reasons for patentability of the claimed subject matter not explicitly stated in this record and Applicant does not waive its rights to such arguments by not further addressing such reasons herein.

Dated this 2nd day of February, 2021.

Respectfully submitted,

The Inventor: Xiaobo Zhang

By: / Xiaobo Zhang/
Xiaobo Zhang

Email: patent@langbomobile.com

Electronic Patent Application Fee Transmittal

Application Number:	16429077
Filing Date:	03-Jun-2019
Title of Invention:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Filer:	Qi Zhou
Attorney Docket Number:	S3876.10063US01

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	600	600

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**600**

Electronic Acknowledgement Receipt	
EFS ID:	41807446
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Qi Zhou
Filer Authorized By:	
Attorney Docket Number:	S3876.10063US01
Receipt Date:	02-FEB-2021
Filing Date:	03-JUN-2019
Time Stamp:	05:31:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$600
RAM confirmation Number	E202122632468389
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	20160089-PCT-US-S3876_10063US01_PTOL85B_V.pdf	231539 bac063d7536c5ebe9a6c2b84e494e1bdba943063	no	2
Warnings:					
Information:					
2	Miscellaneous Incoming Letter	20160089-PCT-US_S3876_10063US01_Transmittal_Letter.pdf	431546 d39bb7e95f75a5e5555cb2469284c8bc9b4d8255	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30637 0f75f8533a35bc92d9e4c16bd939f19435a35ef4	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	693722		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B – FEE(S) TRANSMITTAL

Complete and send this form, together with the applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

By fax, send to: (571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

97149 7590 11/17/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO	CONFIRMATION NO
16/429,077	06/03/2019	Xiaobo ZHANG	S3876.10063US01	2560

TITLE OF INVENTION: METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/17/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
BELUR, DEEPA	2472	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363)

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1. Maschoff Brennan
2.
3.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE	(B) RESIDENCE: (CITY and STATE or COUNTRY)
SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED	SHANGHAI, CHINA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees Submitted: ☑ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment (*Please first reapply any previously paid fee shown above*):

☑ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. Change of Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29. NOTE: Absent a valid Certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27. NOTE: If the application was previously under micro entity status, checking this box will be taken as a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status. NOTE: Checking this box will be taken as a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Xiaobo ZHANG/ Date February 2, 2021

Typed or printed name Xiaobo ZHANG Registration No.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16429077
Filing Date	2019-06-03
First Named Inventor	Xiaobo,ZHANG
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	20160089-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
Change(s) applied to document /G.R.P./ 12/28/2020	1	20110223876	A	2011-09-15	Kang ~~Samsung Electronics Co Ltd~~	
	2	20150010106	A	2015-01-08	Skov et al. NOKIA SOLUTIONS AND ~~NETWORKS OY~~	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	105577318	CN	X	2016-05-11	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY CO.LTD	Abstract and drawing sheets of the patent specification, paragraphs 58、67-97 of the specification,	X
	2	101567865	CN	A	2009-10-28	DINGQIAO COMMUNICATION TECHNOLOGY CO.LTD		☐

EFS Web 2.1.18

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16429077
Filing Date	2019-06-03
First Named Inventor	XiaoBo ZHANG
Art Unit	2464
Examiner Name	NGO, RICKY QUOC
Attorney Docket Number	20160089-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
Change(s) applied to document, /G.R.P./ 12/28/2020	1	20160094326	A1	2016-03-31	Moon et al. KOREA ELECTRONICS ~~TELECOMM~~	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	105577318	CN	A	2016-05-11	LONGBO COMMUNICATION TECHNICAL CO., LTD	English Abstract	☒
	2	103687010	CN	A	2014-03-26	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY	English Abstract	☒
	3	2016018100	WO	A1	2016-02-04	LG ELECTRONICS INC		☐

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/429,077	03/09/2021	10944527	S3876.10063US01	2560

97149 7590 02/17/2021

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Xiaobo ZHANG, Shanghai, CHINA;
SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, Shanghai, CHINA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/429,077
Filing Date	06-03-2019
First Named Inventor	Xiaobo ZHANG
Title	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	ZL0205-0002-PCT-US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Jialin Zhong/	Date (Optional)	
Name	Jialin Zhong	Registration Number	62937
Title (if Applicant is a juristic entity)	Registered Patent Attorney		
Applicant Name (if Applicant is a juristic entity)	APEX BEAM TECHNOLOGIES LLC		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 155075

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

APEX BEAM TECHNOLOGIES LLC

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	Deepak Kumar Sharma	Date (Optional)	11/10/2021
Name	Deepak Sharma		
Title	Managing Director		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: APEX BEAM TECHNOLOGIES LLC

Application No./Patent No.: 16/429,077 Filed/Issue Date: 06-03-2019

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

APEX BEAM TECHNOLOGIES LLC, a Limited Liability Company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: XIAOBO ZHANG To: SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED

   The document was recorded in the United States Patent and Trademark Office at

   Reel 049341, Frame 0156, or for which a copy thereof is attached.

2. From: SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED To: APEX BEAM TECHNOLOGIES LLC

   The document was recorded in the United States Patent and Trademark Office at

   Reel 058068, Frame 0338, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Jialin Zhong/	November 11, 2021
Signature	Date
Jialin Zhong	62,937
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	44268984
Application Number:	16429077
International Application Number:	
Confirmation Number:	2560
Title of Invention:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Jialin Zhong/Eddie Rowell
Filer Authorized By:	Jialin Zhong
Attorney Docket Number:	S3876.10063US01
Receipt Date:	12-NOV-2021
Filing Date:	03-JUN-2019
Time Stamp:	13:26:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ZL0205-0002-PCT-US_Marked_UP_ADS.pdf	1621853 9b2bcfec048034a57fd6e5fdf1bca2faeb4cabad	no	7

Warnings:

Information:					
This is not an USPTO supplied ADS fillable form					
2	Power of Attorney	ZL0205-0002-PCT-US_82A.pdf	313510 0c2036fe4ebfe99b3b1a52ae6f004a97e32e2752	no	1
Warnings:					
Information:					
3	Power of Attorney	POA82B_Apex_ex.pdf	1100582 d420eaec9e65ed86bfe977d519b96e062166a185	no	2
Warnings:					
Information:					
4	Assignee showing of ownership per 37 CFR 3.73	ZL0205-0002-PCT-US_3_73c.pdf	121262 3788647df6fbb57249f5ce866f4bc4b24b661b55	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	3157207		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	16/429,077
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xiaobo		ZHANG	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Shanghai	Country of Residence i	CN

Mailing Address of Inventor:

Address 1	Room 210, 2nd Floor, No. 2088, Xietu Road		
Address 2	Xuhui District		
City	Shanghai	**State/Province**	OT
Postal Code	200032	**Country** i	CN

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	157297		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station		
Attorney Docket Number	20160089-PCT-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	15	**Suggested Figure for Publication (if any)**	12

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	157297		

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					
Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove
Registration Number					

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/CN2017/112033	2017-11-21

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
201611098328.7	CN	2016-12-03	0727

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

(X) Assignee	( ) Legal Representative under 35 U.S.C. 117	( ) Joint Inventor
( ) Person to whom the inventor is obligated to assign.	( ) Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	
If the Applicant is an Organization check here. [X]	APEX BEAM TECHNOLOGIES LLC

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Applicant:

Address 1	104 EAST HOUSTON STREET		
Address 2	SUITE 180		
City	MARSHALL	**State/Province**	TX
Country[i]	US	Postal Code	75670
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	~~Shanghai Langbo Communication Technology Company Limited~~ APEX BEAM TECHNOLOGIES LLC

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	~~Room 210, 2nd Floor, No. 2088, Xieta Road~~ 104 EAST HOUSTON STREET		
Address 2	~~Xuhui District~~ SUITE 180		
City	~~Shanghai~~ MARSHALL	**State/Province**	~~OT~~ TX
Country i	~~CN~~ US	Postal Code	~~200032~~ 75670
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e. g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	~~/Xiaobo ZHANG/~~ /Jialin Zhong/			Date (YYYY-MM-DD)	2021-11-12
First Name	~~Xiaobo~~ Jialin	Last Name	~~ZHANG~~ Zhong	Registration Number	62937

Additional Signature may be generated within this form by selecting the Add button.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/429,077	06/03/2019	Xiaobo ZHANG	S3876.10063US01

CONFIRMATION NO. 2560

97149
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

POWER OF ATTORNEY NOTICE

OC000000129833699

Date Mailed: 11/18/2021

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/12/2021.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/agizaw/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/429,077	06/03/2019	Xiaobo ZHANG	ZL0205-0002-PCT-US

CONFIRMATION NO. 2560

155075
Zhong Law, LLC
100 Connell Drive
Suite 2300
Berkeley Heights, NJ 07922

POA ACCEPTANCE LETTER

OC000000129833732

Date Mailed: 11/18/2021

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/12/2021.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/agizaw/

AO 120 (Rev. 08/10)

TO:		
	Mail Stop 8 **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:21-cv-00438	11/30/2021	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	TCT Mobile International Limited, TCL Electronics Holdings Limited, TCL Technology Group Corporation, TCLCommunication Limited, and TCL Communication Technology Holdings Limited

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
2	10,568,113	2/18/2020	Apex Beam Technologies LLC
3	10,912,081	2/2/2021	Apex Beam Technologies LLC
4	10,944,527	3/9/2021	Apex Beam Technologies LLC
5	10,951,271	3/16/2021	Apex Beam Technologies LLC

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:21-cv-00438	11/30/2021	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	TCT Mobile International Limited, TCL Electronics Holdings Limited, TCL Technology Group Corporation, TCLCommunication Limited, and TCL Communication Technology Holdings Limited

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
2	10,568,113	2/18/2020	Apex Beam Technologies LLC
3	10,912,081	2/2/2021	Apex Beam Technologies LLC
4	10,944,527	3/9/2021	Apex Beam Technologies LLC
5	10,951,271	3/16/2021	Apex Beam Technologies LLC

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

AMENDED

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00031	02/01/2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	ZTE CORPORATION

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
2	10,568,113	2/18/2020	Apex Beam Technologies LLC
3	10,912,081	2/2/2021	Apex Beam Technologies LLC
4	10,944,527	3/9/2021	Apex Beam Technologies LLC
5	10,951,271	3/16/2021	Apex Beam Technologies LLC

In the above---entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above---entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1---Upon initiation of action, mail this copy to Director Copy 3---Upon termination of action, mail this copy to Director
Copy 2---Upon filing document adding patent(s), mail this copy to Director Copy 4---Case file copy

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00031	02/01/2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	ZTE CORPORATION

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	
2	10,568,113	2/18/2020	
3	10,912,081	2/2/2021	
4	10,944,527	3/9/2021	
5	10,951,271	3/16/2021	

In the above---entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above---entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1---Upon initiation of action, mail this copy to Director Copy 3---Upon termination of action, mail this copy to Director
Copy 2---Upon filing document adding patent(s), mail this copy to Director Copy 4---Case file copy

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00032	02-01-2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
2	10,568,113	2/18/2020	Apex Beam Technologies LLC
3	10,912,081	2/2/2021	Apex Beam Technologies LLC
4	10,944,527	3/9/2021	Apex Beam Technologies LLC
5	10,951,271	3/16/2021	Apex Beam Technologies LLC

In the above---entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above---entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1---Upon initiation of action, mail this copy to Director Copy 3---Upon termination of action, mail this copy to Director
Copy 2---Upon filing document adding patent(s), mail this copy to Director Copy 4---Case file copy

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following ☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-000188	06-01-2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	SAMSUNG ELECTRONICS CO., LTD. and SAMSUNG ELECTRONICS AMERICA, INC.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
2	10,568,113	2/18/2020	Apex Beam Technologies LLC
3	10,912,081	2/2/2021	Apex Beam Technologies LLC
4	10,944,527	3/9/2021	Apex Beam Technologies LLC
5	10,951,271	3/16/2021	Apex Beam Technologies LLC

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-000188	06-01-2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	SAMSUNG ELECTRONICS CO., LTD. and SAMSUNG ELECTRONICS AMERICA, INC.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
2	10,568,113	2/18/2020	Apex Beam Technologies LLC
3	10,912,081	2/2/2021	Apex Beam Technologies LLC
4	10,944,527	3/9/2021	Apex Beam Technologies LLC
5	10,951,271	3/16/2021	Apex Beam Technologies LLC

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**