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
2:24-cv-00203	3/20/2024	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	11,063,727	7/13/2021	Apex Beam Technologies LLC
2	11,374,721	6/28/2022	Apex Beam Technologies LLC
3	11,457,426	9/27/2022	Apex Beam Technologies LLC
4	11,546,110	1/3/2023	Apex Beam Technologies LLC
5	11,626,904	4/11/2023	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)

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☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:24-cv-00203	3/20/2024	for the Eastern District of Texas, Marshall Division
PLAINTIFF APEX BEAM TECHNOLOGIES LLC		DEFENDANT SAMSUNG ELECTRONICS CO., LTD. and SAMSUNG ELECTRONICS AMERICA, INC.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	11,917,581	2/27/2024	Apex Beam Technologies LLC
2	10,965,434	3/30/2021	Apex Beam Technologies LLC
3	11,139,944	10/5/2021	Apex Beam Technologies LLC
4	11,108,639	8/31/2021	Apex Beam Technologies LLC
5	10,986,695	4/20/2021	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
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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:24-cv-00203	3/20/2024	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	10,979,128	4/13/2021	Apex Beam Technologies LLC
2	11,637,615	4/25/2023	Apex Beam Technologies LLC
3			
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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
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In the above—entitled case, the following decision has been rendered or judgement issued:

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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

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.
17/143,180	01/03/2023	11546110	20160089-PCT-US-DA1	3253

155075 7590 12/14/2022

Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

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 79 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 Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

INVENTOR(s) (Please see PAIR WEB site http://pair.uspto.gov for additional inventors):

Xiaobo ZHANG, Shanghai, CHINA;

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

APEX BEAM TECHNOLOGIES LLC, MARSHALL, TX;

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.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	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												

Change(s) applied
to document,
/QN/
9/6/2022

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/DEEPA BELUR/ Primary Examiner, Art Unit 2472	26 August 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9

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	17143180
Filing Date	2021-01-07
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	
Attorney Docket Number	

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, /J.G./ 9/8/2022	1	20160094326	A1	2016-03-31	~~Electronics and~~ Telecommunications Research Insti	Moon et al.
	2	20150010106	A1	2015-01-08	~~Nokia Solutions and Networks Oy~~	Skov et al.
	3	20110223876	A1	2011-09-15	Jee Woong Kang	

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	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY	Abstract and drawingsheets of the patentspecification, paragraphs58、67-97 of thespecification,	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

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)

155075 7590 09/01/2022

Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

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.

Eddie Rowell	(Typed or printed name)
/Eddie Rowell/	(Signature)
November 30, 2022	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/143,180	01/07/2021	Xiaobo ZHANG	20160089-PCT-US-DA1	3253

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	12/01/2022

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/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 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 Zhong Law, LLC
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: APEX BEAM TECHNOLOGIES LLC

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Marshall, Texas

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. 602313

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 /Jialin Zhong/ Date November 30, 2022

Typed or printed name Jialin Zhong Registration No. 62,937

Electronic Patent Application Fee Transmittal					
Application Number:	17143180				
Filing Date:	07-Jan-2021				
Title of Invention:	Method and Device for Multi-Antenna Transmission in User Equipment (UE) and Base Station				
First Named Inventor/Applicant Name:	Xiaobo ZHANG				
Filer:	Jialin Zhong/Eddie Rowell				
Attorney Docket Number:	20160089-PCT-US-DA1				
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:	47105788
Application Number:	17143180
International Application Number:	
Confirmation Number:	3253
Title of Invention:	Method and Device for Multi-Antenna Transmission in User Equipment (UE) and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	155075
Filer:	Jialin Zhong/Eddie Rowell
Filer Authorized By:	Jialin Zhong
Attorney Docket Number:	20160089-PCT-US-DA1
Receipt Date:	30-NOV-2022
Filing Date:	07-JAN-2021
Time Stamp:	12:26:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$600
RAM confirmation Number	E2022ATC27271352
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)	17143180_Issue_Fee.pdf	1652925 23983865d99a108664dc7547642 1a9cf5bd2c3029	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38784 66b4d41ff785d4bd41d42052659ec3494728 0e0d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1691709		

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/143,180	01/07/2021	2472	1070	20160089-PCT-US-DA1	20	4

CONFIRMATION NO. 3253

CORRECTED FILING RECEIPT

155075
Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078



Date Mailed: 09/06/2022

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)

APEX BEAM TECHNOLOGIES LLC, MARSHALL, TX;

Assignment For Published Patent Application

APEX BEAM TECHNOLOGIES LLC, MARSHALL, TX

Power of Attorney: The patent practitioners associated with Customer Number 155075

Domestic Priority data as claimed by applicant

This application is a CON of 16/429,077 06/03/2019 PAT 10944527
which 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: 01/21/2021
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/143,180**
Projected Publication Date: Not Applicable
Non-Publication Request: No
Early Publication Request: No
** **SMALL ENTITY** **
Title

Method and Device for Multi-Antenna Transmission in User Equipment (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).

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UNITED STATES PATENT AND TRADEMARK OFFICE

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NOTICE OF ALLOWANCE AND FEE(S) DUE

155075 7590 09/01/2022

Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

EXAMINER	
BELUR, DEEPA	
ART UNIT	PAPER NUMBER
2472	

DATE MAILED: 09/01/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/143,180	01/07/2021	Xiaobo ZHANG	20160089-PCT-US-DA1	3253

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	12/01/2022

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. 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)

155075 7590 09/01/2022

Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

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.
17/143,180	01/07/2021	Xiaobo ZHANG	20160089-PCT-US-DA1	3253

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nonprovisional	SMALL	$600	$0.00	$0.00	$600	12/01/2022

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/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 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

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EXAMINER	
BELUR, DEEPA	

ART UNIT	PAPER NUMBER
2472	

DATE MAILED: 09/01/2022

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.** 17/143,180	**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 amendments and TD filed on 08/22/2022.
   ☐ 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/
Primary Examiner, Art Unit 2472

Examiners Comment

1. Claims 2, 7, 12 and 17 have been amended.

2. The nonstatutory double patenting rejection for claims 1-20 has been overcome, as Terminal Disclaimer has been filed and approved on 08/22/2022.

3. The 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph rejection for claims 2, 7 and 12 has been overcome based on claim amendments.

4. Claims 1-20 are allowed.

Reason for Allowance

5. The following is an examiner's statement of reasons for allowance:

For independent claims 1, and 11, the following underlined claim limitation is not disclosed by any prior art: ***"... 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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling."***

For independent claims 6, and 16, the following underlined claim limitation is not disclosed by any prior art: "... ***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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; and the K is a positive integer greater than 1; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling."***

Closest prior art

Wei (US 11139875 B2) discloses in FIG. 4B, columns 9-10, lines 56-67 and lines 1-10, discloses an example base station transmitting beamformed CSI-RS using CSI-RS resources. These CSI-RS resources may be directed to serve different UE groups... Because different CSI-RS resources are used for different UE groups, when providing CSI feedback, UEs report CQI, PMI (ID codebook), rank indicator, as well as the CSI-RS resource indicator (CRI), if K>1, which identifies to base station which of the CSI-RS resources the UE has measured and provided channel state information (CSI) feedback

for. In class B beamformed CSI reporting, each CSI process may be associated with K NZP CSI-RS resources/configurations, with N_k ports for the kth CSI-RS resource (K could be ≥1), in which N_k may be 1, 2, 4, or 8, and may be different for each CSI-RS resource. Each CSI-RS resource may also have different CSI-RS port virtualization, e.g., virtualized from different sets of antenna elements or from the same set of antenna elements but with different beamforming weights.

Hence in Wei, different UE groups are use different CSI-RS resources that are identified to the base station using "K" number of CSI-RS resources having different CSI-RS port virtualization.

However, Wei does not disclose "...***the first radio signal is transmitted by K antenna port groups; 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; a second antenna virtualization vector is associated with the first antenna port group; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool...***"; nor does it disclose: "... ***the first radio signal is transmitted by K antenna port groups; 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; a second antenna virtualization vector is associated with the first antenna port group; 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:...",***

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

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 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 published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197

(toll-free). If you would like assistance from a USPTO Customer Service

Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DEEPA BELUR/
Primary Examiner, Art Unit 2472

Notice of References Cited	Application/Control No. 17/143,180	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-11245449-B2	02-2022	Frenne; Mattias	H04L5/0092	1/1
*	B	US-11139875-B2	10-2021	Wei; Chao	H04B7/0452	1/1
*	C	US-20190288807-A1	09-2019	ZHANG; Xiaobo	H04L1/0003	1/1
	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
	17/143,180	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/ Primary Examiner, Art Unit 2472	26 August 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9

U.S. Patent and Trademark Office — Part of Paper No.: 20220826

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	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/ Primary Examiner, Art Unit 2472	26 August 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9

U.S. Patent and Trademark Office — Part of Paper No.: 20220826

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	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/ Primary Examiner, Art Unit 2472	26 August 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9

U.S. Patent and Trademark Office — Part of Paper No.: 20220826

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

CPC - Searched*		
Symbol	Date	Examiner
H04L5/005.cpc.	05/20/2022	DB
H04B7/0408.cpc.	05/20/2022	DB
H04B7/0413.cpc.	05/20/2022	DB
H04B7/06.cpc.	05/20/2022	DB
H04B7/0617.cpc.	05/20/2022	DB
H04L1/0003.cpc.	05/20/2022	DB
H04L1/1819.cpc.	05/20/2022	DB
H04L5/0082.cpc	05/20/2022	DB
H04W88/02.cpc.	05/20/2022	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.

/DEEPA BELUR/ Primary Examiner, Art Unit 2472	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

Search Notes		
Search Notes	**Date**	**Examiner**
H04L5/005.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/0408.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/0413.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/06.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/0617.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04L1/0003.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04L1/1819.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04L5/0082.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04W88/02.cpc. in combination with text search, see search history printout	05/20/2022	DB
Inventor and Assignee search in PE2E - see search history printout	05/20/2022	DB
NPL search in chrome and google scholar	05/20/2022	DB
Search updated	08/26/2022	DB

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
	see Interference_SearchHistory.Printout.pdf	08/26/2022	DB

/DEEPA BELUR/ Primary Examiner, Art Unit 2472	

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	0	((("APEX") near3 ("BEAM") near3 ("TECHNOLOGIES") near3 ("LLC"))).AS,AANM.	(USPAT)	OR	ON	ON	2022/05/19 05:43 PM
L2	695	((("ZHANG") near3 ("Xiaobo"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2022/05/19 05:44 PM
L3	1	CN105577318A	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 11:46 AM
L4	10	("20110223876"|"20150010106"|"20160094326").PN.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 11:47 AM
L5	87	(antenna WITH virtual$7) WITH (resource near3 pool)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK,	OR	ON	ON	2022/05/20 11:49 AM

			TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L7	18	(antenna WITH virtual$7) WITH (resource near3 pool) AND (PSS SSS MIB SIB CSI$1RS)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 11:55 AM
L8	2016	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:35 PM
L9	327	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L5/005.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:36 PM
L10	10	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L5/005.cpc. AND H04B7/0408.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2022/05/20 12:36 PM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L11	239	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc.)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:38 PM
L12	33	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc.) AND H04B7/06.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:38 PM
L13	44	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04B7/06.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO;	OR	ON	ON	2022/05/20 12:39 PM

			JPO; DERWENT; IBM_TDB)				
L15	44	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L1/0003.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:50 PM
L16	3	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04L1/1819.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:51 PM
L17	11	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04L5/0082.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:53 PM
L18	48	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04W88/02.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/05/20 12:53 PM

			IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L20	66	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 01:13 PM
L21	134	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 01:13 PM
L22	94	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND MIMO AND @AD< "20160312"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 01:13 PM

L23	32	"53487429".fmid.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; JPO)	OR	ON	ON	2022/05/20 01:14 PM
L24	12	((US-20160094326-A1 OR US-20150010106-A1 OR US-20190386729-A1 OR US-20110223876-A1 OR US-20170373743-A1 OR US-20160157218-A1 OR US-20170041113-A1 OR US-20150341100-A1).did. AND PGPB.dbnm.) OR ((CN-104852756-B OR CN-104853417-B).did. AND FTDB.dbnm.) OR ((WO-2013110219-A1 OR US-20110223876-A1).did. AND DWPI.dbnm.)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 03:24 PM
L26	19	((antenna port) near3 (group$3 set$1 collection$1)) WITH (resource near3 pool$1) WITH (NVF (antenna port) near3 (virtuali$6)) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:00 PM
L27	19	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NVF (antenna port) near3 (virtuali$6))) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV,	OR	ON	ON	2022/05/20 04:04 PM

			MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L28	19	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6))) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:08 PM
L29	20	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:08 PM
L30	41	((antenna port) near3 (group$3 set$1 collection$1)) AND ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:09 PM
L31	1	((("APEX") near3	(USPAT)	OR	ON	ON	2022/08/26

		("BEAM") near3 ("TECHNOLOGIES") near3 ("LLC"))).AS,AANM.					10:38 AM
L32	802	((("ZHANG") near3 ("Xiaobo"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2022/08/26 10:38 AM
L33	1	CN105577318A	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L34	10	("20110223876"|"20150010106"|"20160094326").PN.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L35	92	(antenna WITH virtual$7) WITH (resource near3 pool)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L36	21	(antenna WITH	(US-PGPUB; USPAT;	OR	ON	ON	2022/08/26

		virtual$7) WITH (resource near3 pool) AND (PSS SSS MIB SIB CSI$1RS)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				10:38 AM
L37	2085	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L38	342	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L5/005.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L39	10	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L5/005.cpc. AND H04B7/0408.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/08/26 10:38 AM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L40	246	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc.)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L41	36	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc.) AND H04B7/06.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L42	49	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04B7/06.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L43	44	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY,	OR	ON	ON	2022/08/26 10:38 AM

		AND H04L1/0003.cpc.	CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L44	6	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04L1/1819.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L45	11	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04L5/0082.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L46	48	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04W88/02.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH,	OR	ON	ON	2022/08/26 10:38 AM

			TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L47	66	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L48	137	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L49	96	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND MIMO AND @AD< "20160312"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L50	37	"53487429".fmid.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2022/08/26 10:38 AM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; JPO)				
L51	12	((US-20160094326-A1 OR US-20150010106-A1 OR US-20190386729-A1 OR US-20110223876-A1 OR US-20170373743-A1 OR US-20160157218-A1 OR US-20170041113-A1 OR US-20150341100-A1).did. AND PGPB.dbnm.) OR ((CN-104852756-B OR CN-104853417-B).did. AND FTDB.dbnm.) OR ((WO-2013110219-A1 OR US-20110223876-A1).did. AND DWPI.dbnm.)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L52	21	((antenna port) near3 (group$3 set$1 collection$1)) WITH (resource near3 pool$1) WITH (NVF (antenna port) near3 (virtuali$6)) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L53	21	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NVF (antenna port) near3 (virtuali$6))) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/08/26 10:38 AM

			WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L54	21	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6))) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L55	22	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L56	47	((antenna port) near3 (group$3 set$1 collection$1)) AND ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:38 AM
L57	20	("20110223876"|"20160157218"|"20160094326"|"20170041113"|"20170373743"|"20150010106"|"20150341100").PN.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2022/08/26 10:55 AM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L59	293	((antenna port) WITH (group$3 set$1 collection$1)) SAME (((resource) near3 (group$3 set$1 collection$1 pool$1)) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 10:59 AM
L60	294	((antenna port beam) WITH (group$3 set$1 collection$1)) SAME (((resource) near3 (group$3 set$1 collection$1 pool$1)) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 11:18 AM
L61	40	((antenna port beam) WITH (group$3 set$1 collection$1)) SAME (((resource) near3 (group$3 set$1 collection$1 pool$1)) WITH (NFv (antenna port) near3 (virtuali$6))) AND @ad< "20161203"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT;	OR	ON	ON	2022/08/26 11:22 AM

			IBM_TDB)				
L62	9	(SIB MIS PSS SSS CSI$1RS) WITH ((antenna port beam) WITH (group$3 set$1 collection$1)) SAME (((resource) near3 (group$3 set$1 collection$1 pool$1)) WITH (NFv (antenna port) near3 (virtuali$6))) AND @ad< "20161203"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 11:43 AM
L63	6	(SIB MIS PSS SSS CSI$1RS) WITH ((antenna port beam) near3 (group$3 set$1 collection$1)) SAME (((resource) near3 (group$3 set$1 collection$1 pool$1)) WITH (NFv (antenna port) near3 (virtuali$6))) AND @ad< "20161203"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/26 11:53 AM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Bibliographic Data

Application No: 17/143,180

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.
01/07/2021	370	2472	20160089-PCT-US-DA1
RULE			

APPLICANTS

APEX BEAM TECHNOLOGIES LLC, MARSHALL, TX, UNITED STATES

INVENTORS

Xiaobo ZHANG, Shanghai, CHINA

CONTINUING DATA

This application is a CON of 16429077 06/03/2019 PAT 10944527

16429077 is a CON of PCT/CN2017/112033 11/21/2017

FOREIGN APPLICATIONS

CHINA CN201611098328.7 12/03/2016

IF REQUIRED, FOREIGN LICENSE GRANTED**

01/21/2021

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Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078
UNITED STATES

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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	3	((antenna WITH port WITH group$3) SAME ((resource) near3 (pool$1)) WITH ((antenna) near3 (virtuali$6))).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/08/26 12:52 PM

Our Docket No: ZL0205-0002-PCT-US-CON1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	Examiner: Belur, Deepa
	)	
Xiaobo ZHANG	)	Art Unit: 2472
	)	
Application No: 17/143,180	)	Confirmation No.: 3253
	)	
Filed: January 7, 2021	)	
	)	
For: METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN USER EQUIPMENT (UE) AND BASE STATION (Amended)	)	

AMENDMENT

E-Filed via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir/Madam:

In response to the non-final Office action mailed on May 25, 2022, applicant respectfully requests the Examiner to enter the following amendments and to consider the following remarks.

Amendment to the Title begins on page 2.

Amendments to the Claims begin page 3.

Remarks begin on page 10 of this document.

Amendment to the Title

Please amend the title of the application as follows:

METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN USER EQUIPMENT (UE) AND BASE STATION

In the claims:

For the Examiner's convenience, all pending claims are presented below with changes shown in accordance with the mandatory amendment format.

1. (Original) 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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

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 one of receiving[[,]] or ~~the operating is~~ transmitting the second radio signal; 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. (Original) The method of claim 1, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, comprising:

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

4. (Original) The method of claim 1, further comprising:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s) indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

6. (Original) 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 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; a second

antenna virtualization vector is associated with the first antenna port group; 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; and the K is a positive integer greater than 1; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

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 one of transmitting[[,]] or ~~the performing is~~ receiving the second radio signal; 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. (Original) The method of claim 6, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, comprising:

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

9. (Original) The method of claim 6, further comprising:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s)

indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

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

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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

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 one of receiving[[,]] or ~~the operating is~~ transmitting the second radio signal; 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. (Original) The UE of claim 11, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, the second receiver further receives first information, wherein the first information is used to determine the first antenna port group.

14. (Original) The UE of claim 11, wherein:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s) indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or

more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

16. (Original) 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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; and the K is a positive integer greater than 1; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

17. (Currently amended) 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 one of transmitting[[,]] or ~~the performing is~~ receiving the second radio signal; 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. (Original) The base station equipment of claim 16, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, the second transmitter further transmits first information, wherein the first information is used to determine the first antenna port group.

19. (Original) The base station equipment of claim 16, wherein:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s) indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

REMARKS

Applicant respectfully requests reconsideration of this application as amended.

Status of the Claims

Claims 1, 7, 12, and 17 have been amended. No claims are canceled or added in this response. Therefore, claims 1-20 are presented for examination.

Summary of the Office Action

Claims 1 and 2 are provisionally rejected on the ground of non-statutory obviousness-type double patenting as being unpatentable over claim 1 of commonly-owned U.S. Pat. No. 10,944,527 (the '527 patent).

Claims 2, 7, 12 are rejected under 35 U.S.C. 112(b) as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint-inventor regards as the invention.

Examiner Interview Summary

Applicant thanks the Examiner for the courtesy extended during the Examiner interview between Examiner Deepa Belur and applicant's representative, Jialin Zhong (Reg. No. 62,937) occurred on August 2, 2022. During the interview, the Examiner and applicant's representative discussed proposed amendment to claim 2 in view of the Section 112 rejection. The Examiner and the applicant's representative reached an agreement that the proposed amendments to claim 2 overcome the indefiniteness rejection.

Amendment to the Title

The title of the application is amended for formality reasons. Entry of the amendment to the title is respectfully requested.

Double Patenting

Claims 1 and 2 are provisionally rejected on the ground of non-statutory obviousness-type double patenting as being unpatentable over claims 1 of commonly-owned the '527 patent.

Although applicant may not necessarily agree with the nonstatutory double patenting rejection, to facilitate matters, applicant respectfully submits that the concurrently-submitted terminal disclaimer overcomes the nonstatutory double patenting rejection of claims. Withdrawal of the nonstatutory double patenting rejection is respectfully requested.

Indefiniteness Rejection

Claims 2, 7, 12 are rejected under 35 U.S.C. 112(b) as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint-inventor regards as the invention.

As agreed during the August 2, 2022 Examiner interview, applicant respectfully submits that the amendment to claims 2, 7, 12 (and 17) have overcome the rejection and that the claims are in condition for allowance. Accordingly, applicant respectfully requests the rejections and objections be withdrawn and the claims be allowed.

The Examiner is requested to call the undersigned at (908) 376-3104 if there remains any issue with allowance of the case.

Please charge any shortage to our Deposit Account No. 60-2313.

Respectfully submitted,

ZHONG LAW, LLC

Date: August 22, 2022

/Jialin Zhong/
Jialin Zhong
Reg. No.: 62,937

51 JFK Parkway, First Floor West
Short Hills, New Jersey 07078

Electronic Acknowledgement Receipt	
EFS ID:	46456436
Application Number:	17143180
International Application Number:	
Confirmation Number:	3253
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	155075
Filer:	Jialin Zhong/Eddie Rowell
Filer Authorized By:	Jialin Zhong
Attorney Docket Number:	20160089-PCT-US-DA1
Receipt Date:	22-AUG-2022
Filing Date:	07-JAN-2021
Time Stamp:	13:38:31
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		ZL0205-0002-PCT-US-CON1_Resp_to_NFOA_mailed_5-25-2022.pdf	95100 291d4526984958 2c6f3e40c53ac72c812d6604ee	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Request for Reconsideration-After Non-Final Rejection	1	1
	Specification	2	2
	Claims	3	9
	Applicant Arguments/Remarks Made in an Amendment	10	12
Warnings:			
Information:			
	Total Files Size (in bytes):	95100	

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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.

Doc Code: DIST.E.FILE Document Description: Electronic Terminal Disclaimer - Filed	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	17143180
Filing Date	07-Jan-2021
First Named Inventor	Xiaobo ZHANG
Attorney Docket Number	20160089-PCT-US-DA1
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
APEX BEAM TECHNOLOGIES LLC	100%

The owner(s) with 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 prior patent number(s)

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as the term of said prior patent is presently shortened by any terminal disclaimer. 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 the prior patent 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 the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- 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 presently shortened by any terminal disclaimer.

◉ 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 62937

○ 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	/Jialin Zhong/
Name	Jialin Zhong

*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:	17143180
Filing Date:	07-Jan-2021
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Filer:	Jialin Zhong/Eddie Rowell
Attorney Docket Number:	20160089-PCT-US-DA1

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.: 17143180

Filing Date: 07-Jan-2021

Applicant/Patent under Reexamination: ZHANG

Electronic Terminal Disclaimer filed on August 22, 2022

☒ 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:	46456343
Application Number:	17143180
International Application Number:	
Confirmation Number:	3253
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	155075
Filer:	Jialin Zhong/Eddie Rowell
Filer Authorized By:	Jialin Zhong
Attorney Docket Number:	20160089-PCT-US-DA1
Receipt Date:	22-AUG-2022
Filing Date:	07-JAN-2021
Time Stamp:	13:36:34
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	E20228LD36304961
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	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	41283 baf958b2b9b861c946e6e0699bf936a22e9c6c85f	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38347 562403b57b791d981916d19ebc5cc709707362fd	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	79630		

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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/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/143,180	Filing Date 01/07/2021	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $240 =	
☐ 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).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2				TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT	08/22/2022	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	= 0		x $240 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/FELICIA R FARMER/
*** 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 number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. 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 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.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/143,180	01/07/2021	Xiaobo ZHANG	20160089-PCT-US-DA1	3253

155075 7590 08/08/2022

Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

EXAMINER
BELUR, DEEPA

ART UNIT	PAPER NUMBER
2472	

NOTIFICATION DATE	DELIVERY MODE
08/08/2022	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):

ip@remotedocket.com
szhao@zhong-law.com
zhong@zhong-law.com

Applicant-Initiated Interview Summary	Application No. 17/143,180	Applicant(s) ZHANG, Xiaobo		
	Examiner DEEPA BELUR	Art Unit 2472	AIA (First Inventor to File) Status Yes	Page 1 of 1

All Participants (applicant, applicants representative, PTO personnel)	Title	Type
DEEPA BELUR	Primary Examiner	Telephonic
Mr. Jilian Zhong	Attorney	

Date of Interview: 02 August 2022

Issues Discussed:

Other

The 35 U.S.C. 112(b) rejections for claims 2, 7 and 12 were discussed, based on sample amendment to claim 2. The amendment overcomes the 35 U.S.C. 112(b) rejection. A new search and reconsideration of all the claims will be made based on the actual amendments. No agreement was reached regarding patentability.

/DEEPA BELUR/ Primary Examiner, Art Unit 2472	

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/143,180	01/07/2021	Xiaobo ZHANG	20160089-PCT-US-DA1	3253

155075 7590 05/25/2022

Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

EXAMINER
BELUR, DEEPA

ART UNIT	PAPER NUMBER
2472	

NOTIFICATION DATE	DELIVERY MODE
05/25/2022	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):

ip@remotedocket.com
szhao@zhong-law.com
zhong@zhong-law.com

Office Action Summary	Application No. 17/143,180	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 01/07/2021.

☐ 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 01/07/2021 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.

1. This action is in response to the application filed on 01/07/2021.

2. Claims 1-20 have been examined and rejected.

Double Patenting

3. 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.

4. Claim 1 together with claim 2 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claim 1 of US Patent No. 10,944,527 (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 US patent. That is, claims 1-2 are anticipated by claim 1 of the US Patent.

This is a non-provisional nonstatutory double patenting rejection because the patentably indistinct claims have in fact been patented.

Firstly, the underlined limitation of claim 1 of the instant application is used to determine first resource pool using the second antenna vector. The underlined limitation of claim 1 of the US patent is used to determine the resource pool using both the first antenna vector and the second antenna vector.

Secondly, the italicized limitations in claim 2 of the instant application map to the italicized limitations in claim 1 of the US Patent, 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	**17/143,180 (instant application)**	**10,944,527 (US Patent)**
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 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; a second antenna virtualization vector is associated with the first antenna port group; the second antenna virtualization vector	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

	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; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.	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.*	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 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.

5. Claims 2, 7, 12 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.

Claim 2 recites in part: "... ***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***". It is not clear whether 1) the UE is receiving or transmitting the second radio signal 2) who is the "transmitter of the second signaling in the first time resource sub-pool". 3) It is not clear what the limitation "operating" is for, making these claims unclear and hence indefinite.

Claim 7 recites in part: "... ***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;".*** It is not clear whether 1) the UE is receiving or transmitting the second radio signal 2) who is the "transmitter of the second signaling in the first time resource sub-pool". 3) It is not clear what the limitation "performing" is for, making these claims unclear and hence indefinite.

Claim 12 recites in part: "...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;". It is not clear whether 1) the UE is receiving or transmitting the second radio signal 2) who is the "transmitter of the second signaling in the first time resource sub-pool". 3) It is not clear what the limitation "operating" is for, making these claims unclear and hence indefinite.

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 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 published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-

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Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DEEPA BELUR/
Primary Examiner, Art Unit 2472

Notice of References Cited	Application/Control No. 17/143,180	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-20170373743-A1	12-2017	PARK; Jonghyun	H04L25/0204	1/1
*	B	US-20170041113-A1	02-2017	Park; Hanjun	H04L5/0057	1/1
*	C	US-20160157218-A1	06-2016	Nam; Young-Han	H04B7/0632	370/329
*	D	US-20150341100-A1	11-2015	KWAK; Youngwoo	H04L5/0048	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	CN-104853417-B	08-2018	CN	DUAN R	
	O	CN-104852756-B	09-2018	CN	DUAN R	
	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.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	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	05/20/2022								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

CPC - Searched*		
Symbol	Date	Examiner
H04L5/005.cpc.	05/20/2022	DB
H04B7/0408.cpc.	05/20/2022	DB
H04B7/0413.cpc.	05/20/2022	DB
H04B7/06.cpc.	05/20/2022	DB
H04B7/0617.cpc.	05/20/2022	DB
H04L1/0003.cpc.	05/20/2022	DB
H04L1/1819.cpc.	05/20/2022	DB
H04L5/0082.cpc	05/20/2022	DB
H04W88/02.cpc.	05/20/2022	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.

/DEEPA BELUR/ Primary Examiner, Art Unit 2472	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/143,180	ZHANG, Xiaobo
	Examiner	Art Unit
	DEEPA BELUR	2472

Search Notes		
Search Notes	**Date**	**Examiner**
H04L5/005.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/0408.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/0413.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/06.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04B7/0617.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04L1/0003.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04L1/1819.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04L5/0082.cpc. in combination with text search, see search history printout	05/20/2022	DB
H04W88/02.cpc. in combination with text search, see search history printout	05/20/2022	DB
Inventor and Assignee search in PE2E - see search history printout	05/20/2022	DB
NPL search in chrome and google scholar	05/20/2022	DB

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/DEEPA BELUR/ Primary 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	17143180
Filing Date	2021-01-07
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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
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	1							

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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]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	ZL0205-0002-PCT-US-CON1

	1	TSG RAN WG1, "R1-1608690 Remaining issues on aperiodic CSI-RS," 3GPP20161001, 2016, pp. 1-5	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/DEEPA BELUR/ (05/19/2022)	Date Considered	05/19/2022

*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	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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	/Jialin Zhong/	Date (YYYY-MM-DD)	2022-03-11
Name/Print	Jialin Zhong	Registration Number	62937

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

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Application Number	17143180
Filing Date	2021-01-07
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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	3	105656607	CN	A	2016-06-08	Xiaobo Zhang		☒

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	4	2016077584	WO	A1	2016-05-19	Lee et al.		☐

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Signature	/Jialin Zhong/	Date (YYYY-MM-DD)	2022-02-28
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Web Search History

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5/20/2022 1:08:43 PM	Google Scholar	antenna virtualization in mimo
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digital front end, main processing unit of base band and channel functional division method

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INVENTOR INFORMATION

NAME	CITY	STATE	ZIP CODE	COUNTRY
Duan, Ran	N/A	N/A	N/A	N/A
YUAN, Yan-nan	N/A	N/A	N/A	N/A
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Abstract

Embodiments of the invention provide a digital front end, a base band main processing unit and channel functional division method, wherein the digital front end comprises a control module for obtaining control information sent by the main baseband processing unit of a processing module. used according to the control information, the channel level processing flow of cell processing, generating the processed data, and through exchange network sent to the main baseband processing unit, wherein the cell processing procedure comprises: signal processing flow to the cell load change irrelevant. solution of the invention can realize dynamic exchange of internal data of the base band pool by dynamic migration of UE processing load mode, reduces the integral power consumption of the baseband pool.

Description

INVENTION-TITLE

digital front end, main processing unit of base band and channel functional division method
technical field
The invention relates to wireless network communication field, especially a digital front end, main baseband processing unit and channel functional division method.
background technology
current system architecture of wireless network C-RAN new green evolution, distributed wireless network mainly composed of distal end radio frequency unit (RRU) and an antenna, comprising a light transmission network of high bandwidth, low latency connection distal end radio frequency unit, general processor and real-time virtual technology of centralized baseband processing pool. the base band processing unit and remote end radio frequency unit connected together by optical transmission network of high bandwidth and low latency. baseband processing unit (BBU) collectively form the base band pool at one physical site. the baseband pool in the plurality of baseband processing unit through a high-bandwidth, low-latency, low-cost flexible topology, cross connection. band applications requiring base station virtualization technology, which supports the virtual distribution and combination of baseband pool physical resources and calculating ability. a plurality of BBU interconnection in the centralized base station interconnection architecture consisting of high capacity, low delay. distal end of the RRU exchange any one BBU in the centralized baseband pool through interconnection architecture. In this way the present BBU to centralized integration, can effectively achieve carrier load balancing, disaster-tolerant backup and improve the utilization ratio of equipment, reduces the station room number, the purpose of reducing the energy consumption.
in the existing technical solution to DSP (digital signal processor) and FPGA (field programmable gate array) implementation to realize the base band pool or replaced by general processing CPU DSP physical layer processing function of the BBU. but the two types of solution, the BBU are all flow to finish the base band processing by a DSP or CPU, cannot realize the baseband pool internal data in dynamic switching, and power consumption of the whole base band pool is also high.
summary of the invention
The technical problem to be solved by the invention is to provide a digital front end, a base band main processing unit and channel functional division method to realize base band pool internal data in the dynamic switching, and reduces the power consumption of the whole baseband pool.
To solve the above technical problem, an embodiment of the present invention provides the following technical scheme:
A digital front end, comprising:
control module used for obtaining the control information sent by the base band main processing unit;
processing module, used for according to the control information, the channel of the cell level processing flow to generate the processed data, and through exchange network sent to the main baseband processing unit, wherein the cell processing procedure comprises: signal processing to the cell load change irrelevant.
wherein said processing module includes:
uplink processing sub-module, used for according to the control information, processing the cell-level processing flow of an uplink channel, generating the processed data, and through switching network sending to the baseband main processing unit;
downlink processing sub-module, used for according to the control information, processing the cell-level processing process of the downlink channel, generating and sending the processed data to the remote end radio frequency unit connected with the digital front end.
wherein the uplink processing sub-module comprises:
the first uplink-sub-module, used for according to the control information for the uplink shared channel (PUSCH) and uplink public control channel PUCCH cell level processing pre-processing process, obtaining a first processing result;
the second uplink pre-treatment sub-module, used for according to the control information, pre-processing the cell-level processing flow of the random access channel RACH to obtain a second processing result;
the third uplink pre-processing sub-module, used for according to the control information, the uplink channel quality measuring SRS channel cell level processing pre-processing process, obtaining a third processed result.
wherein the first uplink-sub-module is specifically used for obtaining the uplink shared channel (PUSCH) and cell-level process flow of an uplink common control channel PUCCH of time domain data to half-carrier offset

compensation. After the AGC gain processing and Fourier FFT transform, radio bearer of the current sub-frame to obtain the frequency domain data, and the main baseband processing unit sends the RB resource allocating instruction, obtaining the frequency domain data of effective RB, as the first processing result.
wherein the second uplink pre-processing sub-module is specifically used for according to the band main processing unit sending RACH channel occupying resources instruction, the cell processing procedure of random access channel RACH time-domain sampling and low-pass filtering the data after the gain AGC processing and Fourier FFT transformed into frequency domain data, as the second processing result.
14 symbols wherein the third uplink pre-processing sub-module is specifically used for measuring uplink channel quality SRS configuration information according to the base band sent by the main processing unit, the cell level processing flow of SRS channel of uplink sub-frame in the last symbol independent of gain AGC processing, and extracting the effective data, obtaining a third processed result.
wherein the uplink processing sub-module further comprising:
the first uplink cache sub-module for storing the first processing result;
the second uplink cache sub-module, for storing the second processing result;
the third uplink cache sub-module for storing the third processed result;
uplink caching data dispatching module, used for according to the control information, the first uplink cache sub-module, the second uplink cache sub-module and/or the third uplink cache of data sub-module to send to the main baseband processing unit.
wherein, the control module comprises:
first control interface, for sending the uplink state information and port mapping table data to said first uplink pre-processing sub module;
the second control interface is used for sending physical random access channel PRACH central frequency to the second uplink pre-processing sub module;
the third control interface for sending the uplink channel quality measuring SRS configuration information to the third uplink pre-processing sub module;
the fourth control interface for transmitting the target MAC address to the uplink cache data dispatching module, indicating the uplink cache data scheduling module transmits the first uplink cache sub-module, the second uplink cache sub-module and/or the third uplink cache of data sub-module is sent to the main baseband processing unit through PCIe interface or Ethernet.
wherein, the downlink processing sub-module comprises:
the first downlink data processing sub-module, for obtaining the base band main processing unit establishing the static configuration information sent by the cell and processing;
the second downlink data processing sub-module for downlink static data of the small region to obtain the baseband main processing unit after establishing the cell sending and processing;
the third downlink data processing sub-module, for obtaining the base band sent by the main processing unit, for each downlink sub-frame data needed to be processed control information and processing;
the fourth downlink data processing sub-module, for obtaining the base band sent by the main processing unit, for each downlink sub-frame data to be processed, and processing.
wherein the downlink static data comprises the physical broadcast channel PBCH data, main synchronous signal PSS, a secondary synchronization signal SSS, common pilot signal CRS and the cell parameter;
the second downlink data processing sub-module is specifically used for caching the downlink static data, and according to the cell parameter of the cache, generating a physical broadcast channel PBCH data, main synchronous signal PSS, a secondary synchronization signal SSS and common pilot signal CRS.
wherein the downlink every subframe data to be processed comprises: data of the physical downlink shared channel PDSCH, physical hybrid automatic retransmission of data indicating channel PHICH after coding, data physical common control channel PDCCH scrambling of data after physical control format indication channel PCFICH after scrambling the PDSCH mapping information, PHICH/PDCCH/PCFICH map information, power control information and sending port to the mapping information of the antenna channel;
the fourth data of downlink data processing sub-module is specifically used for according to the PDSCH mapping information, PHICH/PDCCH/PCFICH map information, power control information and mapping information of the sending port to antenna channel to finish the data after coding to the PDSCH, PHICH after channel coding, the data scrambling PDCCH, PCFICH scrambling data to mapping antenna channel.
Embodiments of the invention also provide a base band main processing unit, comprising:

uplink processing module for receiving the digital front end of a channel of the cell processing flow generated after processing the data, and the data processed by the digital front end processing flow for user-level process to obtain the uplink process result;
downlink processing module for processing the data of the relevant downlink channel to user-level process flow of processing to obtain the down processing result, wherein the user-level process flow comprises processing signal related to user load number.
wherein the uplink processing module comprises:
first uplink processing sub-module is used for distributing to the physical uplink data of the digital front end shared channel PUSCH channel after processing in a user-level process flow of processing, generating first uplink processing result;
the second uplink processing sub-module is used for distributing the data in the digital front end to the physical uplink control channel PUCCH channel in the processed user-level process flow of processing, generating second uplink processing result;
the third uplink processing sub-module is used for distributing the uplink channel quality measurement data channel in the user-level process flow of processing, generating the third uplink processing result;
a fourth processing sub-module, which is used for the data of the digital front end distribution in the physical random access channel PRACH channel of the processed user-level processing flow of processing, generating the fourth uplink processing result.
wherein the downlink processing module comprises:
first downlink processing sub-module for processing of the data in the broadcast channel for user-level process flow to obtain the first downlink processing result;
the second downlink sub-module, which is used for processing the data in the control type channel processing flow for user-level process to obtain the second downlink processing result;
the third downlink sub-module, which is used for processing the data of the physical downlink shared channel PDSCH to user-level process, obtaining a third downlink processing result.
Embodiments of the invention also provide a base band processing unit, comprising: a digital front end, further comprising: said main baseband processing unit.
wherein the digital front end with said main base band processing unit through the PCIe interface or Ethernet connection.
Embodiments of the invention also provide a channel function division method, comprising:
to obtain control information sent by the main baseband processing unit of digital front end, and according to the control information, the channel of the cell level processing flow to generate the processed data, and through exchange network sent to the main baseband processing unit, wherein the cell processing procedure comprises: the cell load change unrelated processing signal;
the main baseband processing unit receiving the digital front end channel of the cell level processing flow generated after processing the data, and the data processed by the digital front end for user-level process flow of processing to obtain the uplink process result, and the data of the related downlink channel to user-level processing flow of processing to obtain the down processing result, wherein the user powders to flow comprises processing signal related to user load number.
wherein the digital front end according to the control information, a channel of the cell processing to generate the processed data, and through exchange network sent to the main baseband processing unit of step comprises:
the data in the digital front end according to the control information, processing the cell-level processing process of uplink channel, producing a processed and sent to the baseband main processing unit through a switching network, or
said digital front end according to the control information, processing the cell-level processing process of the downlink channel, generating and sending the processed data to the remote end radio frequency unit connected with the digital front end.
wherein the baseband main processing unit for user-level process flow of processing of step comprises:
or the main baseband processing unit for distributing to the physical uplink data of the digital front end shared channel PUSCH channel after processing in a user-level process flow of processing, generating first uplink processing result;
the main baseband processing unit for distributing the data in the digital front end to the physical uplink

control channel PUCCH channel in the processed user-level process flow of processing, generating second uplink processing result, or
the main baseband processing unit for distributing the uplink channel quality measurement data in the SRS channel processing of the user-level process flow, generating the third uplink processing result, or
processing the base band main processing unit processes the data in the digital front end processing distribution in the physical random access channel PRACH channel of the user-level process flow, it produces the fourth uplink process result, or
the base band main processing unit to the data broadcast channel in the user-level process flow of processing to obtain first downlink processing result, or
the base band main processing unit to control data channel in the user-level process flow of processing to obtain the second downlink processing result, or
the base band main processing unit for data of the physical downlink shared channel PDSCH to user-level process, obtaining a third downlink processing result.
The embodiment of the invention has the following beneficial effects:
the solution of the invention, the data in the digital front end according to the control information sent by the main baseband processing unit of the channel of the cell level processing flow for processing to generate processed, and through exchange network sent to the main baseband processing unit; wherein the cell processing procedure comprises: processing the signal processing load change unrelated to cell, and corresponding with the user load data related to a change of the user level processing flow by the base band main processing unit, so that the base band signal when processing. after firstly processing by the digital front end, dynamically transfers the corresponding main baseband processing unit for processing, the baseband pool in dynamic data exchange; and in the baseband pool; load change irrelevant to the cell processing and user-level process associated with user load change processing, and the processing of the signal processing with the cell load change is independent of front end in the digital front end of the exchange network processing, while the load number change related to the user user-level signal is placed at a back end main baseband processing unit of the exchange network processing. baseband signal without receiving the digital front end processing after the main processing unit can be selectively closed, reducing the power consumption of the whole baseband pool.
Description
FIG. 1 an embodiment of the present invention, the whole architecture of the baseband pool;
FIG. 2 is an embodiment of the present invention, the base band pool in digital front end with the main baseband processing unit functionally divided schematic diagram;
FIG. 3 is an embodiment of the invention, the digital function module structure schematic diagram of front end;
FIG. 4 is an embodiment of the invention, the digital front end to realize specific module structure schematic diagram of uplink data transmission;
FIG. 5 is a digital front end shown in FIG. 4 realizes the uplink data sent by the specific module of the implementation flow diagram;
FIG. 6 is a digital front end shown in FIG. 4 realizes the uplink data transmission implementation flow diagram of specific modules;
FIG. 7 is a digital front end of the structure schematic diagram of specific modules descending data sent out;
FIG. 8 is a digital front end shown in FIG. 7 realizes the downlink data sent by the specific module of the flow diagram;
FIG. 9 is a digital front end shown in FIG. 7 in implementing downlink data transmission implementation flow diagram of specific modules;
FIG. 10 is a digital front end shown in FIG. 7 in implementing downlink data transmission implementation flow diagram of specific modules;
FIG. 11 a block structure diagram of the base band main processing unit of the present invention;
specific modules of the main baseband processing unit shown in FIG. 11 FIG. 12 the flow chart of uplink processing;
specific modules of the main baseband processing unit shown in FIG. 11 FIG. 13 the flowchart of a downlink processing.
Specific implementation methods

to make the technical problem to be solved by the present invention, technical solution and advantages of the present invention more clearly, the accompanying drawings and specific embodiment will be described in detail.

the following embodiment of the present invention, the base band pool (BBU) architecture such as shown in FIG. 1, comprises a rear end exchanging network and a front end switching network, wherein in back exchange network comprises: a main processing unit of base band, each of the base band main processing unit can be realized by a host computer or a server, and a plurality of base band main processing unit can communicate with each other and connecting the front end switching network comprises a digital front end, multiple digital front end are capable of mutual communication connection; and the baseband main processing unit of a digital front end corresponding to the digital front end can be connected through the PCIe interface. the digital front end and other baseband main processing unit in the baseband pool can be connected through Ethernet port. Furthermore, the architecture, the digital front end further connection with the far end radio frequency unit (RRU), every digital front end can be connected through CPRI interface (common public radio interface) with the far-end radio frequency unit (RRU).

Based on the above architecture, as shown in FIG. 2, an embodiment of the present invention, the processing of the signal processing load change unrelated to cell (i.e. cell process) processing in the digital front end processing, and the signal load number relevant to the user (i.e., user-level process flow) is processing in the main baseband processing unit for processing and connected through a switching network between band main processing unit and a digital front end, digital front end connected with the far-end radio frequency unit RRU.

Specifically, as shown in Figure 3, digital front end provided by an embodiment of the present invention comprises:

control module used for obtaining the control information sent by the base band main processing unit;

processing module, used for according to the control information, the channel of the cell level processing flow to generate the processed data, and through exchange network sent to the main baseband processing unit, wherein the cell processing procedure comprises: signal processing to the cell load change irrelevant. by the embodiment of data in a digital front end according to the control information sent by the main baseband processing unit of the channel of the cell level processing flow for processing to generate processed, and through exchange network sent to the main baseband processing unit, wherein the cell processing procedure comprises: processing the signal processing load change unrelated to cell, cell processing load refers to the communication traffic in the cell, and correspondingly, the user load data related to a change processing is processing of user-level signal by the main baseband processing unit. so that the base band signal when processing, firstly processing by the digital front end and dynamically to the corresponding base-band main processing unit processes the baseband pool in dynamic data exchange.

wherein the processing module may specifically include:

uplink processing sub-module, used for according to the control information, processing the cell-level processing flow of an uplink channel, generating the processed data, and through switching network sending to the baseband main processing unit;

downlink processing sub-module, used for according to the control information, processing the cell-level processing process of the downlink channel, generating and sending the processed data to the remote end radio frequency unit connected with the digital front end.

respectively below on uplink data of the digital front end processing and the processing of downlink data will be described:

1. The uplink data processing of the digital front end

As shown in FIG. 4, the uplink processing sub-module comprises:

the first uplink-sub-module, used for according to the control information for the uplink shared channel (PUSCH) and uplink public control channel PUCCH cell level processing pre-processing process, obtaining a first processing result;

the second uplink pre-treatment sub-module, used for according to the control information, pre-processing the cell-level processing flow of the random access channel RACH to obtain a second processing result;

the third uplink pre-processing sub-module, used for according to the control information, the uplink channel quality measuring SRS channel cell level processing pre-processing process, obtaining a third processed result.

wherein the first uplink-sub-module is specifically used for obtaining the uplink shared channel (PUSCH) and cell-level process flow of an uplink common control channel PUCCH of time domain data to half-carrier offset compensation. After the AGC gain processing and Fourier FFT transform, radio bearer of the current sub-frame to obtain the frequency domain data, and the main baseband processing unit sends the RB resource allocating instruction, obtaining the frequency domain data of effective RB, as the first processing result; and further, the frequency domain data of the effective bit width compression, to obtain the first processed result.
wherein the second uplink pre-processing sub-module is specifically used for according to the band main processing unit sending RACH channel occupying resources instruction. the cell-level processing flow obtained by random access channel RACH time-domain sampling and low-pass filtering the data after performing the gain after AGC processing and FFT Fourier transform into frequency domain data, said frequency domain data as the second processing result, and further can convert the frequency domain data bit width compression. obtaining a second processed result.
14 symbols wherein the third uplink pre-processing sub-module is specifically used for SRS (uplink channel quality measurement) configuration information according to the base band sent by the main processing unit, processing the cell-level flow of the SRS channel of the uplink sub-frame in the last symbol independent of gain AGC processing, and extracting the effective data, obtaining a third processed result.
wherein the uplink processing sub-module further comprising:
the first uplink cache sub-module for storing the first processing result;
the second uplink cache sub-module, for storing the second processing result;
the third uplink cache sub-module for storing the third processed result.
Furthermore, the uplink processing sub-module further comprises: an uplink cache data scheduling module, used for according to the control information, the first uplink cache sub-module, the second uplink cache sub-module and/or the third uplink cache of data sub-module to send to the main baseband processing unit.
wherein, the control module comprises:
first control interface, for sending the uplink state information and URB port mapping table data to said first uplink pre-processing sub module;
a second control interface for transmitting the PRACH (physical random access channel) central frequency to the second uplink pre-processing sub module;
the third control interface sends the SRS (for uplink channel quality measurement) configuration information to the third uplink pre-processing sub module;
the fourth control interface for transmitting the target MAC address to the uplink cache data dispatching module, indicating the uplink cache data scheduling module transmits the first uplink cache sub-module, the second uplink cache sub-module and/or the third uplink cache of data sub-module is sent to the main baseband processing unit through PCIe interface or Ethernet.
Specifically, as shown in FIG. 5 each uplink channel processing flow of the digital front end as follows:
1) first uplink pre-processing sub-module for uplink shared channel (PUSCH) and uplink digital pre-processing of common control channel (PUCCH);
the CPRI (common interface) from the RRU to obtain time domain data for half the carrier offset compensation, AGC processing (gain processing), FFT transform (Fourier transform), radio bearer selection, compression of the bits, so as to convert to the frequency domain. and according to high layer protocol stack (main baseband processing unit of high layer protocol stack) issues of the current sub-frame RB (radio bearer) resource allocation indicator (including position information) of the PUSCH and the PUCCH channel, after selecting the effective data. performing bit width compression the finally stored in the internal cache (first uplink cache sub-module).
2) second uplink pre-processing sub-module for RACH (random access channel) channel digital pre-processing
The pre-sent RACH channel occupying resources instruction, to execute the down-sampling and low-pass filtering the time domain signal to obtain the RACH channel of time domain data, then executes AGC (gain processing) and FFT (Fourier) transform and then converted into the frequency domain, the compressed data is stored in the internal cache (i.e., the second uplink cache sub-module).
3) pretreatment of the third uplink sub-module performs SRS channel (uplink) channel quality measurement pre-processing
The SRS configuration information sent by the high layer protocol stack, for the last symbol 14 of the symbol

of the uplink subframe in the independent AGC processing of bit width compression, and extract the relevant data into the cache.
4) uplink cache data dispatching module according to the command word and the target data address sent by the upper layer, the data (including PUSCH, PUCCH, SRS, PRACH, etc.) or transmitted on the PCIe host (server or base band main processing unit), or forwarding to other host (i.e. the server or base band main processing unit) via the Ethernet interface according to the configured address cache in the memory
5) the control module
cache the received command control word of this subframe, and according to content of the control command word indicates the working mode and the working mode of each module. the specific control information comprises:
A), an uplink state
indicating the current uplink state, including: whether the special sub-frame, number of uplink PRACH, forwarding destination address number, the SRS configuration information and so on.
specific information B), PRACH central frequency point according to the number of the uplink PRACH, the PRACH frequency point in the center of the configuration.
C), the URB port mapping table data
efficient uplink RB mapping resource indication, that indicates the UE occupying the uplink resource state
D), MAC address of the target digital front end
indicating the data of the current sub-frame distribution manner by local PCIe reporting to the host, or transmits the data through Ethernet to the other host according to MAC address of the configuration.
As shown in FIG. 6, the uplink processing logic work flow of each component sub-module is as follows:
1) receives the control information from the main baseband processing unit and cache;
2) according to the empty data frame number is equal to the control information corresponding to the sub-frame number;
3) if yes, judging according to the uplink SRS channel signal link state, respectively pre-pre-channel signal, the PUSCH/PUCCH PRACH signal;
4) cache in the channel signal into the corresponding cache;
5) according to the target MAC address, sends the data to the host (the server or the base band main processing unit) or through the Ethernet interface to other host (server or other baseband main processing unit).
2. The uplink data processing of the digital front end
As shown in FIG. 7, the downlink processing sub-module comprises:
the first downlink data processing sub-module, for obtaining the base band main processing unit establishing the static configuration information sent by the cell and processing;
the second downlink data processing sub-module for downlink static data of the small region to obtain the baseband main processing unit after establishing the cell sending and processing;
the third downlink data processing sub-module, for obtaining the base band sent by the main processing unit, for each downlink sub-frame data needed to be processed control information and processing;
the fourth downlink data processing sub-module, for obtaining the base band sent by the main processing unit, for each downlink sub-frame data to be processed, and processing.
wherein the downlink static data comprises the physical broadcast channel PBCH data, main synchronous signal PSS, a secondary synchronization signal SSS, common pilot signal CRS and the cell parameter;
the second downlink data processing sub-module is specifically used for caching the downlink static data, and according to the cell parameter of the cache, generating a physical broadcast channel PBCH data, main synchronous signal PSS, a secondary synchronization signal SSS and common pilot signal CRS.
wherein the downlink every subframe data to be processed comprises: data of the physical downlink shared channel PDSCH, physical hybrid automatic retransmission of data indicating channel PHICH after coding, data physical common control channel PDCCH scrambling of data after physical control format indication channel PCFICH after scrambling the PDSCH mapping information, PHICH/PDCCH/PCFICH map information, power control information and sending port to the mapping information of the antenna channel;
the fourth data of downlink data processing sub-module is specifically used for according to the PDSCH mapping information, PHICH/PDCCH/PCFICH map information, power control information and mapping information of the sending port to antenna channel to finish the data after coding to the PDSCH, PHICH after

channel coding, the data scrambling PDCCH, PCFICH scrambling data to mapping antenna channel. Specifically, as shown in FIG. 8, digital front end to finish downlink control channel according to the control information of the static configuration information and each subframe through the PCIe or Ethernet interface such as universal interface receives data and information from the base band main processing unit by the data distributing module in the corresponding cache, then guidance process, the resource mapping of the control module and each antenna OFDM symbol generation.
the main processing unit of the base band and the data quantity of the digital front end interface along with the load dynamic change, and the maximum is about 2M/ms.
The invention of the digital front end of the LTE system downlink function described in, it is easy to realize the base band main processing unit and data between digital front end flexibly and effectively, which is more helpful for the exchange, so as to implement CoMP and carrier transfer function.
In addition, if the digital front end also can be put in the RRU, so the data transmission bandwidth from the original CPRI19.8Gb/s to the maximum of 2Gb/s. Because the digital front end in the RRU, the data transmission bandwidth of the band main processing unit and RRU dynamic change along with the load, then can be transmitted to RRU data different from the statistical multiplexing on the transmission.
As shown in FIG. 9, uniform processing process of the downlink of each channel of digital front end comprises:
the main baseband processing unit sends the static configuration information to the digital front end;
the main baseband processing unit sends the downlink static data to the digital front end;
the main baseband processing unit sends the downlink every subframe processing control information to the digital front end;
the main baseband processing unit sends the downlink every subframe data to be processed to the digital front end;
digital front end based on configuration and control information, to process downlink data, downlink data transmission, repeatedly executing said action.
As shown in FIG. 10, the function of the downlink digital front end process, firstly, establishing the cell front band main processing unit sends the static configuration information to the digital front end, wherein the static configuration information comprises cell ID, system bandwidth and CP type;
secondly, after establishing cell band main processing unit sends downlink static data of the small area to the digital front end, wherein, downlink static data may include a physical broadcast channel PBCH, imposed by the reference signal, synchronization signal (PSS/SSS), and so on. In order to reduce the main baseband processing unit interacting with the data digital front end between the proposed downlink static data on the digital front end to cache, so it does not need to be transmitted multiple times.
again, the main baseband processing unit transmits control information required for processing of downlink every subframe to the digital front end.
Finally, main baseband processing unit sends the downlink data of each frame to be processed to the digital front end, the control information and the data is not always corresponding to the same sub-frame as downlink sub-frame data processing meets the LTE air interface time sequence can be both no absolute time of precedence relationship, then, the digital front end processing based on control information on the downlink data sent to the RRU.
the specific process, as shown in FIG. 10, the main baseband processing unit can be PCIe or Ethernet and so on to the digital front end transmitting the process-relevant data and information;
the main baseband processing unit the data after coding, the PDSCH PDSCH mapping information, PHICH channel coded data, PDCCH, PCFICH scrambling the scrambled data PHICH/PDCCH/PCFICH data, mapping information, power control information and mapping information of the sending port to antenna channel to the digital front end. the information corresponding to each downlink sub-frame, namely each ms may be different, and thus in order to reduce band main processing unit and the interface bandwidth of the digital front end, a base band main processing unit data and mapping information of the PDSCH, PDCCH, PHICH and PCFICH data compression. If the main baseband processing unit to compress the data, the digital front end is needed to be correspondingly decompressed. data compression and decompression according to the actual system, realizing the condition is an optional function.
after establishing the cell PBCH, PSS, SSS, CRS, and cell parameter will not change, therefore the main baseband processing unit only establishes the cell at the beginning of sending the PBCH scrambled data, a

ZC sequence of 2 bit representation of PSS/SSS, CRS data and plot parameters to the digital front end. if the downlink static data is not changed, then no longer transmitted to the digital front end. after receiving the data, to store it in the digital front end. then finish the PBCH data generation according to cell parameter, PSS/SSS, CRS, at last the said data mapping on the time-frequency resource to be transmitted according to the cell parameter.

As shown in FIG. 11, the embodiment of the invention further claims a base-band main processing unit, comprising:

uplink processing module for receiving the digital front end of a channel of the cell processing flow generated after processing the data, and the data processed by the digital front end processing flow for user-level process to obtain the uplink process result;

downlink processing module for processing the data of the relevant downlink channel to user-level process flow of processing to obtain the down processing result, wherein the user-level process flow comprises processing signal related to user load number.

wherein, as shown in FIG. 12, the uplink processing module of the base band main processing unit comprises:

first uplink processing sub-module is used for distributing to the physical uplink data of the digital front end shared channel PUSCH channel after processing in a user-level process flow of processing, generating first uplink processing result, specifically, for user-level process flow of the PUSCH channel comprising: A) performing channel estimation on the reference channel to obtain channel estimation result, B) multi-antenna the data domain signal equalization processing to obtain the data to be demodulated, C) performing IDFT operation to obtain the original data stream; D) de-multiplexing the received data and reporting control information; E) modulation method according to MAC layer configuration of demodulation; F) Bit-level processing (de-interleaving, de-rate matching, decoding, etc.) to obtain the original data stream, G) for CRC detection, judging correctness of received data, report data and detection result to the MAC layer;

the second uplink processing sub-module is used for distributing the data in the digital front end to the physical uplink control channel PUCCH channel in the processed user-level process flow of processing, generating second uplink processing result, specifically, For PUCCH RB block of channel processing, each PUCCH carrying the plurality of PUCCH signals, the complexity is fully determined, the process comprising: A block) by the PUCCH RB for PUCCH on reference short sequence for channel estimation; B) according to the activation decision and channel estimation result (channel estimation), detection data field is the actual sending data; C) multi-user data de-spreading to obtain a sending sequence of the UE, D) Bit level processing, decoding the PUCCH transmission of source data;

the third uplink processing sub-module is used for distributing the uplink channel quality measurement data channel in the user-level process flow of processing, generating the third uplink processing result, specifically, the SRS signal processing. the complexity of SRS period of the current online UE decision, comprising the following process flow: A) channel estimate to obtain the current SRS sequence) the SRS channel estimation result, B channel is activated, obtaining the receiving sequence of peak position, C) The peak position information and so on. calculating the TA measurement value, frequency offset estimation and channel quality measurement value;

Specifically, a fourth processing sub-module, which is used for the data of the digital front end distribution in the physical random access channel PRACH channel of the processed user-level processing flow of processing, generating the fourth uplink process result; for the PRACH channel processing, complexity of the remainder processing with the channel configuration and usage state (the number of root sequences, the current active window the number of root sequences, the effective signature number detected) and other directly related, specific processing flow comprises: A) the to-be-detected sequence point multiplying and performing the time-frequency domain conversion related detecting root sequence, B) performs multi-antenna correlation results, summing power of C) according to the valid configuration sequence detection window, after summing the result for peak power detection. judging whether it has effectively received PRACH sequence, D) judging whether it is the last root sequence, the cycle of sequence detection, in such a process, the root number sequence determines the number of cycles detected, and each root sequence is judging whether complexity probability of the PRACH signal. depends on the cell of the time service user number.

main processing unit of base band outer only comprises part of the physical layer processing, further

comprising MAC and higher layer protocol stack. MAC layer according to the measurement result of the physical layer, allocates resources to each one needs scheduling of the UE.
wherein, as shown in FIG. 13, the downlink processing module of the main baseband processing unit comprises:
first downlink processing sub-module for processing of the data in the broadcast channel for user-level process flow to obtain the first downlink processing result, broadcast channel processing only occurs once processing flow, generating the to-be-sent data, it does not need to process processing repeatedly when the cell is established;
the second downlink sub-module, which is used for processing the data in the control type channel processing flow for user-level process to obtain the second downlink processing result; control channel processing. is directly related to the bearing data of the current PDCCH/PHICH channel, only to Bit level processing to generate data to be transmitted after the resource mapping to obtain the data to be transmitted of control domain symbols, the rest operation and regardless of the number of users to be scheduled, belonging to cell level processing, down to the digital front end;
the third downlink sub-module, which is used for processing the data of the physical downlink shared channel PDSCH to user-level process to obtain the processing result of the third downlink, PDSCH channel, the processing procedure comprises: encoding, rate matching, scrambling, modulation process such as protocol standard, until the layer mapping operation, the complexity of the processing process are related to actual user distributing resource and scheduling configuration, main baseband processing unit load varies with air interface resource is changed, it is changed along with the user.
Embodiments of the invention also provide a base band processing unit, comprising: a digital front end, further comprising: said main baseband processing unit.
wherein the digital front end with said main base band processing unit through the PCIe interface or Ethernet connection.
the embodiment of the invention, the digital front end and base band main processing unit of channel function dividing method is not limited to the LTE system, and may further comprise a 3G or 5G system of the future.
The invention of the implementation solution of the base band pool, compared with traditional DSP software solution, has the following advantages:
1) of the embodiment of the invention the digital front end and a baseband function of main processing unit dividing, and realizes the data low-bandwidth dynamic baseband pool in exchange;
SRIO Serial RapidIO interface) 2) compared with the traditional DSP software scheme used by the communication interface, the embodiment of the invention uses the Ethernet interface, the Ethernet interface is more flexible, the networking capability is strong;
3) traditional DSP software solution difficult to realize baseband pool of thermal protection, but this solution is easy to realize hot standby protection.
The invention of the implementation solution of the base band pool, comparing the pure general purpose processing platform solution, embodiments of the present invention can more flexibly into baseband pool scheme based on virtual machine (VM) on a general purpose processing platform. and further the compressed channel data total throughput of the exchange network, reduce the pressure and cost of universal exchange; the processing imposed by the signal on the digital front end, fully considering the processing efficiency of the hardware imposed by fixed algorithm part, improves the performance-to-power consumption ratio of the whole system.
Embodiments of the invention also provide a base band processing unit, comprising: a digital front end, further comprising: a main baseband processing unit for supplying power to the digital front end sends the control information, and receives the digital front end transmitting the uplink data.
wherein the digital front end with said main base band processing unit through the PCIe interface or Ethernet connection.
Further, a plurality of baseband processing unit of the invention can form the base band pool, in the baseband pool, multiple digital front end can be mutually connected through a switching network, a plurality of baseband processing units can be mutually connected through a switching network, any digital front end can also be connected through data transmission network and any band main processing unit.
In addition, embodiments of the present invention also provides a channel function division method,

comprising:
step 11, digital front end to obtain control information sent by the base band main processing unit, and according to the control information, the channel of the cell level processing flow to generate the processed data, and through exchange network sent to the main baseband processing unit, wherein the cell processing procedure comprises: the cell load change unrelated processing signal;
step 12, the base band main processing unit receives the digital front end according to the control information sent by the base band main processing unit, the channel of the cell level processing flow generated after processing the data. The data and processing the digital front end after the user-level process flow of processing to obtain the uplink process result, and the data of the related downlink channel to user-level processing flow of processing to obtain the down processing result, wherein the user-level process flow comprises processing signal related to user load number.
wherein the digital front end according to the control information, a channel of the cell processing to generate the processed data, and through exchange network sent to the main baseband processing unit of step comprises:
the data in the digital front end according to the control information, processing the cell-level processing process of uplink channel, producing a processed and sent to the baseband main processing unit through a switching network, or
said digital front end according to the control information, processing the cell-level processing process of the downlink channel, generating and sending the processed data to the remote end radio frequency unit connected with the digital front end.
wherein the baseband main processing unit for user-level process flow of processing of step comprises:
or the main baseband processing unit for distributing to the physical uplink data of the digital front end shared channel PUSCH channel after processing in a user-level process flow of processing, generating first uplink processing result;
the main baseband processing unit for distributing the data in the digital front end to the physical uplink control channel PUCCH channel in the processed user-level process flow of processing, generating second uplink processing result, or
the main baseband processing unit for distributing the uplink channel quality measurement data in the SRS channel processing of the user-level process flow, generating the third uplink processing result, or
processing the base band main processing unit processes the data in the digital front end processing distribution in the physical random access channel PRACH channel of the user-level process flow, it produces the fourth uplink process result, or
the base band main processing unit to the data broadcast channel in the user-level process flow of processing to obtain first downlink processing result, or
the base band main processing unit to control data channel in the user-level process flow of processing to obtain the second downlink processing result, or
the base band main processing unit for data of the physical downlink shared channel PDSCH to user-level process, obtaining a third downlink processing result.
Further, the first uplink-sub-module, specifically to realize the function of a second uplink pre-processing sub-module and the third uplink pre-processing sub-module is applied in the step 121, it also can reach the same technical effect;
the specific implementation function of the first downlink data processing sub-module, a second downlink data processing sub-module, a third downlink data processing sub-module and a fourth downlink data processing sub-module is applied in the step 122, it also can reach the same technical effect.
various implementation of the main baseband processing unit are applied to the method of the embodiment, it also can reach the same technical effect.
The above preferred embodiments of the present invention, should be indicated, for the technical field of common technician, does not separate from the invention the principle of premise, also can make several improved and modify, these improved and polish should be regarded as the protection range of the invention.

Claims

1. A digital front end, wherein it comprises a control module for obtaining control information sent by the main baseband processing unit of a processing module, used for according to the control information, the channel of the cell level processing flow for processing to generate the processed data, and through exchange network sent to the main baseband processing unit, wherein the cell processing procedure comprises: signal processing to the cell load change irrelevant.
2. The digital front end according to claim 1, wherein the processing module comprises an uplink processing sub-module, used for according to the control information, processing the cell-level processing process of uplink channel, the generated processed data. and sending to the base band main processing unit through a switching network, downlink processing sub-module, used for according to the control information, processing the cell-level processing of downlink channel, generating and sending the processed data to the remote end radio frequency unit connected with the digital front end.
3. The digital front-end according to claim 2, wherein, said uplink processing sub-module comprises a first uplink pre-treatment sub-module, used for according to the control information. the uplink shared channel PUSCH and the uplink common control channel PUCCH cell level processing flow pre-processing to obtain the first processed result, the second uplink pre-treatment sub-module, used for according to the control information, pre-processing the cell random access channel RACH processing flow. obtaining a second processed result; the third uplink pre-processing sub-module, used for according to the control information, the uplink channel quality measuring SRS channel cell level processing pre-processing process, obtaining a third processed result.
4. The digital front end according to claim 3, wherein the first uplink-sub-module is specifically used for obtaining the uplink shared channel PUSCH and the uplink common control channel the time domain data of the cell processing procedure of PUCCH for semi-carrier offset compensation, AGC gain processing and Fourier FFT transform, radio bearer of the current sub-frame to obtain the frequency domain data, and the main baseband processing unit sends the RB resource allocating instruction, obtaining the frequency domain data of effective RB. as the first processing result.
5. The digital front-end according to claim 3, wherein the second uplink pre-processing sub-module is specifically used for according to the band main processing unit sending RACH channel occupying resources instruction, cell level processing flow to obtain the random access channel RACH time-domain sampling and low-pass filtering the data after the gain AGC processing and Fourier FFT transform and then converted into frequency domain data, obtaining a second processed result.
6. The digital front end according to claim 3, wherein the third uplink pre-processing sub-module is specifically used for the last symbol 14 of the symbol according to the uplink channel quality measuring SRS configuration information sent by the main baseband processing unit of the cell level processing flow of the SRS channel in the uplink sub-frame of the independent AGC gain processing, and extracting the effective data, obtaining a third processed result.
7. The digital front end according to claim 3, wherein the uplink processing sub-module further comprising: a first uplink cache sub-module for storing the first processing result, and a second uplink cache sub-module for storing the second processing result; the third uplink cache sub-module. for storing the third processed result, uplink cache data scheduling module, used for according to the control information, the first uplink cache sub-module, the second uplink cache sub-module and/or the third uplink cache of data sub-module to send to the main baseband processing unit.
8. The digital front-end according to claim 7, wherein said control module comprises a first control interface for transmitting uplink state information and port mapping table data to said first uplink pre-processing sub module; the second control interface is used for sending physical random access channel PRACH central frequency to the second uplink pre-treatment sub-module, a third control interface for transmitting uplink channel quality measurement the SRS configuration information to the third uplink pre-processing sub module; the fourth control interface for transmitting the target MAC address to the uplink cache data dispatching module, indicating the uplink cache data scheduling module transmits the first uplink cache sub-module, the second uplink cache sub-module and/or the third uplink cache of data sub-module is sent to the main baseband processing unit through PCIe interface or Ethernet.
9. The digital front-end according to claim 2, wherein, said down processing sub-module comprises a first downlink data processing sub-module, for obtaining the base band main processing unit establishing the static configuration information sent by the cell and processing; the second downlink data processing sub-

module, used for downlink static data of the small region to obtain the baseband main processing unit transmitted after the cell is established, and processing the third downlink data processing sub-module, for obtaining the base band downlink every subframe sent by the main processing unit to be processed control information required for the data. and processing the fourth downlink data processing sub-module, for obtaining the base band downlink every subframe sent by the main processing unit data to be processed, and processing.

10. The digital front end according to claim 9, wherein the downlink static data comprises the physical broadcast channel PBCH data, main synchronous signal PSS, secondary synchronization signal SSS. common pilot signal CRS and the level parameter, the second downlink data processing sub-module is specifically used for caching the downlink static data, and according to the cell parameter of the cache, generating a physical broadcast channel PBCH data, main synchronous signal PSS, secondary synchronization signal SSS. public pilot signal CRS.

11. The digital front-end according to claim 9, wherein the downlink sub-frame data to be processed comprises: after physical downlink shared channel PDSCH coding of data. physical hybrid automatic retransmission of data after coding of data indicator channel PHICH data physical common control channel PDCCH scrambling, physical control format indication channel PCFICH after scrambling the PDSCH mapping information, PHICH/PDCCH/PCFICH mapping information. the fourth downlink data processing sub-module is specifically used for according to the PDSCH mapping information, PHICH/PDCCH/PCFICH map information, power control information and mapping information of the sending port to the antenna channel; power control information and mapping information of the sending port to antenna channel to finish the data after coding to the PDSCH, the PHICH channel coded data, data after scrambling PDCCH, PCFICH scrambling data to mapping antenna channel.

12. A main processing unit of base band, wherein, comprising: an uplink processing module for receiving the digital front end channel of the cell level processing flow generated after processing the data, The data and processing the digital front end after the user-level process flow of processing to obtain the uplink process result, descending processing module, used for data related downlink channel to user-level processing flow of processing to obtain the down processing result, wherein the user-level process flow comprises the following steps: and user load data related to signal processing.

13. The band main processing unit according to claim 12, said uplink processing module comprises: a first uplink processing sub-module is used for distributing the physical uplink shared channel processing data in the PUSCH channel of the digital front end processed user-level process flow, generating first uplink processing result, a second uplink processing sub-module is used for distributing the data to physical uplink control channel PUCCH channel of the digital front end processed user-level processing flow of the processing. generating a second uplink processing result; the third uplink processing sub-module is used for distributing the uplink channel quality measurement data channel in the user-level process flow of processing, generating third uplink process result and a fourth uplink processing sub-module for data to the digital front end distributed in the physical random access channel PRACH channel after processing of processing user-level flow of processing, generating the fourth uplink processing result.

14. The band main processing unit according to claim 12, the said downlink processing module comprises: a first downlink processing sub-module for processing of the data in the broadcast channel for user-level process flow to obtain the first downlink processing result; the second downlink sub-module, which is used for processing the data in the control type channel for user-level processing flow of processing to obtain the second downlink processing result; the third downlink sub-module, which is used for processing the data of the physical downlink shared channel PDSCH to user-level process. obtaining a third downlink processing result.

15. A base band processing unit, wherein it comprises according to any one of claims 1-11 the digital front end, further comprising: according to any one of claims 12-14 the main baseband processing unit.

16. The base-band processing unit according to claim 15, wherein the digital front end with said main base band processing unit through the PCIe interface or Ethernet connection.

17. A channel functional division method, wherein, comprising: a digital front end to obtain control information sent by the base band main processing unit, and according to the control information, the channel of the cell level processing flow to generate the processed data. and sending to the main baseband processing unit through a switching network, wherein the cell processing procedure comprises: processing

the signal processing load change unrelated to cell; the base band main processing unit receives the digital front end of a channel of the cell processing flow for processing to generate the data; The data and processing the digital front end after the user-level process flow of processing to obtain the uplink process result, and the data of the related downlink channel to user-level processing flow of processing to obtain the down processing result, wherein the user-level process flow comprises processing signal related to user load number.

18. The channel functional division method according to claim 17, wherein, said digital front end according to the control information, the cell-level processing of the channel to generate the processed data. and sending to the main baseband processing unit through a switching network of the step comprises: said digital front end according to the control information, processing the cell-level processing flow of an uplink channel, generating the processed data, and sent to the baseband main processing unit through a switching network, or the digital front end according to the control information. the cell-level processing process of the downlink channel to generate the processed data, and sending to the far end radio frequency unit connected with the digital front end.

19. The channel functional division method according to claim 17, wherein the step of processing the base band main processing unit for user-level processing process comprises: processing the main baseband processing unit for distributing to the physical uplink data of the digital front end shared channel PUSCH channel after processing in a user-level process flow of processing, generating first uplink processing result, or the main baseband processing unit for distributing the data in the digital front end to the physical uplink control channel PUCCH channel in the processed user-level process flow, generating a second uplink processing result, or the main baseband processing unit for distributing the uplink channel quality measurement data in the SRS channel processing of the user-level process flow, generating the third uplink processing result; processing the data or the main baseband processing unit to the digital front end distribution in the physical random access channel PRACH channel of the processed user-level process flow, generating a fourth uplink processing result, or the base band main processing unit the data in the broadcast channel in the user-level process flow of processing. obtaining the first downlink processing result, or the band main processing unit to control data channel in the user-level process flow of processing to obtain the second downlink processing result, or the baseband main processing unit for data of the physical downlink shared channel PDSCH to user-level process, obtaining a third downlink processing result.

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(73)专利权人 中国移动通信集团公司
地址 100032 北京市西城区金融大街29号

(72)发明人 段然 袁雁南 孔令斌 易芝玲

(74)专利代理机构 北京银龙知识产权代理有限公司 11213
代理人 黄灿 安利霞

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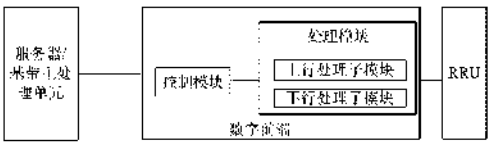
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数字前端、基带主处理单元及信道功能划分方法

(57)摘要

本发明的实施例提供一种数字前端、基带主处理单元及信道功能划分方法，其中，数字前端包括：控制模块，用于获得基带主处理单元发送的控制信息；处理模块，用于根据所述控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理流程。本发明的方案可以实现基带池中内部数据的动态交换，通过动态迁移UE级处理负载的方式，降低基带池的整体功耗。



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1.一种数字前端，其特征在于，包括：

控制模块，用于获得基带主处理单元发送的控制信息；

处理模块，用于根据所述控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理。

2.根据权利要求1所述的数字前端，其特征在于，所述处理模块包括：

上行处理子模块，用于根据所述控制信息，对上行信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给所述基带主处理单元；

下行处理子模块，用于根据所述控制信息，对下行信道的小区级处理进行处理，产生处理后的数据，并发送给与所述数字前端连接的远端射频单元。

3.根据权利要求2所述的数字前端，其特征在于，所述上行处理子模块包括：

第一上行预处理子模块，用于根据所述控制信息，对上行共享信道PUSCH和上行公共控制信道PUCCH的小区级处理流程进行预处理，得到第一处理结果；

第二上行预处理子模块，用于根据所述控制信息，对随机接入信道RACH的小区级处理流程进行预处理，得到第二处理结果；

第三上行预处理子模块，用于根据所述控制信息，对上行信道质量测量SRS信道的小区级处理流程进行预处理，得到第三处理结果。

4.根据权利要求3所述的数字前端，其特征在于，所述第一上行预处理子模块具体用于将获取的上行共享信道PUSCH和上行公共控制信道PUCCH的小区级处理流程的时域数据进行半载波偏移补偿、AGC增益处理和傅立叶FFT变换后，得到频域数据，并根据所述基带主处理单元下发的当前子帧的无线承载RB资源分配指示，获得有效RB的频域数据，作为所述第一处理结果。

5.根据权利要求3所述的数字前端，其特征在于，所述第二上行预处理子模块具体用于根据所述基带主处理单元下发的RACH信道占用资源指示，将获得的随机接入信道RACH的小区级处理流程的时域数据进行采样和低通滤波后，进行增益AGC处理和傅立叶FFT变换后，转换为频域数据，得到第二处理结果。

6.根据权利要求3所述的数字前端，其特征在于，所述第三上行预处理子模块具体用于根据所述基带主处理单元下发的上行信道质量测量SRS配置信息，对SRS信道的小区级处理流程的上行子帧的14个符号中最后一个符号进行独立的增益AGC处理，并提取有效数据，得到第三处理结果。

7.根据权利要求3所述的数字前端，其特征在于，所述上行处理子模块还包括：

第一上行缓存子模块，用于存储所述第一处理结果；

第二上行缓存子模块，用于存储所述第二处理结果；

第三上行缓存子模块，用于存储所述第三处理结果；上行缓存数据调度模块，用于根据所述控制信息，将所述第一上行缓存子模块、所述第二上行缓存子模块和/或所述第三上行缓存子模块中的数据发送给基带主处理单元。

8.根据权利要求7所述的数字前端，其特征在于，所述控制模块包括：

第一控制接口，用于发送上行链路状态信息和端口映射表数据给所述第一上行预处理子模块；

第二控制接口，用于发送物理随机接入信道PRACH中心频点给所述第二上行预处理子模块；

第三控制接口，用于发送上行信道质量测量SRS配置信息给所述第三上行预处理子模块；

第四控制接口，用于发送目标MAC地址给所述上行缓存数据调度模块，指示所述上行缓存数据调度模块将所述第一上行缓存子模块、所述第二上行缓存子模块和/或所述第三上行缓存子模块中的数据通过PCIe接口或者以太网口发送给基带主处理单元。

9.根据权利要求2所述的数字前端，其特征在于，所述下行处理子模块包括：

第一下行数据处理子模块，用于获得所述基带主处理单元在建立小区前下发的静态配置信息，并处理；

第二下行数据处理子模块，用于获得所述基带主处理单元在建立小区后发送的此小区的下行静态数据，并处理；

第三下行数据处理子模块，用于获得所述基带主处理单元下发的下行每子帧待处理数据所需的控制信息，并处理；

第四下行数据处理子模块，用于获得所述基带主处理单元下发的下行每子帧待处理数据，并处理。

10.根据权利要求9所述的数字前端，其特征在于，所述下行静态数据包括：物理广播信道PBCH数据，主同步信号PSS，辅同步信号SSS，公共导频信号CRS和小区级参数；

所述第一下行数据处理子模块具体用于缓存所述下行静态数据，并根据缓存的所述小区级参数，生成物理广播信道PBCH数据，主同步信号PSS，辅同步信号SSS，公共导频信号CRS。

11.根据权利要求9所述的数字前端，其特征在于，所述下行每子帧待处理数据包括：物理下行共享信道PDSCH预编码后的数据，物理混合自动重传指示信道PHICH编码后的数据，物理公共控制信道PDCCH加扰后的数据，物理控制格式指示信道PCFICH加扰后的数据，PDSCH映射信息，PHICH/PDCCH/PCFICH映射信息，功率控制信息和发送端口到天线通道的映射信息；

所述第四下行数据处理子模块具体用于根据所述PDSCH映射信息，PHICH/PDCCH/PCFICH映射信息、功率控制信息和发送端口到天线通道的映射信息，完成所述PDSCH预编码后的数据，PHICH信道编码后的数据，PDCCH加扰后的数据，PCFICH加扰后的数据到天线通道的映射。

12.一种基带主处理单元，其特征在于，包括：

上行处理模块，用于接收数字前端对信道的小区级处理流程进行处理后产生的数据，并对所述数字前端处理后的数据进行用户级处理流程的处理，得到上行处理结果；

下行处理模块，用于对相关下行信道的数据进行用户级处理流程的处理，得到下行处理结果；其中，所述用户级处理流程包括：与用户负载数相关的信号的处理。

13.根据权利要求12所述的基带主处理单元，所述上行处理模块包括：

第一上行处理子模块，用于对分发到物理上行共享信道PUSCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第一上行处理结果；

第二上行处理子模块，用于对分发到物理上行链路控制信道PUCCH信道中的所述数字

前端处理后的数据进行用户级处理流程的处理，产生第二上行处理结果；

第三上行处理子模块，用于对分发到上行信道质量测量SRS信道中的数据进行用户级处理流程的处理，产生第三上行处理结果；

第四上行处理子模块，用于对分发到物理随机接入信道PRACH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第四上行处理结果。

14.根据权利要求12所述的基带主处理单元，所述下行处理模块包括：

第一下行处理子模块，用于对广播类信道中的数据进行用户级处理流程的处理，得到第一下行处理结果；

第二下行处理子模块，用于对控制类信道中的数据进行用户级处理流程的处理，得到第二下行处理结果；

第三下行处理子模块，用于对物理下行共享信道PDSCH的数据进行用户级处理流程处理，得到第三下行处理结果。

15.一种基带处理单元，其特征在于，包括：如权利要求1－11任一项所述的数字前端；还包括：如权利要求12－14任一项所述的基带主处理单元。

16.根据权利要求15所述的基带处理单元，其特征在于，所述数字前端与所述基带主处理单元通过PCIe接口或者以太网络连接。

17.一种信道功能划分方法，其特征在于，包括：

数字前端获得基带主处理单元发送的控制信息，并根据所述控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理；

所述基带主处理单元接收所述数字前端对信道的小区级处理流程进行处理后产生的数据，并对所述数字前端处理后的数据进行用户级处理流程的处理，得到上行处理结果；并对相关下行信道的数据进行用户级处理流程的处理，得到下行处理结果；其中，所述用户级处理流程包括：与用户负载数相关的信号的处理。

18.根据权利要求17所述的信道功能划分方法，其特征在于，所述数字前端根据所述控制信息，对信道的小区级处理进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元的步骤包括：

所述数字前端根据所述控制信息，对上行信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给所述基带主处理单元；或者

所述数字前端根据所述控制信息，对下行信道的小区级处理流程进行处理，产生处理后的数据，并发送给与所述数字前端连接的远端射频单元。

19.根据权利要求17所述的信道功能划分方法，其特征在于，所述基带主处理单元进行用户级处理流程的处理的步骤包括：

所述基带主处理单元对分发到物理上行共享信道PUSCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第一上行处理结果；或者

所述基带主处理单元对分发到物理上行链路控制信道PUCCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第二上行处理结果；或者

所述基带主处理单元对分发到上行信道质量测量SRS信道中的数据进行用户级处理流程的处理，产生第三上行处理结果；或者

所述基带主处理单元对分发到物理随机接入信道PRACH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第四上行处理结果；或者

所述基带主处理单元对广播类信道中的数据进行用户级处理流程的处理，得到第一下行处理结果；或者

所述基带主处理单元对控制类信道中的数据进行用户级处理流程的处理，得到第二下行处理结果；或者

所述基带主处理单元对物理下行共享信道PDSCH的数据进行用户级处理流程处理，得到第三下行处理结果。

数字前端、基带主处理单元及信道功能划分方法

技术领域

[0001] 本发明涉及通信领域无线网，特别是指一种数字前端、基带主处理单元及信道功能划分方法。

背景技术

[0002] 目前新型绿色演进的无线网络C-RAN的系统架构，主要是由远端无线射频单元(RRU)与天线组成的分布式无线网络，具备高带宽、低延迟的光传输网络连接远端无线射频单元，通用处理器和实时虚拟技术组成的集中式基带处理池。所有基带处理单元和远端无线射频单元通过高带宽、低延迟的光传输网络连接起来。基带处理单元(BBU)集中在一个物理站点构成基带池。基带池中多个基带处理单元之间通过高带宽、低延迟、灵活拓扑、低成本交叉连接。基带池上需要应用基站虚拟化技术，支持基带池物理资源和计算能力的虚拟分配和组合。

[0003] 集中式基站内多个BBU互联互通构成高容量、低延迟的互联架构。远端的RRU通过互联架构交换到集中式基带池中任一个BBU。这种方式是对现有BBU进行集中化集成，可有效实现载波负载均衡、容灾备份，并达到提高设备利用率、减少基站机房数量、降低能耗的目的。

[0004] 现有技术方案中多以DSP(数字信号处理器)+FPGA(现场可编程门阵列)的实现方式实现基带池，或者以通用处理CPU替代DSP实现BBU的物理层处理功能。但这两类方案中，BBU均是由一个DSP或者CPU来完成基带处理的所有流程，无法实现基带池中内部数据动态交换，且整个基带池的功耗也高。

发明内容

[0005] 本发明要解决的技术问题是提供一种数字前端、基带主处理单元及信道功能划分方法，实现基带池中内部数据动态交换，且降低整个基带池的功耗。

[0006] 为解决上述技术问题，本发明的实施例提供的技术方案如下：

[0007] 一种数字前端，包括：

[0008] 控制模块，用于获得基带主处理单元发送的控制信息；

[0009] 处理模块，用于根据所述控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理。

[0010] 其中，所述处理模块包括：

[0011] 上行处理子模块，用于根据所述控制信息，对上行信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给所述基带主处理单元；

[0012] 下行处理子模块，用于根据所述控制信息，对下行信道的小区级处理流程进行处理，产生处理后的数据，并发送给与所述数字前端连接的远端射频单元。

[0013] 其中，所述上行处理子模块包括：

[0014] 第一上行预处理子模块，用于根据所述控制信息，对上行共享信道PUSCH和上行公共控制信道PUCCH的小区级处理流程进行预处理，得到第一处理结果；

[0015] 第二上行预处理子模块，用于根据所述控制信息，对随机接入信道RACH的小区级处理流程进行预处理，得到第二处理结果；

[0016] 第三上行预处理子模块，用于根据所述控制信息，对上行信道质量测量SRS信道的小区级处理流程进行预处理，得到第三处理结果。

[0017] 其中，所述第一上行预处理子模块具体用于将获取的上行共享信道PUSCH和上行公共控制信道PUCCH的小区级处理流程的时域数据进行半载波偏移补偿、AGC增益处理和傅立叶FFT变换后，得到频域数据，并根据所述基带主处理单元下发的当前子帧的无线承载RB资源分配指示，获得有效RB的频域数据，作为所述第一处理结果。

[0018] 其中，所述第二上行预处理子模块具体用于根据所述基带主处理单元下发的RACH信道占用资源指示，将获得的随机接入信道RACH的小区级处理流程的时域数据进行采样和低通滤波后，进行增益AGC处理和傅立叶FFT变换后，转换为频域数据，作为第二处理结果。

[0019] 其中，所述第三上行预处理子模块具体用于根据所述基带主处理单元下发的上行信道质量测量SRS配置信息，对SRS信道的小区级处理流程的上行子帧的14个符号中最后一个符号进行独立的增益AGC处理，并提取有效数据，得到第三处理结果。

[0020] 其中，所述上行处理子模块还包括：

[0021] 第一上行缓存子模块，用于存储所述第一处理结果；

[0022] 第二上行缓存子模块，用于存储所述第二处理结果；

[0023] 第三上行缓存子模块，用于存储所述第三处理结果；

[0024] 上行缓存数据调度模块，用于根据所述控制信息，将所述第一上行缓存子模块、所述第二上行缓存子模块和/或所述第三上行缓存子模块中的数据发送给基带主处理单元。

[0025] 其中，所述控制模块包括：

[0026] 第一控制接口，用于发送上行链路状态信息和端口映射表数据给所述第一上行预处理子模块；

[0027] 第二控制接口，用于发送物理随机接入信道PRACH中心频点给所述第二上行预处理子模块；

[0028] 第三控制接口，用于发送上行信道质量测量SRS配置信息给所述第三上行预处理子模块；

[0029] 第四控制接口，用于发送目标MAC地址给所述上行缓存数据调度模块，指示所述上行缓存数据调度模块将所述第一上行缓存子模块、所述第二上行缓存子模块和/或所述第三上行缓存子模块中的数据通过PCIe接口或者以太网口发送给基带主处理单元。

[0030] 其中，所述下行处理子模块包括：

[0031] 第一下行数据处理子模块，用于获得所述基带主处理单元在建立小区前下发的静态配置信息，并处理；

[0032] 第二下行数据处理子模块，用于获得所述基带主处理单元在建立小区后发送的此小区的下行静态数据，并处理；

[0033] 第三下行数据处理子模块，用于获得所述基带主处理单元下发的下行每子帧待处理数据所需的控制信息，并处理；

[0034] 第四下行数据处理子模块，用于获得所述基带主处理单元下发的下行每子帧待处理数据，并处理。

[0035] 其中，所述下行静态数据包括：物理广播信道PBCH数据，主同步信号PSS，辅同步信号SSS，公共导频信号CRS和小区级参数；

[0036] 所述第二下行数据处理子模块具体用于缓存所述下行静态数据，并根据缓存的所述小区级参数，生成物理广播信道PBCH数据，主同步信号PSS，辅同步信号SSS，公共导频信号CRS。

[0037] 其中，所述下行每子帧待处理数据包括：物理下行共享信道PDSCH预编码后的数据，物理混合自动重传指示信道PHICH编码后的数据，物理公共控制信道PDCCH加扰后的数据，物理控制格式指示信道PCFICH加扰后的数据，PDSCH映射信息，PHICH/PDCCH/PCFICH映射信息，功率控制信息和发送端口到天线通道的映射信息；

[0038] 所述第四下行数据处理子模块具体用于根据所述PDSCH映射信息，PHICH/PDCCH/PCFICH映射信息、功率控制信息和发送端口到天线通道的映射信息，完成所述PDSCH预编码后的数据，PHICH信道编码后的数据，PDCCH加扰后的数据，PCFICH加扰后的数据到天线通道的映射。

[0039] 本发明的实施例还提供一种基带主处理单元，包括：

[0040] 上行处理模块，用于接收数字前端对信道的小区级处理流程进行处理后产生的数据，并对所述数字前端处理后的数据进行用户级处理流程的处理，得到上行处理结果；

[0041] 下行处理模块，用于对相关下行信道的数据进行用户级处理流程的处理，得到下行处理结果；其中，所述用户级处理流程包括：与用户负载数相关的信号的处理。

[0042] 其中，所述上行处理模块包括：

[0043] 第一上行处理子模块，用于对分发到物理上行共享信道PUSCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第一上行处理结果；

[0044] 第二上行处理子模块，用于对分发到物理上行链路控制信道PUCCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第二上行处理结果；

[0045] 第三上行处理子模块，用于对分发到上行信道质量测量SRS信道中的数据进行用户级处理流程的处理，产生第三上行处理结果；

[0046] 第四上行处理子模块，用于对分发到物理随机接入信道PRACH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第四上行处理结果。

[0047] 其中，所述下行处理模块包括：

[0048] 第一下行处理子模块，用于对广播类信道中的数据进行用户级处理流程的处理，得到第一下行处理结果；

[0049] 第二下行处理子模块，用于对控制类信道中的数据进行用户级处理流程的处理，得到第二下行处理结果；

[0050] 第三下行处理子模块，用于对物理下行共享信道PDSCH的数据进行用户级处理流程处理，得到第三下行处理结果。

[0051] 本发明的实施例还提供一种基带处理单元，包括：如上所述的数字前端；还包括：如上所述的基带主处理单元。

[0052] 其中，所述数字前端与所述基带主处理单元通过PCIe接口或者以太网络连接。

[0053] 本发明的实施例还提供一种信道功能划分方法，包括：

[0054] 数字前端获得基带主处理单元发送的控制信息，并根据所述控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理；

[0055] 所述基带主处理单元接收所述数字前端对信道的小区级处理流程进行处理后产生的数据，并对所述数字前端处理后的数据进行用户级处理流程的处理，得到上行处理结果；并对相关下行信道的数据进行用户级处理流程的处理，得到下行处理结果；其中，所述用户处级理流程包括：与用户负载数相关的信号的处理。

[0056] 其中，所述数字前端根据所述控制信息，对信道的小区级处理进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元的步骤包括：

[0057] 所述数字前端根据所述控制信息，对上行信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给所述基带主处理单元；或者

[0058] 所述数字前端根据所述控制信息，对下行信道的小区级处理流程进行处理，产生处理后的数据，并发送给与所述数字前端连接的远端射频单元。

[0059] 其中，所述基带主处理单元进行用户级处理流程的处理的步骤包括：

[0060] 所述基带主处理单元对分发到物理上行共享信道PUSCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第一上行处理结果；或者

[0061] 所述基带主处理单元对分发到物理上行链路控制信道PUCCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第二上行处理结果；或者

[0062] 所述基带主处理单元对分发到上行信道质量测量SRS信道中的数据进行用户级处理流程的处理，产生第三上行处理结果；或者

[0063] 所述基带主处理单元对分发到物理随机接入信道PRACH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第四上行处理结果；或者

[0064] 所述基带主处理单元对广播类信道中的数据进行用户级处理流程的处理，得到第一下行处理结果；或者

[0065] 所述基带主处理单元对控制类信道中的数据进行用户级处理流程的处理，得到第二下行处理结果；或者

[0066] 所述基带主处理单元对物理下行共享信道PDSCH的数据进行用户级处理流程处理，得到第二下行处理结果。

[0067] 本发明的上述实施例具有如下有益效果：

[0068] 本发明的上述方案中，通过在数字前端中根据基带主处理单元发送的控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理；而相应的，与用户负载数变化有关的用户级处理流程则由基带主处理单元处理，从而使基带信号在处理时，首先由数字前端进行处理后，动态地转给相应的基带主处理单元进行处理，实现基带池中数据动态交换；并且在基带池中，与小区处理负载变化无关的处理和与用户负载数变化有关的用户级处理分开处理，即与小区处理负载变化无关的信号的处理放在数字前端所在的前端交换网络处理，而将与用户负载数变化有关的用户级信号放在基带主处理单元所在的后端交换网络处理，这样不需要接收数字前端处理后的信号的基带主处理单元可

以选择性关闭，降低整个基带池的功耗。

附图说明

[0069] 图1为本发明的实施例中，基带池的整体架构示意图；

[0070] 图2为本发明的实施例中，基带池中数字前端与基带主处理单元的功能划分示意图；

[0071] 图3为本发明的实施例中，数字前端的功能模块结构示意图；

[0072] 图4为本发明的实施例中，数字前端在实现上行数据发送的具体模块结构示意图；

[0073] 图5为图4所示的数字前端在实现上行数据发送的具体模块的实现流程示意图一；

[0074] 图6为图4所示的数字前端在实现上行数据发送的具体模块的实现流程示意图二；

[0075] 图7为数字前端在实现下行数据发送的具体模块的结构示意图；

[0076] 图8为图7所示的数字前端在实现下行数据发送的具体模块的实现流程示意图一；

[0077] 图9为图7所示的数字前端在实现下行数据发送的具体模块的实现流程示意图二；

[0078] 图10为图7所示的数字前端在实现下行数据发送的具体模块的实现流程示意图三；

[0079] 图11为本发明的基带主处理单元的模块结构示意图；

[0080] 图12为图11所示的基带主处理单元的具体模块实现上行处理的流程图；

[0081] 图13为图11所示的基带主处理单元的具体模块实现下行处理的流程图。

具体实施方式

[0082] 为使本发明要解决的技术问题、技术方案和优点更加清楚，下面将结合附图及具体实施例进行详细描述。

[0083] 本发明的以下实施例中所述的基带池(BBU)架构如图1所示，包括后端交换网络和前端交换网络，其中，后端交换网络中包括：基带主处理单元，每一个基带主处理单元均可以由一台主机或者一台服务器实现；且多个基带主处理单元之间可以相互通信连接；前端交换网络中包括：数字前端，多个数字前端之间可以相互通信连接；且一数字前端与该数字前端对应的基带主处理单元之间可以通过PCIe接口连接，该数字前端与基带池中的其它基带主处理单元之间可以通过以太网口连接。进一步的，该架构中，数字前端还进一步与远端射频单元(RRU)连接，每一个数字前端与远端射频单元(RRU)可以通过CPRI接口(通用公共无线接口)连接。

[0084] 基于上述架构，如图2所示，本发明的实施例中将与小区处理负载变化无关的信号的处理(即小区级处理流程)处理放在数字前端中处理，而将与用户负载数有关的信号的(即用户级处理流程)处理放在基带主处理单元中进行处理而基带主处理单元和数字前端之间通过交换网络连接，数字前端与远端射频单元RRU连接。

[0085] 具体的，如图3所示，本发明的实施例提供的数字前端包括：

[0086] 控制模块，用于获得基带主处理单元发送的控制信息；

[0087] 处理模块，用于根据所述控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理。

[0088] 该实施例通过在数字前端中根据基带主处理单元发送的控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理；小区处理负载是指小区内的通讯业务量；而相应的，与用户负载数变化有关的用户级信号的处理则由基带主处理单元处理，从而使基带信号在处理时，首先由数字前端进行处理后，动态地转给相应的基带主处理单元进行处理，实现基带池中数据动态交换。

[0089] 其中，所述处理模块具体可以包括：

[0090] 上行处理子模块，用于根据所述控制信息，对上行信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给所述基带主处理单元；

[0091] 下行处理子模块，用于根据所述控制信息，对下行信道的小区级处理流程进行处理，产生处理后的数据，并发送给与所述数字前端连接的远端射频单元。

[0092] 下面分别就数字前端的上行数据的处理以及下行数据的处理进行说明：

[0093] 1.数字前端的上行数据的处理

[0094] 如图4所示，所述上行处理子模块包括：

[0095] 第一上行预处理子模块，用于根据所述控制信息，对上行共享信道PUSCH和上行公共控制信道PUCCH的小区级处理流程进行预处理，得到第一处理结果；

[0096] 第二上行预处理子模块，用于根据所述控制信息，对随机接入信道RACH的小区级处理流程进行预处理，得到第二处理结果；

[0097] 第三上行预处理子模块，用于根据所述控制信息，对上行信道质量测量SRS信道的小区级处理流程进行预处理，得到第三处理结果。

[0098] 其中，所述第一上行预处理子模块具体用于将获取的上行共享信道PUSCH和上行公共控制信道PUCCH的小区级处理流程的时域数据进行半载波偏移补偿、AGC增益处理和傅立叶FFT变换后，得到频域数据，并根据所述基带主处理单元下发的当前子帧的无线承载RB资源分配指示，获得有效RB的频域数据，作为所述第一处理结果；并进一步的，可以对有效RB的频域数据进行位宽压缩，得到所述第一处理结果。

[0099] 其中，所述第二上行预处理子模块具体用于根据所述基带主处理单元下发的RACH信道占用资源指示，将获得的随机接入信道RACH的小区级处理流程的时域数据进行采样和低通滤波后，进行增益AGC处理和傅立叶FFT变换后，转换为频域数据，将所述频域数据作为所述第二处理结果，并进一步的，可以对将所述频域数据进行位宽压缩后，得到第二处理结果。

[0100] 其中，所述第三上行预处理子模块具体用于根据所述基带主处理单元下发的SRS(上行信道质量测量)配置信息，对SRS信道的小区级处理流程的上行子帧的14个符号中最后一个符号进行独立的增益AGC处理，并提取有效数据，得到第三处理结果。

[0101] 其中，所述上行处理子模块还包括：

[0102] 第一上行缓存子模块，用于存储所述第一处理结果；

[0103] 第二上行缓存子模块，用于存储所述第二处理结果；

[0104] 第三上行缓存子模块，用于存储所述第三处理结果。

[0105] 进一步的，所述上行处理子模块还包括：上行缓存数据调度模块，用于根据所述控制信息，将所述第一上行缓存子模块、所述第二上行缓存子模块和/或所述第三上行缓存子

模块中的数据发送给基带主处理单元。

[0106] 其中，所述控制模块包括：

[0107] 第一控制接口，用于发送上行链路状态信息和URB端口映射表数据给所述第一上行预处理子模块；

[0108] 第二控制接口，用于发送PRACH(物理随机接入信道)中心频点给所述第二上行预处理子模块；

[0109] 第三控制接口，用于发送SRS(上行信道质量测量)配置信息给所述第三上行预处理子模块；

[0110] 第四控制接口，用于发送目标MAC地址给所述上行缓存数据调度模块，指示所述上行缓存数据调度模块将所述第一上行缓存子模块、所述第二上行缓存子模块和/或所述第三上行缓存子模块中的数据通过PCIe接口或者以太网口发送给基带主处理单元。

[0111] 具体的，如图5所示数字前端的上行各信道处理流程如下：

[0112] 1)第一上行预处理子模块进行上行共享信道(PUSCH)和上行公共控制信道(PUCCH)的数字预处理：

[0113] 将CPRI(通用接口)从RRU获取的时域数据进行半载波偏移补偿、AGC处理(增益处理)，FFT变换(傅立叶变换)，无线承载的选择，比特位的压缩，从而转换到频域，并根据高层协议栈(基带主处理单元的高层协议栈)下发的当前子帧的RB(无线承载)资源分配指示(包括PUSCH和PUCCH信道的位置信息)，挑选有效RB数据后，对其进行比特位宽压缩，最终存储于内部缓存(第一上行缓存子模块)。

[0114] 2)第二上行预处理子模块进行RACH信道(随机接入信道)的数字预处理

[0115] 根据提前下发的RACH信道占用资源指示，对时域信号进行降采样和低通滤波，得到RACH信道的时域数据，而后对其进行AGC(增益处理)和FFT(傅立叶)变换后，转换为频域数据，将其压缩后，存储于内部缓存中(即第二上行缓存子模块)。

[0116] 3)第三上行预处理子模块进行SRS信道(上行信道质量测量)的预处理

[0117] 根据高层协议栈下发的SRS配置信息，针对上行子帧的14个符号中最后一个符号进行独立的AGC处理，比特位宽压缩，并提取相关的有效数据放入缓存。

[0118] 4)上行缓存数据调度模块根据上层下发的命令字和目标数据地址，将缓存于内存中的数据(包括：PUSCH、PUCCH、SRS、PRACH等)或者通过PCIe上传至主机(服务器或者基带主处理单元)，或者根据配置的地址通过以太网接口转发给其它的主机(即服务器或者基带主处理单元)

[0119] 5)控制模块

[0120] 缓存接收到本子帧的控制字命令，并根据控制命令字的内容指示上述各模块的工作模式和工作方式。具体的控制信息包括：

[0121] A)，上行链路状态

[0122] 指示当前上行链路的状态，包括：是否是特殊子帧，上行PRACH的数量，转发目的地址数量，SRS配置信息等。

[0123] B)，PRACH中心频点根据上行链路PRACH的数量，配置的PRACH中心频点的具体信息。

[0124] C)，URB端口映射表数据

[0125] 指示上行RB的有效映射资源，即指示UE占用上行资源的状态

[0126] D)，目标数字前端的MAC地址

[0127] 指示当前子帧数据的分发方式：通过本地PCIe上报给主机，或者根据配置的MAC地址将数据通过以太网口传送给其它主机。

[0128] 如图6所示，上行链路处理子模块的各组成部分的逻辑工作流程如下：

[0129] 1)从基带主处理单元接收控制信息并缓存；

[0130] 2)根据空口数据子帧号是否等于控制信息对应的子帧号；

[0131] 3)若是，则根据上行链路状态判断，分别进行SRS信道信号的预处理，PUSCH/PUCCH信道信号的预处理，PRACH信号的预处理；

[0132] 4)缓存上述信道中信号至相应的缓存中；

[0133] 5)根据目标MAC地址，将数据发送给本主机(本服务器或者本基带主处理单元)或者通过以太网接口发送给其它主机(其它服务器或者其它基带主处理单元)。

[0134] 2.数字前端的上行数据的处理

[0135] 如图7所示，所述下行处理子模块包括：

[0136] 第一下行数据处理子模块，用于获得所述基带主处理单元在建立小区前下发的静态配置信息，并处理；

[0137] 第二下行数据处理子模块，用于获得所述基带主处理单元在建立小区后发送的此小区的下行静态数据，并处理；

[0138] 第三下行数据处理子模块，用于获得所述基带主处理单元下发的下行每子帧待处理数据所需的控制信息，并处理；

[0139] 第四下行数据处理子模块，用于获得所述基带主处理单元下发的下行每子帧待处理数据，并处理。

[0140] 其中，所述下行静态数据包括：物理广播信道PBCH数据，主同步信号PSS，辅同步信号SSS，公共导频信号CRS和小区级参数；

[0141] 所述第二下行数据处理子模块具体用于缓存所述下行静态数据，并根据缓存的所述小区级参数，生成物理广播信道PBCH数据，主同步信号PSS，辅同步信号SSS，公共导频信号CRS。

[0142] 其中，所述下行每子帧待处理数据包括：物理下行共享信道PDSCH预编码后的数据，物理混合自动重传指示信道PHICH编码后的数据，物理公共控制信道PDCCH加扰后的数据，物理控制格式指示信道PCFICH加扰后的数据，PDSCH映射信息，PHICH/PDCCH/PCFICH映射信息，功率控制信息和发送端口到天线通道的映射信息；

[0143] 所述第四下行数据处理子模块具体用于根据所述PDSCH映射信息，PHICH/PDCCH/PCFICH映射信息、功率控制信息和发送端口到天线通道的映射信息，完成所述PDSCH预编码后的数据，PHICH信道编码后的数据，PDCCH加扰后的数据，PCFICH加扰后的数据到天线通道的映射。

[0144] 具体的，如图8所示，数字前端通过如PCIe或者以太网接口等通用接口接收来自基带主处理单元的数据和信息，通过数据分发模块放在对应的缓存中，然后在控制模块的指导下根据静态配置信息和每子帧的控制信息完成下行控制信道的处理、资源映射和每天线OFDM符号生成。

[0145] 基带主处理单元和数字前端间接口的数据量随负载轻重动态变化，最大值约为2M/ms。

[0146] 本发明的上述LTE系统的数字前端的下行链路功能描述中，可以更易于实现基带主处理单元和数字前端间的数据灵活有效的交换，从而，更有利于实现CoMP、载波迁移等功能。

[0147] 另外，如果将数字前端也可以放入RRU中，这样就将数据传输带宽由原有的CPRI 19.8Gb/s降至最大为2Gb/s。由于数字前端放入RRU后，基带主处理单元和RRU间的数据传输带宽随负载轻重而动态变化，那么就可以对传输到不同的RRU的数据进行传输上的统计复用。

[0148] 如图9所示，数字前端的下行各信道的统一处理流程包括：

[0149] 基带主处理单元发送静态配置信息给数字前端；

[0150] 基带主处理单元发送下行静态数据给数字前端；

[0151] 基带主处理单元发送下行每子帧处理控制信息给数字前端；

[0152] 基带主处理单元发送下行每子帧待处理数据给数字前端；

[0153] 数字前端基于配置及控制信息，进行下行数据处理，下行数据发送，依次反复执行上述动作。

[0154] 如图10所示，数字前端的下行链路的功能实现过程中，首先，在建立小区前基带主处理单元将静态配置信息发送给数字前端，其中，静态配置信息包括：小区ID、系统带宽、CP类型等；

[0155] 其次，小区建立后基带主处理单元发送此小区的下行静态数据给数字前端，其中，下行静态数据可包括：物理广播信道PBCH、小区级参考信号、主辅同步信号(PSS/SSS)等。为了减少基带主处理单元与数字前端之间交互的数据量，建议下行静态数据在数字前端上进行缓存，从而不需要多次发送。

[0156] 再次，基带主处理单元发送下行每子帧处理所需的控制信息给数字前端。

[0157] 最后，基带主处理单元发送下行每子帧待处理的数据给数字前端，上述的控制信息和数据不一定是对应同一子帧，只要下行子帧数据处理满足LTE空口时序即可，两者没有绝对的时间先后关系，然后，数字前端基于控制信息对下行数据进行处理交发送给RRU。

[0158] 具体的流程，如图10所示，基带主处理单元可以通过PCIe或者以太网口等向数字前端发送处理相关的数据和信息；

[0159] 基带主处理单元将PDSCH预编码后的数据、PDSCH映射信息、PHICH信道编码后数据、PDCCH加扰后数据、PCFICH加扰后数据、PHICH/PDCCH/PCFICH映射信息、功率控制信息和发送端口到天线通道的映射信息发送给数字前端。这些信息对应于每个下行子帧，即每个ms都可能不同，因此为了减少基带主处理单元与数字前端的接口带宽，基带主处理单元可对PDSCH、PDCCH、PHICH和PCFICH的数据和映射信息等进行数据压缩。如果基带主处理单元对数据进行了压缩，那么数字前端上需要进行相应地解压缩。数据压缩和解压缩视实际系统实现情况，是可选的功能。

[0160] 由于小区建立后PBCH、PSS、SSS、CRS和小区级参数就不在发生改变，因此基带主处理单元仅在小区建立之初发送PBCH加扰后数据、PSS/SSS的ZC序列、以2比特表示的CRS数据和小区级参数给数字前端。如果这些下行静态数据未发送改变，则不再向数字前端发送。数

字前端接收到上述数据后，对其进行存储。然后根据小区级参数完成PBCH数据生成、PSS/SSS生成、CRS生成，最后在根据小区级参数将上述数据映射在需要发送的时频资源上。

[0161] 如图11所示，本发明的实施例还提供一种基带主处理单元，包括：

[0162] 上行处理模块，用于接收数字前端对信道的小区级处理流程进行处理后产生的数据，并对所述数字前端处理后的数据进行用户级处理流程的处理，得到上行处理结果；

[0163] 下行处理模块，用于对相关下行信道的数据进行用户级处理流程的处理，得到下行处理结果；其中，所述用户级处理流程包括：与用户负载数相关的信号的处理。

[0164] 其中，如图12所示，基带主处理单元的上行处理模块包括：

[0165] 第一上行处理子模块，用于对分发到物理上行共享信道PUSCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第一上行处理结果；具体的，对于PUSCH信道的用户级处理流程包括：A)对参考信道进行信道估计，得到信道估计结果；B)对数据域信号进行多天线均衡处理得到待解调数据；C)进行IDFT操作得到原始数据流；D)解复用接收数据，上报控制信息；E)根据MAC层配置的调制方法解调；F)进行Bit级处理(解交织、解速率匹配、译码等)得到原始数据码流；G)进行CRC检测，判断接收数据的正确性，上报数据和检测结果给MAC层；

[0166] 第二上行处理子模块，用于对分发到物理上行链路控制信道PUCCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第二上行处理结果；具体的，对于PUCCH信道处理，每个PUCCH的RB块上承载了多个PUCCH信号，其复杂度完全由RB块上的PUCCH数量决定，其流程包括：A)针对PUCCH上的参考短序列进行信道估计；B)根据信道估计结果(激活判断和信道估计)，检测数据域上实际发送数据；C)多用户数据的解扩频，得到某一个UE的发送序列；D)Bit级处理，解码得到PUCCH传输的源数据；

[0167] 第三上行处理子模块，用于对分发到上行信道质量测量SRS信道中的数据进行用户级处理流程的处理，产生第三上行处理结果；具体的，SRS信号处理，其复杂度由当前在线UE的SRS周期决定，其处理流程：A)信道估计，得到当前SRS序列的信道估计结果；B)判断SRS信道是否激活，得到接收序列的峰值位置；C)根据峰值位置信息等，计算得到TA测量值、频偏估计和信道质量等测量值；

[0168] 第四上行处理子模块，用于对分发到物理随机接入信道PRACH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第四上行处理结果；具体的，对于PRACH信道处理，剩余部分处理的复杂度与信道的配置和使用状态(根序列的数量、当前根序列的有效窗个数、检测到的有效签名个数)等直接相关，具体处理流程包括：A)与待检测根序列点乘，并进行时频域转换实现根序列的相关检测；B)进行多天线相关结果的功率求和；C)根据序列的有效配置检测窗，对求和后的结果进行峰值功率检测，判断是否具有有效PRACH序列接收；D)判断是否是最后一个根序列，进行循环根序列检测；在这一过程中，根序列的个数决定了循环检测的次数，而每一个根序列上是否有PRACH信号的判断复杂度概率，取决于这一时刻的小区服务用户数。

[0169] 基带主处理单元除包含部分物理层处理外，还包括MAC及高层协议栈。MAC层根据物理层的测量结果，分配资源给每一个需要调度的UE。

[0170] 其中，如图13所示，基带主处理单元的下行处理模块包括：

[0171] 第一下行处理子模块，用于对广播类信道中的数据进行用户级处理流程的处理，

得到第一下行处理结果；广播类信道处理仅在小区建立时发生一次处理流程，生成待发送数据后，就不再进行反复的流程处理；

[0172] 第二下行处理子模块，用于对控制类信道中的数据进行用户级处理流程的处理，得到第二下行处理结果：控制信道处理，与当前PDCCH/PHICH信道的承载数据量直接相关，仅进行Bit级处理生成待发送数据后，将其进行资源映射得到控制域符号的待发送数据，余下操作与待调度用户数无关，属于小区级处理，下放至数字前端实现；

[0173] 第三下行处理子模块，用于对物理下行共享信道PDSCH的数据进行用户级处理流程处理，得到第三下行处理结果：PDSCH信道，处理流程包括：编码、速率匹配、加扰、调制等协议标准规定的流程，直至层映射操作为止，处理流程的复杂度均与实际用户分配资源和调度配置有关，基带主处理单元的负载随空口资源变化而变化，因此是随用户发生变化的。

[0174] 本发明的实施例还提供一种基带处理单元，包括：如上所述的数字前端；还包括：如上所述的基带主处理单元。

[0175] 其中，所述数字前端与所述基带主处理单元通过PCIe接口或者以太网络连接。

[0176] 本发明的上述实施例中的数字前端和基带主处理单元的信道功能划分方法不仅仅限定于LTE系统，也可包括3G或未来的5G系统。

[0177] 本发明的上述基带池的实现方案，相比较传统的DSP软件方案，具有以下优势：

[0178] 1)本发明的上述实施例通过对数字前端和基带主处理单元的功能划分，实现了基带池内部的数据低带宽动态交换；

[0179] 2)比较传统DSP软件方案的通信接口所使用的SRIO(即RapidIO接口)，本发明的实施例采用了以太网接口，以太网接口更加灵活、组网能力更强；

[0180] 3)传统DSP软件方案难以做到热保护的基带池，而本方案更易实现热备保护。

[0181] 本发明的上述基带池的实现方案，相比较纯通用处理平台方案，本发明的实施例可以更加灵活地在通用处理平台上引入基于虚拟机(VM)的基带池方案；并可更进一步压缩信道数据在交换网络中的总吞吐量，降低通用交换压力和成本；将小区级信号的处理放在数字前端实现，充分考虑了小区级固定算法部分的硬件处理效率，提高了整体系统的性能功耗比。

[0182] 本发明的实施例还提供一种基带处理单元，包括：如上所述的数字前端；还包括：基带主处理单元，用于向所述数字前端发送控制信息，并接收数字前端发送的上行数据。

[0183] 其中，所述数字前端与所述基带主处理单元通过PCIe接口或者以太网络连接。

[0184] 进一步的，本发明的多个基带处理单元还可组成基带池，在基带池中，多个数字前端可以通过交换网络相互连接，多个基带处理单元可以通过交换网络相互连接，任一数字前端也可通过数据传输网络与任一基带主处理单元连接。

[0185] 此外，本发明的实施例还提供一种信道功能划分方法，包括：

[0186] 步骤11，数字前端获得基带主处理单元发送的控制信息，并根据所述控制信息，对信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元；其中，所述小区级处理流程包括：与小区处理负载变化无关的信号的处理；

[0187] 步骤12，基带主处理单元接收所述数字前端根据所述基带主处理单元发送的控制信息，对信道的小区级处理流程进行处理后产生的数据，并对所述数字前端处理后的数据进行用户级处理流程的处理，得到上行处理结果；并对相关下行信道的数据进行用户级处

理流程的处理，得到下行处理结果；其中，所述用户级处理流程包括：与用户负载数相关的信号的处理。

[0188] 其中，所述数字前端根据所述控制信息，对信道的小区级处理进行处理，产生处理后的数据，并通过交换网络发送给基带主处理单元的步骤包括：

[0189] 所述数字前端根据所述控制信息，对上行信道的小区级处理流程进行处理，产生处理后的数据，并通过交换网络发送给所述基带主处理单元；或者

[0190] 所述数字前端根据所述控制信息，对下行信道的小区级处理流程进行处理，产生处理后的数据，并发送给与所述数字前端连接的远端射频单元。

[0191] 其中，所述基带主处理单元进行用户级处理流程的处理的步骤包括：

[0192] 所述基带主处理单元对分发到物理上行共享信道PUSCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第一上行处理结果；或者

[0193] 所述基带主处理单元对分发到物理上行链路控制信道PUCCH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第二上行处理结果；或者

[0194] 所述基带主处理单元对分发到上行信道质量测量SRS信道中的数据进行用户级处理流程的处理，产生第三上行处理结果；或者

[0195] 所述基带主处理单元对分发到物理随机接入信道PRACH信道中的所述数字前端处理后的数据进行用户级处理流程的处理，产生第四上行处理结果；或者

[0196] 所述基带主处理单元对广播类信道中的数据进行用户级处理流程的处理，得到第一下行处理结果；或者

[0197] 所述基带主处理单元对控制类信道中的数据进行用户级处理流程的处理，得到第二下行处理结果；或者

[0198] 所述基带主处理单元对物理下行共享信道PDSCH的数据进行用户级处理流程处理，得到第三下行处理结果。

[0199] 进一步的，上述第一上行预处理子模块、第二上行预处理子模块以及第三上行预处理子模块的具体实现功能均适用于该步骤121中，也能达到相同的技术效果；

[0200] 上述第一下行数据处理子模块、第二下行数据处理子模块、第三下行数据处理子模块以及第四下行数据处理子模块的具体实现功能均适用于该步骤122中，也能达到相同的技术效果。

[0201] 上述基带主处理单元的各种实现方式均适用于该方法的实施例中，也能达到相同的技术效果。

[0202] 以上所述是本发明的优选实施方式，应当指出，对于本技术领域的普通技术人员来说，在不脱离本发明所述原理的前提下，还可以作出若干改进和润饰，这些改进和润饰也应视为本发明的保护范围。

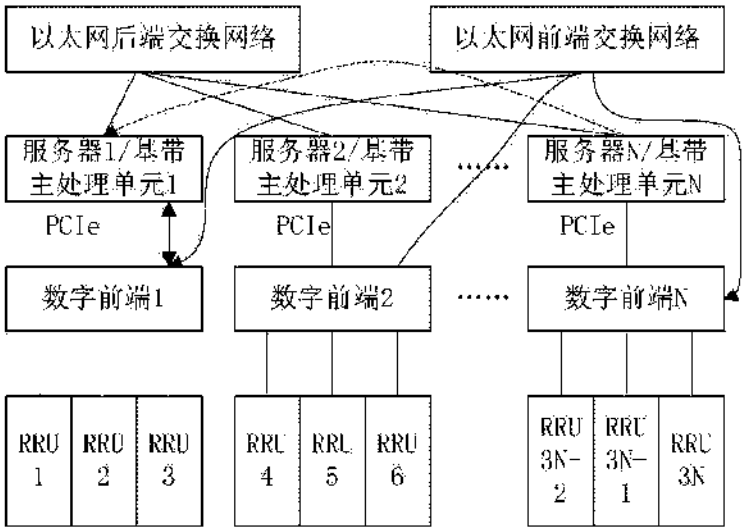

以太网后端交换网络
以太网前端交换网络
服务器1/基带主处理单元1
服务器2/基带主处理单元2
……
服务器N/基带主处理单元N
PCIe
PCIe
PCIe
数字前端1
数字前端2
……
数字前端N
RRU 1
RRU 2
RRU 3
RRU 4
RRU 5
RRU 6
RRU 3N-2
RRU 3N-1
RRU 3N

图1

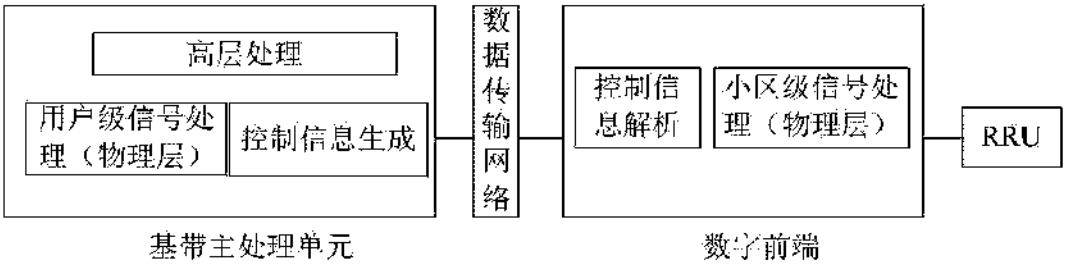

高层处理
用户级信号处理（物理层）
控制信息生成
数据传输网络
控制信息解析
小区级信号处理（物理层）
RRU
基带主处理单元
数字前端

图2

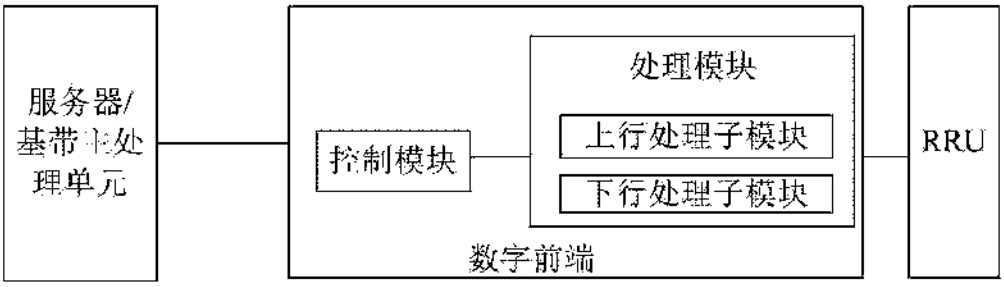

服务器/基带主处理单元
控制模块
处理模块
上行处理子模块
下行处理子模块
数字前端
RRU

图3

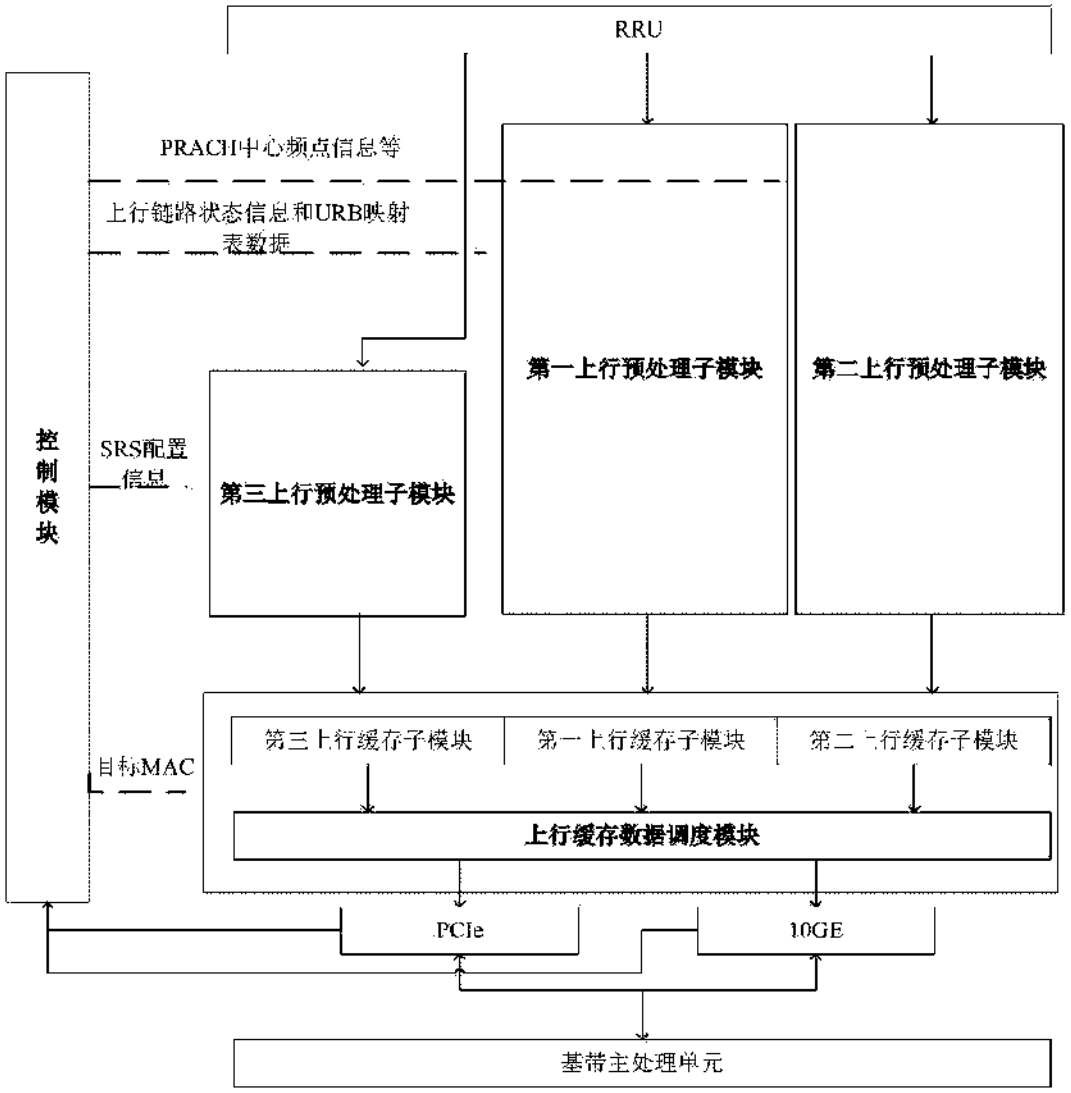

RRU
PRACH中心频点信息等
上行链路状态信息和URB映射表数据
控制模块
SRS配置信息
第三上行预处理子模块
第一上行预处理子模块
第二上行预处理子模块
目标MAC
第三上行缓存子模块
第一上行缓存子模块
第二上行缓存子模块
上行缓存数据调度模块
PCIe
10GE
基带主处理单元

图4

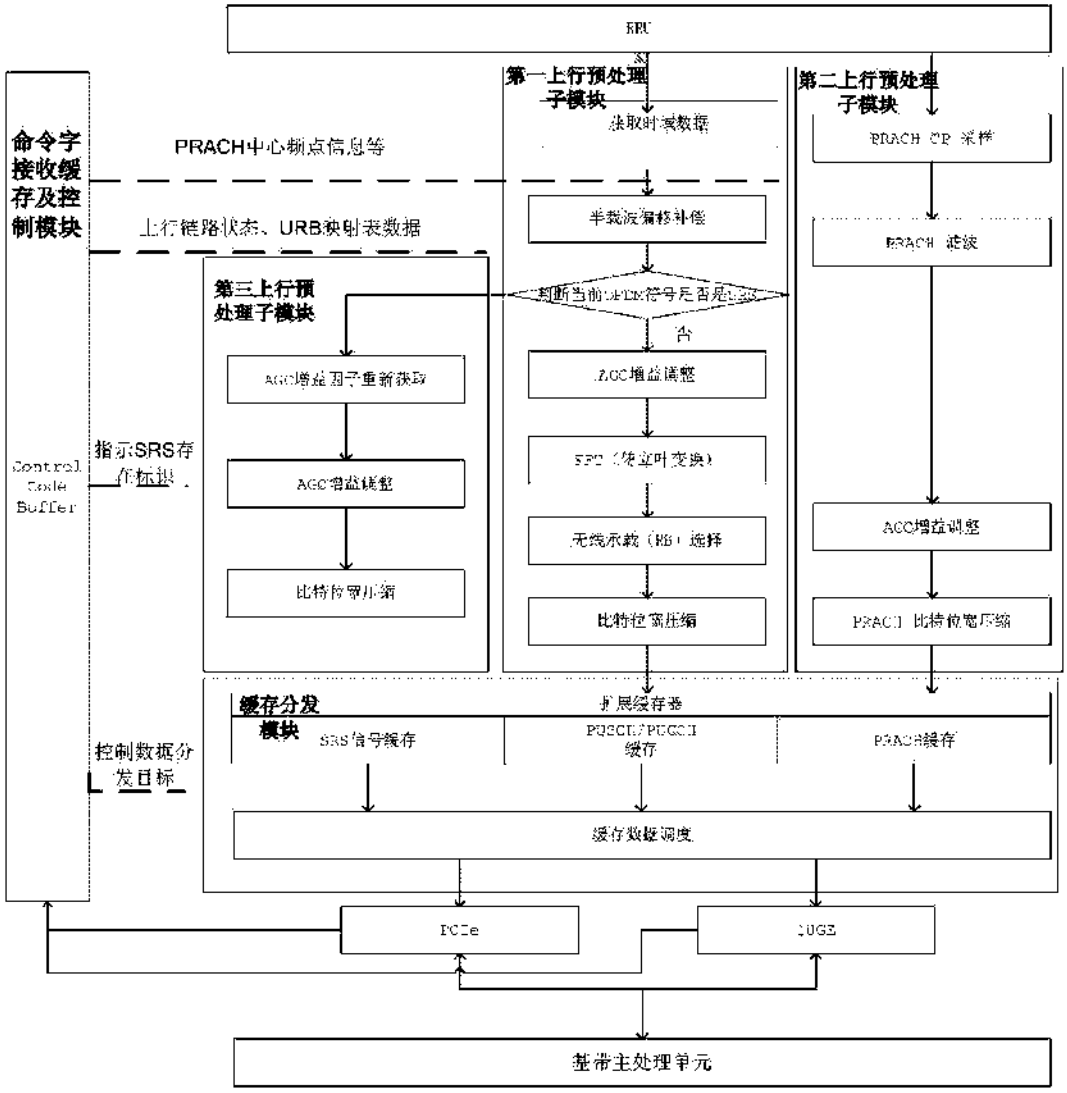

RRU
第一上行预处理子模块
第二上行预处理子模块
命令字接收缓存及控制模块
PRACH中心频点信息等
上行链路状态、URB映射表数据
第三上行预处理子模块
半载波偏移补偿
PRACH 滤波
AGC增益调整
FFT（快速叶变换）
无线承载（RB）选择
比特位宽压缩
PRACH 比特位宽压缩
AGC增益调整
比特位宽压缩
Control Code Buffer
指示SRS存储标识
缓存分发模块
扩展缓存器
SRS信号缓存
PUSCH/PUCCH缓存
PRACH缓存
控制数据分发目标
缓存数据调度
PCIe
10GE
基带主处理单元

图5

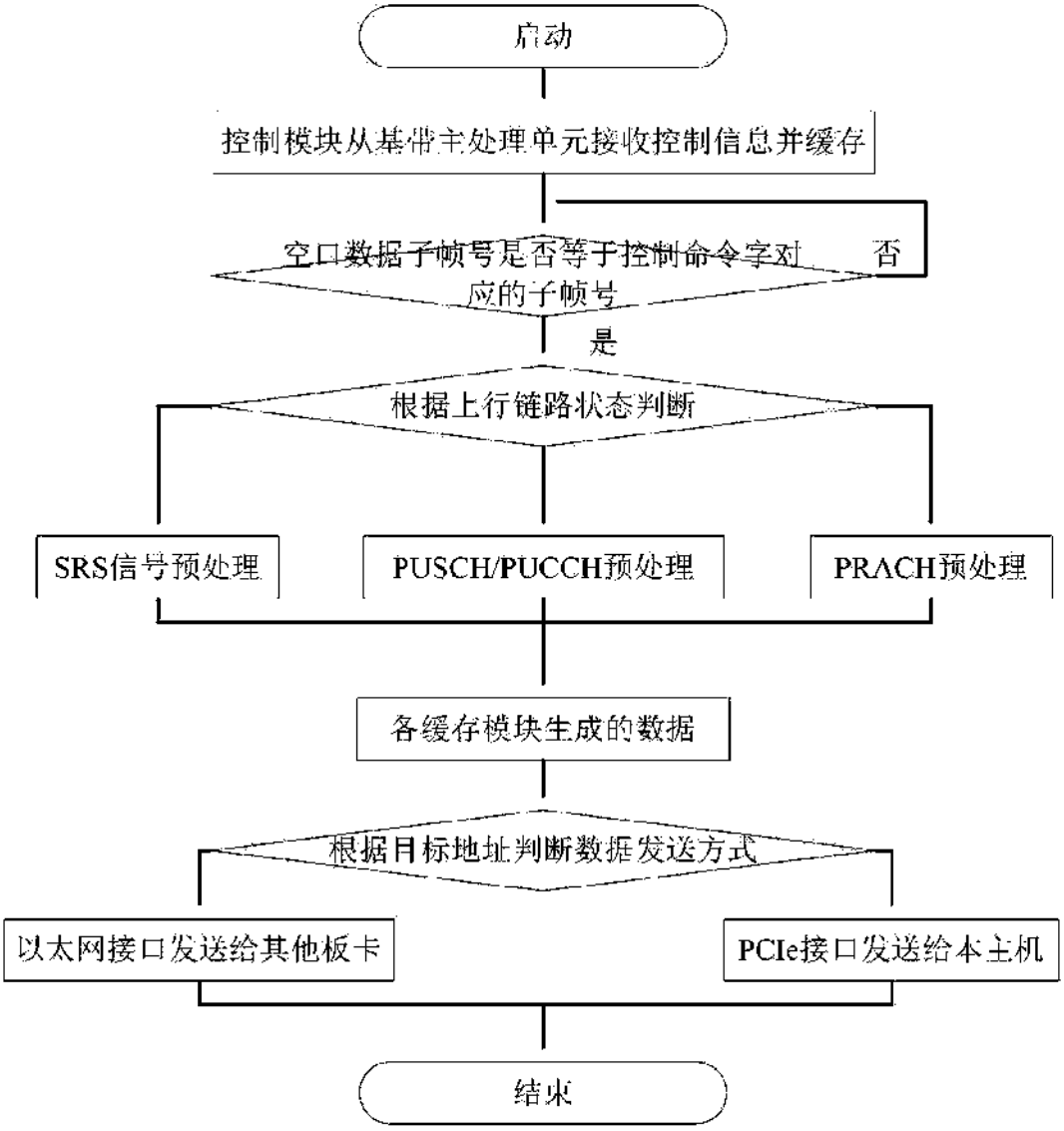

启动
控制模块从基带主处理单元接收控制信息并缓存
空口数据子帧号是否等于控制命令字对应的子帧号
否
是
根据上行链路状态判断
SRS信号预处理
PUSCH/PUCCH预处理
PRACH预处理
各缓存模块生成的数据
根据目标地址判断数据发送方式
以太网接口发送给其他板卡
PCIe接口发送给本主机
结束

图6

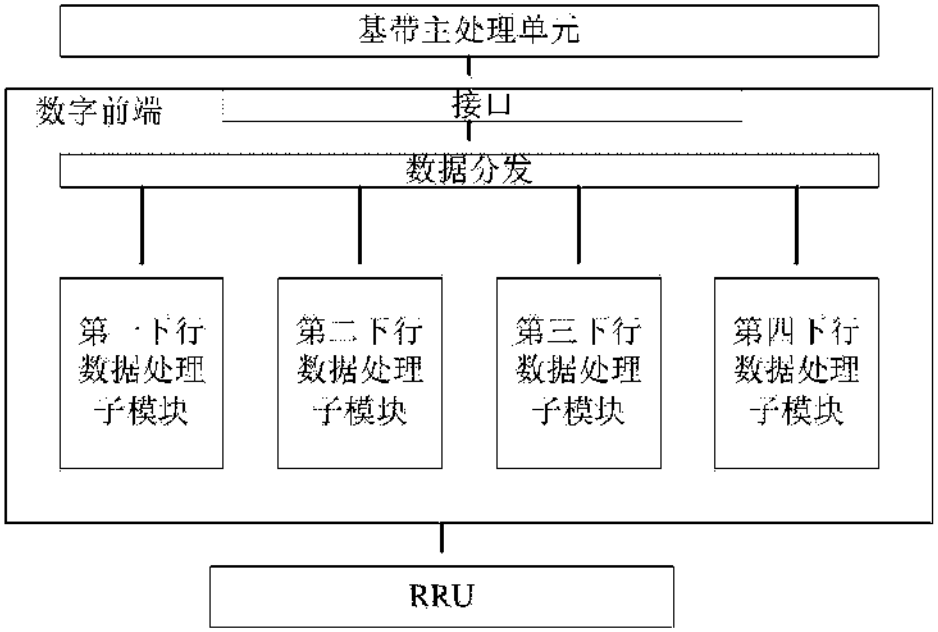

基带主处理单元
数字前端
接口
数据分发
第一下行数据处理子模块
第二下行数据处理子模块
第三下行数据处理子模块
第四下行数据处理子模块
RRU

图7

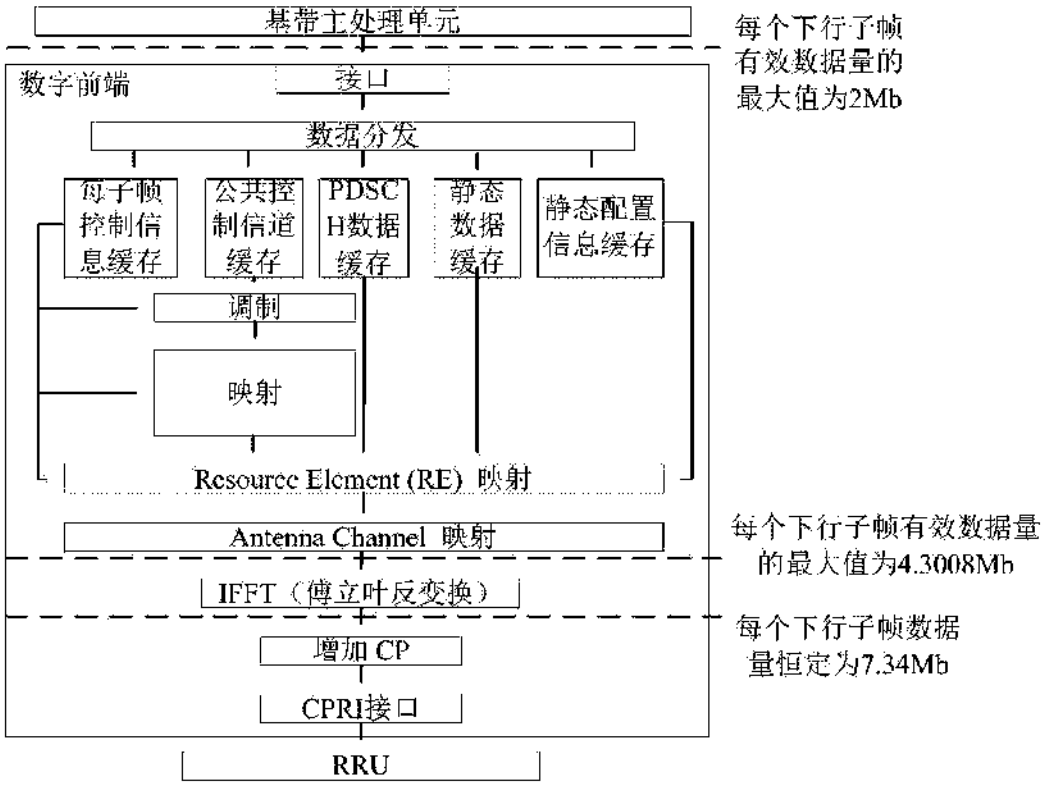

基带主处理单元
每个下行子帧
有效数据量的
最大值为2Mb
数字前端
接口
数据分发
每子帧
控制信
息缓存
公共控
制信道
缓存
PDSC
H数据
缓存
静态
数据
缓存
静态配置
信息缓存
调制
映射
Resource Element (RE) 映射
Antenna Channel 映射
每个下行子帧有效数据量
的最大值为4.3008Mb
IFFT（傅立叶反变换）
每个下行子帧数据
量恒定为7.34Mb
增加 CP
CPRI接口
RRU

图8

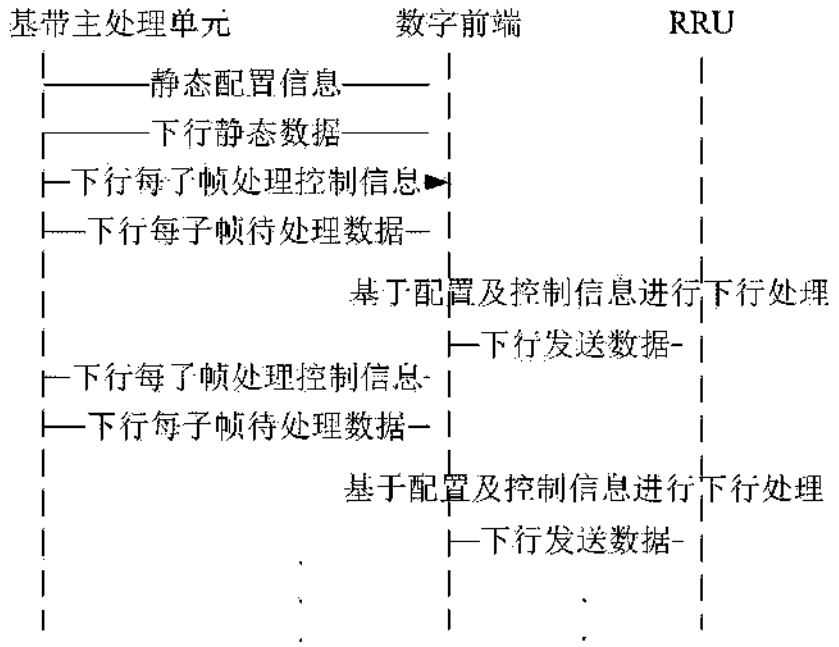

基带主处理单元
数字前端
RRU
静态配置信息
下行静态数据
下行每子帧处理控制信息
下行每子帧待处理数据
基于配置及控制信息进行下行处理
下行发送数据
下行每子帧处理控制信息
下行每子帧待处理数据
基于配置及控制信息进行下行处理
下行发送数据

图9

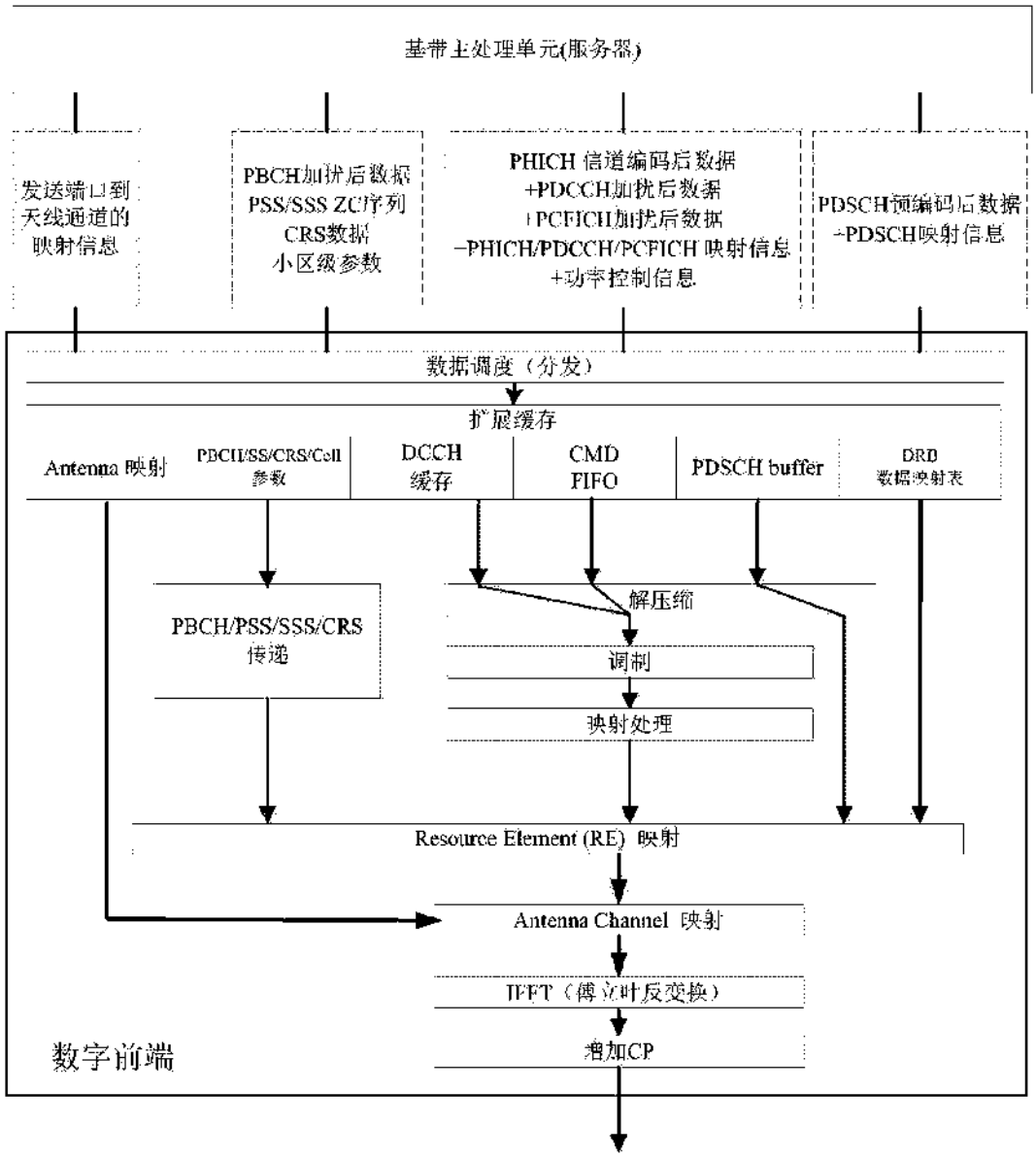

基带主处理单元(服务器)
发送端口到天线通道的映射信息
PBCH加扰后数据
PSS/SSS ZC序列
CRS数据
小区级参数
PHICH 信道编码后数据
+PDCCH加扰后数据
+PCFICH加扰后数据
+PHICH/PDCCH/PCFICH 映射信息
+功率控制信息
PDSCH预编码后数据
+PDSCH映射信息
数据调度（分发）
扩展缓存
Antenna 映射
PBCH/SS/CRS/Cell 参数
DCCH 缓存
CMD FIFO
PDSCH buffer
DRB 数据映射表
PBCH/PSS/SSS/CRS 传递
解压缩
调制
映射处理
Resource Element (RE) 映射
Antenna Channel 映射
IFFT（傅立叶反变换）
增加CP
数字前端

图10

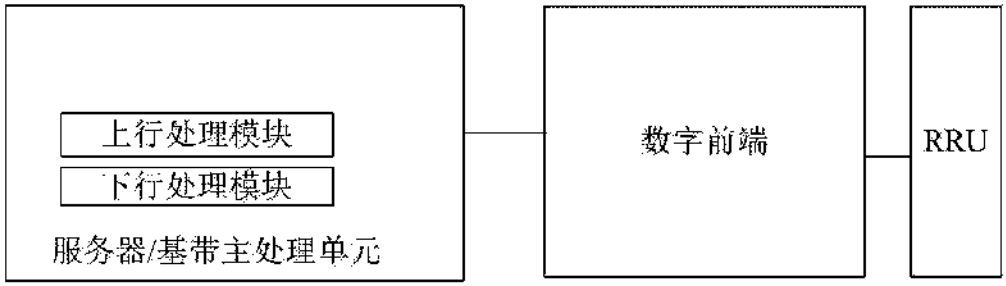


图11

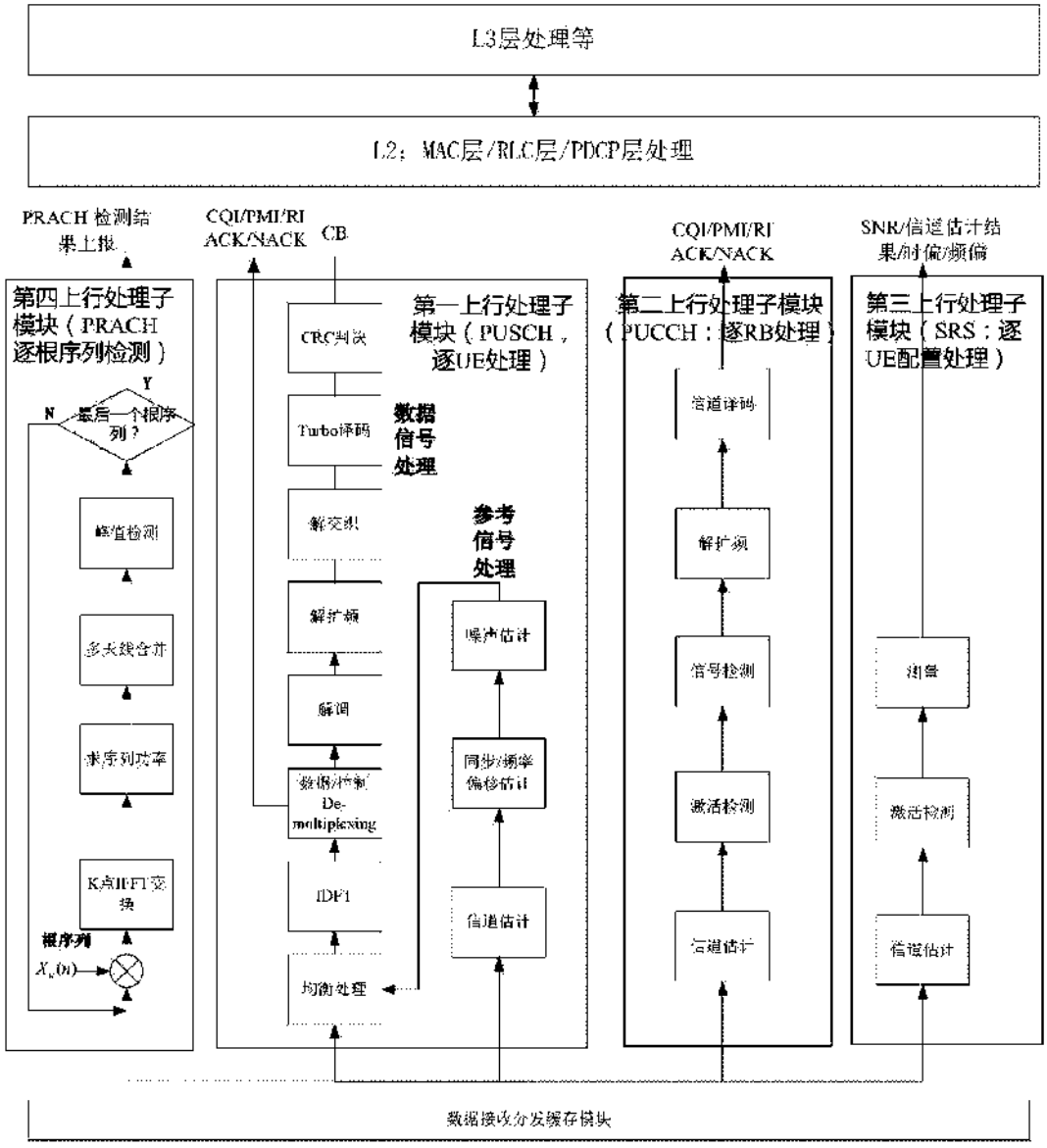

L3层处理等
L2：MAC层/RLC层/PDCP层处理
PRACH 检测结果上报
CQI/PMI/RI ACK/NACK
CB
CQI/PMI/RI ACK/NACK
SNR/信道估计结果/时偏/频偏
第四上行处理子模块（PRACH逐根序列检测）
第一上行处理子模块（PUSCH，逐UE处理）
第二上行处理子模块（PUCCH：逐RB处理）
第三上行处理子模块（SRS：逐UE配置处理）
Y
N
最后一个根序列？
峰值检测
多天线合并
序列功率
K点IFFT变换
根序列
$X_u(n)$
CRC判决
Turbo译码
解交织
解扩频
解调
数据分离 De-multiplexing
IDFT
均衡处理
数据信号处理
参考信号处理
噪声估计
同步/频率偏移估计
信道估计
信道译码
解扩频
信号检测
激活检测
信道估计
测量
激活检测
信道估计
数据接收分发缓存模块

图12

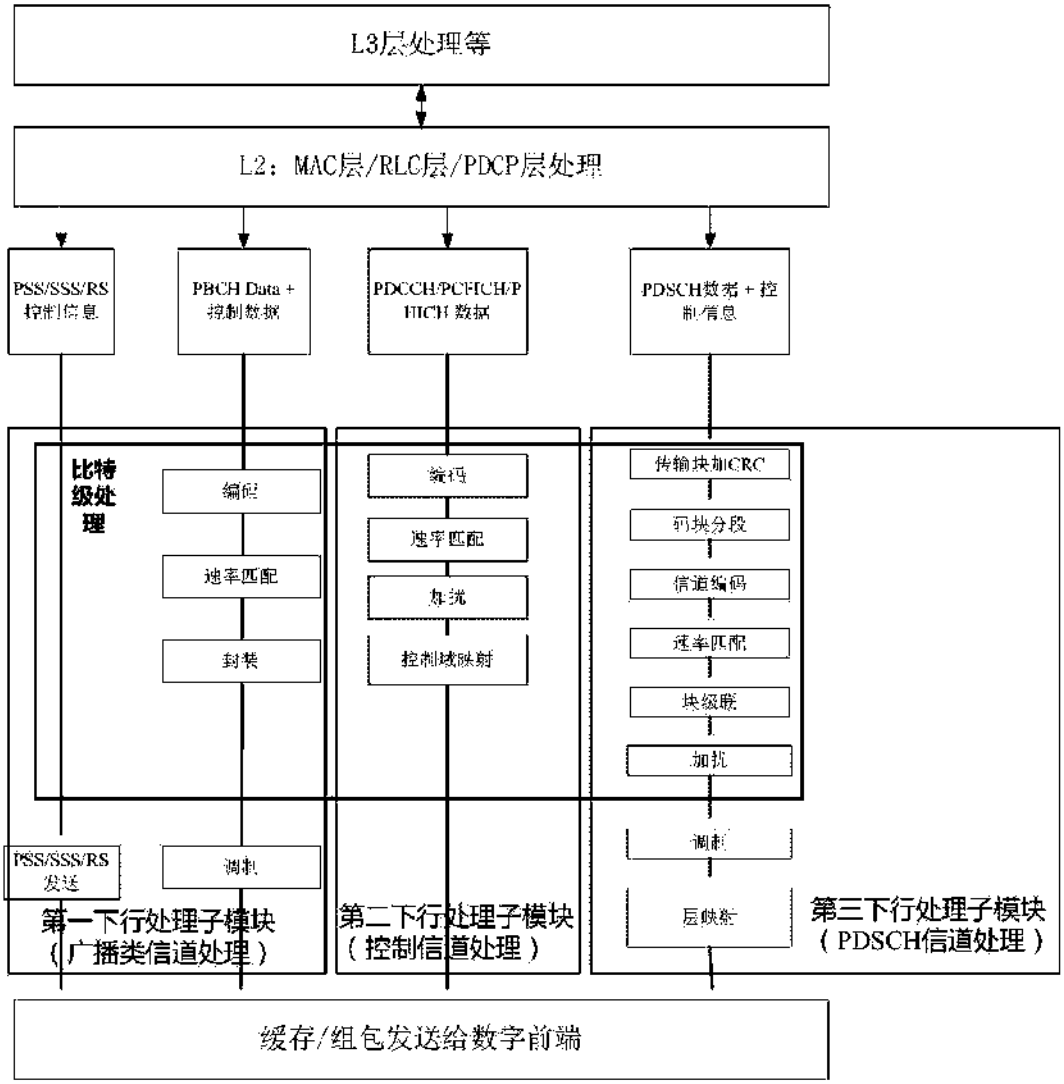

L3层处理等
L2：MAC层/RLC层/PDCP层处理
PSS/SSS/RS 控制信息
PBCH Data + 控制数据
PDCCH/PCFICH/PHICH 数据
PDSCH数据 + 控制信息
比特级处理
编码
速率匹配
封装
编码
速率匹配
加扰
控制域映射
传输块加CRC
码块分段
信道编码
速率匹配
块级联
加扰
调制
层映射
PSS/SSS/RS 发送
调制
第一下行处理子模块（广播类信道处理）
第二下行处理子模块（控制信道处理）
第三下行处理子模块（PDSCH信道处理）
缓存/组包发送给数字前端

图13

Bibliographic Data

Application No: 17/143,180

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.
01/07/2021	370	2472	20160089-PCT-US-DA1
RULE			

APPLICANTS

APEX BEAM TECHNOLOGIES LLC, MARSHALL, TX, UNITED STATES

INVENTORS

Xiaobo ZHANG, Shanghai, CHINA

CONTINUING DATA

This application is a CON of 16429077 06/03/2019 PAT 10944527

16429077 is a CON of PCT/CN2017/112033 11/21/2017

FOREIGN APPLICATIONS

CHINA CN201611098328.7 12/03/2016

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01/21/2021

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ADDRESS

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51 JFK Parkway
1st Floor West
Short Hills, NJ 07078
UNITED STATES

FILING FEE RECEIVED

$1,070

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
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(Not for submission under 37 CFR 1.99)

Application Number	17143180
Filing Date	2021-01-07
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	
Attorney Docket Number	

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	1	20160094326	A1	2016-03-31	Electronics and Telecommunications Research Insti	
	2	20150010106	A1	2015-01-08	Nokia Solutions and Networks Oy	
	3	20110223876	A1	2011-09-15	Jee Woong Kang	

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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	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY	Abstract and drawingsheets of the patentspecification, paragraphs58、67-97 of thespecification,	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	
	Attorney Docket Number	

	2	103687010	CN	A	2014-03-26	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY		
	3	101567865	CN	A	2009-10-28	TD TECH LTD		
	4	2016018100	WO	A1	2016-02-04	LG ELECTRONICS INC		

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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.	T5
	1	Nortel Discussion on RS Designfor Higher-order MIMOin LTE-A,2009.03.27 3GPPTSG-RAN Working Group 1 Meeting#56bis R1-091591	
	2	LG Electronics RS designenhancements forsupporting EB and FD-MIMO,2014.10.10,3GPP TSG RAN WG1 Meeting #78bisR1-144047	
	3	Ericsson Phasee2modeling of 2D AntennaArrays,2014.11.21,3GPP TSG-RAN WG1#79 R1-145169	
	4	Texas InstrumentsRemaining Issues onULMIMO TransmissionMode and DCI FormatDesign,2010.07.02,3GGP TSG RAN WG161bis R1-103705	
	5	ISR received in application No. PCT/CN2017/112033 dated 07 February 2018	☒
	6	First Office Action received from the no. 201611098328.7 dated January 06, 2020.	☒

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	
	Attorney Docket Number	

	7	First Search Report received from the no. 201611098328.7 dated December 26,2019	☒
	8	Notice of Granting Patent Right for Invention received from the no. 201611098328.7 dated April.21,2020	☒

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EXAMINER SIGNATURE

Examiner Signature	/DEEPA BELUR/ (05/19/2022)	Date Considered	05/19/2022

*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.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	
	Attorney Docket Number	

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)	2021-03-29
Name/Print	/Xiaobo ZHANG/	Registration Number	

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.B/

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	0	((("APEX") near3 ("BEAM") near3 ("TECHNOLOGIES") near3 ("LLC"))).AS,AANM.	(USPAT)	OR	ON	ON	2022/05/19 05:43 PM
L2	695	((("ZHANG") near3 ("Xiaobo"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2022/05/19 05:44 PM
L3	1	CN105577318A	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 11:46 AM
L4	10	("20110223876"|"20150010106"|"20160094326").PN.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 11:47 AM
L5	87	(antenna WITH virtual$7) WITH (resource near3 pool)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK,	OR	ON	ON	2022/05/20 11:49 AM

			TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L7	18	(antenna WITH virtual$7) WITH (resource near3 pool) AND (PSS SSS MIB SIB CSI$1RS)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 11:55 AM
L8	2016	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:35 PM
L9	327	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L5/005.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:36 PM
L10	10	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L5/005.cpc. AND H04B7/0408.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2022/05/20 12:36 PM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L11	239	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc.)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:38 PM
L12	33	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc.) AND H04B7/06.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:38 PM
L13	44	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04B7/06.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO;	OR	ON	ON	2022/05/20 12:39 PM

			JPO; DERWENT; IBM_TDB)				
L15	44	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND H04L1/0003.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:50 PM
L16	3	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04L1/1819.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:51 PM
L17	11	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04L5/0082.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 12:53 PM
L18	48	(antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.) AND H04W88/02.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/05/20 12:53 PM

			IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L20	66	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND (H04B7/0408.cpc. H04B7/0413.cpc. H04B7/0617.cpc.)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 01:13 PM
L21	134	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 01:13 PM
L22	94	((antenna port) near3 (group$3)) WITH (antenna WITH virtual$7) WITH (PSS SSS MIB SIB CSI$1RS) AND MIMO AND @AD< "20160312"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 01:13 PM

L23	32	"53487429".fmid.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; JPO)	OR	ON	ON	2022/05/20 01:14 PM
L24	12	((US-20160094326-A1 OR US-20150010106-A1 OR US-20190386729-A1 OR US-20110223876-A1 OR US-20170373743-A1 OR US-20160157218-A1 OR US-20170041113-A1 OR US-20150341100-A1).did. AND PGPB.dbnm.) OR ((CN-104852756-B OR CN-104853417-B).did. AND FTDB.dbnm.) OR ((WO-2013110219-A1 OR US-20110223876-A1).did. AND DWPI.dbnm.)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 03:24 PM
L26	19	((antenna port) near3 (group$3 set$1 collection$1)) WITH (resource near3 pool$1) WITH (NVF (antenna port) near3 (virtuali$6)) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:00 PM
L27	19	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NVF (antenna port) near3 (virtuali$6))) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV,	OR	ON	ON	2022/05/20 04:04 PM

			MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L28	19	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6))) AND MIMO	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:08 PM
L29	20	((antenna port) near3 (group$3 set$1 collection$1)) SAME ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:08 PM
L30	41	((antenna port) near3 (group$3 set$1 collection$1)) AND ((resource near3 pool$1) WITH (NFv (antenna port) near3 (virtuali$6)))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/05/20 04:09 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

An antenna mapping method, device and digital front end

DOCUMENT ID	DATE PUBLISHED
CN-104852756-B	2018-09-04

PATENT FAMILY ID
53852136

INVENTOR INFORMATION

NAME	CITY	STATE	ZIP CODE	COUNTRY
Duan, Ran	N/A	N/A	N/A	N/A
YUAN, Yan-nan	N/A	N/A	N/A	N/A
KONG, Ling-bin	N/A	N/A	N/A	N/A
I, CHIH-LIN	N/A	N/A	N/A	N/A

APPLICANT INFORMATION

NAME	CITY	STATE	ZIP CODE	COUNTRY
CHINA MOBILE COMMUNICATIONS CORPORATION	BEIJING	N/A	100032	CN

AUTHORITY	TYPE
N/A	N/A

DATE FILED
2014-02-19

DOMESTIC PRIORITY (CONTINUITY DATA)
related-publication CN 104852756 A 20150819

Abstract

The embodiment of the invention claims an antenna mapping method, device and digital front end. method comprises the following steps: obtaining front end switching network output to be the downlink antenna mapping process on data to be transmitted according to the downlink data to be transmitted to the wireless transmission resource, determining multi-antenna mapping information corresponding to the downlink data to be sent according to the multi-antenna mapping information, the downlink data to be transmitted to antenna mapping process in the wireless transmission resource, obtaining to-be-sent data via the antenna. The embodiment of the invention reduces the data exchange amount of the front end switching network.

Description

INVENTION-TITLE
An antenna mapping method, device and digital front end
Technical field
The invention relates to communication IT technology field, especially relates to an antenna mapping method, device and digital front end.
the background technology
In recent years facing the energy and power price of the price, global system for mobile communications network operators facing fierce competition of increasingly severe cost pressure and telecommunication market, single user average revenue (ARPU) increase slowly even falling problem for the industry profit and long-term development considerations, new wireless network architecture C-RAN provides the green evolution mobile communication industry to guide future centralized baseband processing network architecture technology development.
system architecture of the C-RAN distributed wireless network mainly composed of distal end radio frequency unit (RRU) and an antenna, with high bandwidth, optical transmission network of low-delay connection distal end radio frequency unit, a universal processor and real-time virtual technology of centralized baseband processing pool three parts. the base band processing unit and remote end radio frequency unit connected together by optical transmission network of high bandwidth and low latency. baseband processing unit (BBU) collectively form the base band pool at one physical site. the baseband pool in the plurality of baseband processing unit through a high-bandwidth, low-latency, low-cost flexible topology, cross connection. band applications requiring base station virtualization technology, which supports the virtual distribution and combination of baseband pool physical resources and calculating ability. a plurality of BBU interconnection in the centralized base station interconnection architecture consisting of high capacity, low delay. distal end of the RRU exchange any one BBU in the centralized baseband pool through interconnection architecture. In this way the present BBU to centralized integration, can effectively achieve carrier load balancing, disaster-tolerant backup and improve the utilization ratio of equipment, reduces the station room number, the purpose of reducing the energy consumption.
realizing the base band pool in the existing technical solution to implementation of DSP + FPGA, or replaced by general processing CPU DSP physical layer processing function of the BBU.
Invention content
Therefore, it is an object of the invention is to provide an antenna mapping method, device and digital front end to reduce the data exchange of the front end switching network.
To solve the above technical problem, the present invention provides the following:
The embodiment of the invention claims an antenna mapping method for digital front end, comprising:
the front end switching network output to be the downlink antenna mapping process on data to be transmitted;
according to the downlink data to be transmitted corresponding to the wireless transmission resource, determining the multi-antenna mapping information corresponding to the downlink data to be transmitted;
The multi-antenna mapping information of the downlink data to be transmitted to antenna mapping process in the wireless transmission resource, obtaining to-be-sent data via the antenna.
Preferably, the information comprises multi-antenna mapping ports and each port respectively corresponding to the ports corresponding to the port to antenna mapping bit map and the beam shaping factor.
Preferably, the wireless transmission resource corresponding to the physical layer channel type is a broadcast or shared channel, type of the beamforming factor is an omni-directional broadcast shaping factors, or
the wireless transmission resource corresponding to the physical layer channel type antenna beamforming factor special for the user terminal is the user terminal dedicated channel and the type of the beamforming factor.
Preferably, further comprising:
receiving the front end switching network output antenna mapping information of cell level, the cell antenna mapping information comprises each port of the port to the antenna corresponding to the cell-level bitmap and the beam shaping factor;

according to the downlink data to be transmitted to the wireless transmission resource, determining multi-antenna mapping information corresponding to the downlink data to be transmitted comprises:
the wireless transmission resource corresponding to the physical layer channel type is a broadcast or common channel data to be transmitted in the physical layer channel transmission mode, determining the ports according to the downlink;
according to each port of the ports and the port to the antenna of the cell corresponding to the bitmap, determining the port corresponding to the port of the port respectively corresponding to antenna mapping bitmap;
according to each port of the ports and the cell corresponding to the beam shaping factor, determining the port corresponding to the port of the corresponding beam forming weight factors, respectively.
Preferably, the wireless transmission resource comprises a time-frequency resource, the physical layer channel corresponding to the time-frequency resource type is shared channel, the port and the time-frequency resource of the time-frequency resource block corresponding to each port of the ports corresponding to the ports respectively corresponding to antenna mapping bitmap and wave beam forming factor for each port of the time-frequency resource block corresponding to the respectively corresponding port to antenna mapping bitmap and wave beam forming factor.
Preferably, corresponding to each port of the ports comprising at least a first port and a second port;
according to the multi-antenna mapping information of the downlink data to be transmitted to antenna mapping process in the wireless transmission resource, obtaining to-be-sent data via the antenna comprising:
determining the downlink data to be transmitted first data respectively corresponding to the first port and the second port and a second data;
respectively corresponding to the first port and the second port of the port to antenna bitmap, determines that the first port and the second port are respectively mapped to the antenna;
according to said first data, said second data, said first port and said second port are respectively corresponding to the beam forming weight factors to generate the wireless transmission resource via the respectively mapped to the antennas respectively transmitting data.
Preferably, according to the first data, the second data, the first port and the second port respectively corresponding to the beam forming weight factors to generate the wireless transmission resource via the respectively mapped to the antennas respectively transmitting data comprising:
the beam forming weight factors corresponding to the first data and the first port of the multiplying to obtain the to be the wireless transmission resources by said first port mapped to the antenna transmitting data;
the port corresponding to the second data and the second beam forming weight factor multiplying to obtain the to be the wireless transmission resources by mapping the second port to antenna transmitting the data.
Preferably, the first port and the second port are mapped to antenna comprises at least a first antenna and a second antenna.
the first port corresponding to the beam shaping factor comprises: respectively mapping to the first beam forming weight factor and the second beam forming weight factor to the first antenna and the second antenna corresponding to the first port;
the second port corresponding to the beam shaping factor comprises: respectively mapping third beam forming weight factor and the fourth beam forming weight factor to the first antenna and the second antenna corresponding to the second port;
according to said first data, said second data, said first port and said second port are respectively the corresponding beam forming weight factors to generate the wireless transmission resource via the respectively mapped to the antennas respectively transmitting data comprising:
the first data and the second data respectively multiplying with the first beam forming weight factor and the third beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by said first antenna data;
the first data and the second data respectively multiplying with the second beam forming weight factor and the fourth beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by the second antenna data.
Preferably, the digital front end to the far end radio frequency unit RRU side.
Preferably, the method for use in a long term evolution LTE system, the radio transmission resource is the

resource element RE.
Preferably, the method is used for a time division synchronization code division multiple access TD-SCDMA system, said wireless transmission resource is effective sub-frame identification of spreading code and distributing corresponding resource.
The embodiment of the invention further claims an antenna mapping device for digital front end, comprising:
an obtaining module for obtaining the front end switching network output to be the downlink antenna mapping process on data to be transmitted, wherein the downlink data to be transmitted to a wireless transmission resource;
a determining module, used for according to the downlink data to be transmitted to the wireless transmission resource, determining multi-antenna mapping information corresponding to the downlink data to be transmitted;
processing module, used for according to the multi-antenna mapping information, data to be transmitted to antenna mapping process for the downlink in the wireless transmission resource, obtaining to-be-sent data via the antenna.
Preferably, the information comprises multi-antenna mapping ports, and each port respectively corresponding to the ports corresponding to the port to antenna mapping bit map and the beam shaping factor.
Preferably, the wireless transmission resource corresponding to the physical layer channel type is a broadcast or shared channel, type of the beamforming factor is an omni-directional broadcast shaping factors, or
the wireless transmission resource corresponding to the physical layer channel type antenna beamforming factor special for the user terminal is the user terminal dedicated channel and the type of the beamforming factor.
Preferably, further comprising:
a receiving module for receiving the output of the front end switching network antenna mapping information of cell level, the cell antenna mapping information comprises each port of the port to the antenna corresponding to the cell-level bitmap and the beam shaping factor;
the determining module comprises:
a first determining unit, which is used for the wireless transmission resource corresponding to the physical layer channel type is a broadcast or common channel according to the downlink data to be transmitted in the physical layer channel transmission mode, determining the ports;
a second determining unit, used for according to each port of the port and the port to the antenna of the cell corresponding to the bitmap, determining the port corresponding to the port of the port respectively corresponding to antenna mapping bitmap;
a third determining unit, used for according to each port of the ports and the cell corresponding to the beam shaping factor, determining the port corresponding to the port of the corresponding beam forming weight factors, respectively.
Preferably, the wireless transmission resource comprises a time-frequency resource, the physical layer channel corresponding to the time-frequency resource type is shared channel, the port and the time-frequency resource of the time-frequency resource block corresponding to each port of the ports corresponding to the ports respectively corresponding to antenna mapping bitmap and wave beam forming factor for each port of the time-frequency resource block corresponding to the respectively corresponding port to antenna mapping bitmap and wave beam forming factor.
Preferably, corresponding to each port of the ports comprising at least a first port and a second port;
said processing module comprises:
a fourth determining unit for determining the downlink data to be transmitted first data respectively corresponding to the first port and the second port and the second data;
a fifth determining unit for respectively corresponding to the first port and the second port of the port to antenna bitmap, determines that the first port and the second port are respectively mapped to the antenna;
generating unit, for according to the first data and the second data, respectively corresponding to the first port and the second port of the beam forming weight factors to generate the wireless transmission resource by the respectively mapped to the antennas respectively transmitting data.
Preferably, the generating unit comprises:

first calculating sub-unit for said first data and said first port multiplying to obtain the beam forming weight factors corresponding to the wireless transmission resources by said first port mapped to the antenna transmitting data;
second calculating sub-unit, used for making said second data and said second port multiplying to obtain the beam forming weight factors corresponding to the wireless transmission resource via the second port mapped to the antenna to send data.
Preferably, the first port and the second port are mapped to antenna comprises at least a first antenna and a second antenna.
the first port corresponding to the beam shaping factor comprises: respectively mapping to the first beam forming weight factor and the second beam forming weight factor to the first antenna and the second antenna corresponding to the first port;
the second port corresponding to the beam shaping factor comprises: respectively mapping third beam forming weight factor and the fourth beam forming weight factor to the first antenna and the second antenna corresponding to the second port;
the generating unit comprises:
the third calculating sub-unit for transmitting the first data and the second data respectively multiplying with the first beam forming weight factor and the third beamforming factor, then to overlay to get to be the wireless transmission resource is transmitted by said first antenna data;
a fourth calculating sub-unit, used for transmitting the first data and the second data are respectively multiplying with the second beam forming weight factor and the fourth beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by the second antenna data.
The embodiment of the invention further claims a digital front end comprising the above antenna mapping device.
from the above it can be seen that the embodiment of the present invention at least has the following beneficial effects:
Because the antenna mapping processing to the digital front end, so that the lower multi-antenna configuration, front end switching network does not need to exchange the antenna redundant information caused by the mapping processing so as to reduce data exchange amount of the front end exchange network, reduces the switching bandwidth.
Description
FIG. 1A, 1B describes the digital front end and the connection relation between the server description pattern;
FIG. 2 shows an antenna mapping method of step flow chart of the invention embodiment;
FIG. 3 shows an embodiment of of the present invention embodiment 1 for processing of corresponding downlink antenna mapping interface and a data flow graph;
FIG. 4 shows the preferred embodiment of an embodiment of the present invention antenna mapping flow diagram of embodiment 1;
FIG. 5 shows the preferred embodiment of the invention the embodiment 2 coding spread spectrum process diagram;
FIG. 6 a structure diagram of an antenna mapping device according to an embodiment of the invention.
Specific executing trenchs
In order to make the purpose of the invention, technology scheme advantages and more clearly, under the embodiments of the present invention will be described in detail by combining the accompanying drawings and specific embodiments.
the two types of solutions in the prior art can not completely solve the dynamic carrier for baseband pool migration, performance problems of backup. Based on this, the invention claims a method based on accelerator board card of baseband pool transferring scheme. In this scheme, the whole system is composed of 4 parts: 1) general purpose processor platform; 2) acceleration card (digital front end board card physical layer); 3) Generic exchange unit; 4) high speed Ethernet switch. the core part of the physical layer board has the function of three aspects: physical layer processing or part of physical layer processing, terminating CPRI interface, external data exchange function. we will plate external exchange function definition of the card front end switching network. the three functional forms the standard elements of the

acceleration board card.
wherein the digital base-band part of the physical layer (L1) processing is separated, put on the RRU side, other L1/L2/L3 protocol stack to RRU and the digital front end base band pool responsible for radio frequency transceiver and part of physical layer processing.
FIG. 1A, 1B are description of digital front end with description of the connection relationship between the server, the server is processing baseband main processing unit of the remainder L1/L2/L3, and FE (digital front end plate card) part L1, function of dividing method part L1 part L1 and baseband main processing embodiment of this invention describes the digital front end, and to realize the exchange network between them reduce the switching bandwidth. digital front end may be, for example, in the form of board card. Specifically, in FIG. 1A, digital front end plate card and a server connected through the PCIe interface, digital front end board card are connected through Ethernet front end switching network connected through the transferring of digital front end board card, it can realize any server and data interactive front end exchanging network any digital front end plate is clamped between, in FIG. 1B, digital front end plate card and a server via the 10GE switch (Switch) front end switching network to perform the data interaction.
for multi-antenna system, we found that caused by beamforming transmission redundancy is very high. For example, TDD-LTE system comparing the LTE FDD system, LTE realizes the joint transmission of the downlink multi-antenna data so as to realize intelligent beamforming antenna function. the downlink transmission mode TM7 and TM8, needs a data amount of 8 antennas in downlink transmission, according to rough description, needs a bandwidth of 10 Gbps, excessive data exchange amount under multi-cell base-band pool configuration, will cause total system change cost is greatly increased. so it urgently needed to find a transmission method to reduce the downlink transmission bandwidth.
FIG. 2 shows an antenna mapping method of step flow chart of the invention embodiment, with reference to FIG. 2. The embodiment of the invention claims an antenna mapping method, comprising the following steps:
downlink step 201, obtaining front end switching network to be output by antenna mapping processing of the data to be sent;
step 202, according to the downlink data to be transmitted to the wireless transmission resource, determining multi-antenna mapping information corresponding to the downlink data to be transmitted;
step 203, according to the multi-antenna mapping information of the downlink data to be transmitted to antenna mapping process in the wireless transmission resource, obtaining to-be-sent data via the antenna. the method for digital front end.
Therefore, the antenna mapping processing to the digital front end, so that the lower multi-antenna configuration, front end switching network does not need to exchange the antenna redundant information caused by the mapping processing so as to reduce data exchange amount of the front end exchange network, reduces the switching bandwidth.
wherein the front end switching network may comprise an Ethernet switch and its interface to the outer, or the Ethernet switch and the outer interface thereof, and connected with the Ethernet switch of the other digital front end device and a PCIe interface connected with it.
the wireless transmission resource may include a time domain resources, frequency domain resources, code resource of at least one. specific to the LTE system, the radio transmission resources such as resource element (Resource Element, RE), the time frequency domain resources. specifically to a TD-SCDMA system, said wireless transmission resources such as the effective sub-frame identification of spreading code and distributing corresponding resource, which is a code division and time domain resource.
In the embodiment of the invention, the multi-antenna mapping information may include ports, and each port respectively corresponding to the ports corresponding to the port to antenna mapping bit map and the beam shaping factor.
wherein the wireless transmission resource corresponding to the physical layer channel type is a broadcast or shared channel, the type of the beam forming weight factors can be the whole shaping factors to broadcast, or
the wireless transmission resource corresponding to the physical layer channel type is special channel of the user terminal, the type of the beam forming weight factors may antenna beamforming factor special for the user terminal.
In addition, further comprises:

receiving the front end switching network output antenna mapping information of cell level, the cell antenna mapping information comprises each port of the port to the antenna corresponding to the cell-level bitmap and the beam shaping factor;
according to the downlink data to be transmitted to the wireless transmission resource, determining multi-antenna mapping information corresponding to the downlink data to be transmitted may include:
the wireless transmission resource corresponding to the physical layer channel type is a broadcast or common channel data to be transmitted in the physical layer channel transmission mode, determining the ports according to the downlink;
according to each port of the ports and the port to the antenna of the cell corresponding to the bitmap, determining the port corresponding to the port of the port respectively corresponding to antenna mapping bitmap;
according to each port of the ports and the cell corresponding to the beam shaping factor, determining the port corresponding to the port of the corresponding beam forming weight factors, respectively.
In addition, the wireless transmission resource may include a time-frequency resource, the physical layer channel corresponding to the time-frequency resource type is shared channel, the port number can be combined with the time-frequency resource of the time-frequency resource block corresponding to the ports corresponding to each port of each port corresponding to the port to antenna mapping bitmap and wave beam forming factor can be the time-frequency resource block corresponding to the respectively corresponding port to antenna mapping bitmap and wave beam forming factor.
In addition, there may be:
corresponding to each port of the ports comprising at least a first port and a second port;
according to the multi-antenna mapping information of the downlink data to be transmitted to antenna mapping process in the wireless transmission resource, obtaining to-be-sent data via the antenna comprising:
determining the downlink data to be transmitted first data respectively corresponding to the first port and the second port and a second data;
respectively corresponding to the first port and the second port of the port to antenna bitmap, determines that the first port and the second port are respectively mapped to the antenna;
according to said first data, said second data, said first port and said second port are respectively corresponding to the beam forming weight factors to generate the wireless transmission resource via the respectively mapped to the antennas respectively transmitting data.
wherein, according to said first data, said second data, said first port and said second port are respectively the corresponding beam forming weight factors to generate the wireless transmission to be the resource via said antenna respectively are respectively mapped to transmitted data may include:
the beam forming weight factors corresponding to the first data and the first port of the multiplying to obtain the to be the wireless transmission resources by said first port mapped to the antenna transmitting data;
the port corresponding to the second data and the second beam forming weight factor multiplying to obtain the to be the wireless transmission resources by mapping the second port to antenna transmitting the data.
Here, the type of beam shaping factor can be the whole shaping factors to broadcast.
In addition, the first port and the second port are mapped to antenna can comprise at least a first antenna and a second antenna.
the first port corresponding to the beam shaping factor can comprises: respectively mapping to the first beam forming weight factor and the second beam forming weight factor to the first antenna and the second antenna corresponding to the first port;
the second port corresponding to the beam shaping factor can comprises: respectively mapping third beam forming weight factor and the fourth beam forming weight factor to the first antenna and the second antenna corresponding to the second port;
according to said first data, said second data, said first port and said second port are respectively the corresponding beam forming weight factors to generate the wireless transmission resource via the respectively mapped to the antennas respectively sent the data may include:
the first data and the second data respectively multiplying with the first beam forming weight factor and the third beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by said first antenna data;

the first data and the second data respectively multiplying with the second beam forming weight factor and the fourth beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by the second antenna data.
Here, the type of beam shaping factor can be special antenna wave beam forming factor of the user terminal.
In the embodiment of the invention, the digital front end to the far end radio frequency unit RRU side. Thus, further reduces the downlink transmission bandwidth between the baseband pool and RRU.
In the embodiment of the invention, the method can be used for long term evolution LTE system or TD-SCDMA system. For the former case, the wireless transmission resource can be a resource element RE, belonging to resource blocks (RB Resource Block). For the latter case, the wireless transmission resource can be effectively spread spectrum code and distributing sub-frame identification of the corresponding resource.
less preferred embodiment >
embodiment of the present invention more clearly understood, providing better implementation manner of the embodiment of the present invention.
method and device for realizing the preferred embodiment relates to a digital front end exchange structure in downlink antenna weight mapping and a front end switching structure for using antenna correlation reduces the switching bandwidth method and realizing device.
The preferred embodiments proposed mapping scheme and the downlink antenna weight device, the baseband pool total exchange under the frame, using the multi-antenna correlation of downlink multi-antenna system only sends the data to be transmitted and the transmission antenna mapping factor and antenna transmission weight value, the digital front end to realize antenna mapping process. This will greatly reduce the switching bandwidth. In addition, if the digital front end placed at the RRU side, the antenna mapping process on the RRU side, and also can reduce the downlink transmission bandwidth between the BBU and the RRU is another application scene.
for the downlink of TD-LTE, Example 1:
As shown in FIG. 3, the HS-PDSCH channel, the public channel, the broadcast channel to classify other antenna mapping processing, and defines the relative interface and data flow graph according to antenna mapping method:
an antenna mapping processing subsystem of the downlink link is mainly composed of 3 parts:
1) receiving the cache distribution module
the module is used for receiving and caching previous level obtained from the PCIe and Ethernet physical layer algorithm output data packet information. Because this preferred embodiment only the concerned antenna mapping and beam-forming process, the lower row receiving data format to be transmitted and forms no requirement. and point the antenna mapping associated with the data structure definition. receiving the cache distribution module receives data, according to the type of the class A) to E) cache:
A) level control parameters: bandwidth, PhyCellID, subframe uplink special subframe configuration, subframe number (per millisecond update), the PHICH channel configuration, port number, cell antenna bitmap and the omnidirectional weight value factor and power configuration information of each channel; wherein the cell antenna mapping and antenna full value definition of the factor to weight shown in Table 1:
table 1:

plot for realizing CRS/PSS/SSS/PBCH/PDCCH/PCFICH/PHICH to antenna mapping information channel antenna mapping process.
B) imposed by the data cache: caching CRS PBCH data, to be transmitted the data to be transmitted, PSS, SSS and data to be transmitted
C) shared channel mapping information, the data per millisecond update indicating each RB (frequency resource) occupied by the PDSCH mapping relation and the downlink transmission mode (set by protocol Trans-Mode).
D) common channel data cache for temporarily storing the data per millisecond update PCFICH/PDCCH/PHICH downlink transmission of data.
E) shared channel data and antenna mapping cache the data per millisecond update, buffering the HS-PDSCH channel according to the transmission end port number of each port to be sent data, and cache

antenna mapping parameters. antenna mapping parameters indicating the current RB also includes the port number, sent BF factors can be used for single-TM7/TM8 transmission mode of the UE, also can be used for the cooperative data of UE inter-cell transmission.
As shown in Table 2, the ports and mapping factor corresponding to each RB:
Table 2

2) the resource mapping table sub-module
The current cell configuration information and sub-frame number corresponding to the CRS/PBCH/PSS/SSS/PHICH/PCFICH/PDCCH RE position, thereby generating the RE is resource mapping table granularity, all of the common channel antenna mapping modes are common mode. an antenna mapping mode and then integrated shared channel (PDSCH) mapped information, the shared channel mapping resource mapping information into the table, and marking each RE resource dedicated mode and common mode. RE is the granularity of resource mapping table to describe each RE resources is what type of channel occupied, and indicating the mode of the antenna mapping. dedicated mode i.e. the current RE is occupied by the specific UE (1, or 2), and a need for UE-specific beamforming (TM7/TM8) UE is improved reception quality. public mode, i.e. the current RE is occupied by the HS-PDSCH channel for transmitting common channel or non-TM7/TM8 mode, the antenna mapping by the mapping mode of the port to an antenna cell level, and adopts the omni-directional beam forming weight factors.
3) the antenna mapping sub-module
The preferred embodiments and not the predetermined storage format of the broadcast channel data and control channel-like data in the cache, that is, capable of storing data before downlink pre-coding, can also be stored in port-coded data. if using pre-coding the data before storage, it can use the way of constellation point bit map memory so as to save the use quantity of memory. Therefore, in the subsidiary module, needs the public and broadcasting channels of data part of the physical layer processing to obtain the pre-coded data, similarly, also can obtain the shared channel data after pre-coding result, flow of antenna mapping as shown in FIG. 4.
The map describes the specific operation step:
step one, establishing the mapping relationship between the resource mapping table and cache data. For example, when judging one RE is occupied by the CRS, obtaining the actual data of the CRS. or, judging whether some actual data when RE is occupied by PDSCH, it can query the PDSCH channel sent on the RE, and obtaining the antenna mapping parameters;
step two, initializing the RE index is 0 (start circulation processing corresponding to each RE of the data mapping process).
step three, judging the RE antenna mapping mode when it is determined that the common mode, turning to the step four, judging that the special mode, jumping to the step six;
step four, the common mode has two types, one is a CRS/PSS/SSS channel, the channel data is transmitted only with the concept of single-layer transmission. PSS/SSS are single-port mapping and omni-directional beam-forming transmission, CRS are single-port mapping and port bitmap selection part of the antenna full value to the right. second is PBCH/PHICH/PDCCH/PCFICH/PDSCH (non-BF), port number for coding and transmitting the pre-coded data to data distribution to the antenna mapping relation according to the port. The transmission manner different two types, transformation imposed by antenna mapping and antenna full value factor information to obtain the data to antenna mapping needed number of ports and each port corresponds to the beam shaping factor;
step five, port, according to the port mapping antenna bit map indicating the port data with the antenna beam forming factor multiplying to obtain the actual data on the antenna. skip to step eight;
step six, obtaining the current RE under special mode ports of the RB and the mapping factor;
step seven, according to circulation ports, corresponding to the each circulation port pre-data BF factor multiplying with the corresponding mapping, and by accumulating the obtained result according to the antenna so as to obtain the superposed multi-port data transmitted on the same antenna of the final empty transmission data. skip to step eight;
step eight, accumulating the RE index, judging whether to process all of the RE. if it does not finish polling all RE, jumping to the step three, otherwise the process is ended.
for the downlink of TD-SCDMA, the embodiment 2:

Referring to FIG. 5, a brief description of TD-SCDMA system coding spread spectrum process: firstly, taking the current code data, then, the current code channel of spreading sequences, and spreading again, a group of data respectively multiplying factor of multiple antenna; then, processing data accumulation according to the antenna, then, judging whether there is un-processed code channel, if there is, then return step of the current code data, otherwise the process ends.
It can be seen on each antenna of the actual sending data because of code for distinguishing the user of the TD-SCDMA is spread so that each user is shown The process ` to spread and multiplied by each antenna corresponding to the antenna mapping value to obtain each code channel, then perform accumulation of multi-code channel data for a same antenna of different code mapping value, so as to obtain the actual transmission of each antenna is multi-code channel data according to said process.
Similarly, the antenna mapping process also can move to digital front end position of the same with embodiment 1. Here is omitted here.
The preferred embodiment provides uses only the transmission antenna port mapping data and the downlink antenna weight value mapping value of method to achieve the compressed downlink data transmission bandwidth.
The key point of the solution:
1) the host and the digital front end communication in the downlink direction, using the characteristic of the antenna correlation, only the transmission of data to be transmitted before antenna mapping (or more before downlink processing on the data point);
2) matching the data to be sent, the host sends to the antenna mapping information of the digital front end, comprising: ports, port to antenna mapping bitmap, BF BF factor (including omnidirectional and the orientation). an antenna mapping information with may be defined as a standardized interface in the future.
3) the antenna mapping broadcast channel and channel type (public/shared channel), selecting different types of beam shaping factor. can select the UE special beam shaping factor and the common/broadcast channel using the omnidirectional broadcast shaping factors for a channel of a specific user.
4) specific TD-LTE system, digital front end outer only according to channel type judging, further according to channel transmission mode, selecting the mapping mode and beamforming factor mapping of ports to antenna, and finally to send data in air interface.
5) port to antenna mapping process, channel type for distinguishing the "common mode" and the "special mode" two different mapping process. common mode, using the port bitmap of the cell level and the omnidirectional antenna beam forming BF factor mapping process. under the special mode, using the directional antenna beam forming BF factor mapping processing flow, and further judging the sending mode to realize multi-layer mapping, thereby realizing TM7/TM8/ inter-cell cooperation data transmission.
with respect to the sub-module for dividing and processing flow described herein are only two specific embodiments. This preferred embodiment major protection using antenna correlation reducing multi-antenna data transmission, antenna mapping information defined and protected content interface, under such a premise, there also can be a more specific embodiment of the method and process. the future of the system is also possible through analogous method.
comparing the complete transmission of a downlink antenna port data, the better implementation manner to only transmission: 1) antenna before mapping the data to be transmitted, 2) transmitting the map information of the port to the antenna, which may be:
1) reducing the downlink direction, host to the digital front end sent data quantity;
2) flexibly to realize multi-cell cooperative joint transmission data;
3) according to channel type classification processing mechanism, which can simplify the process of overall complexity, and improve the reusability of the logic processing.
FIG. 6 a structure diagram of an antenna mapping device provided by the embodiment of the invention, referring to FIG. 6. The embodiment of the invention claims an antenna mapping device, comprising:
an obtaining module 601, for obtaining the front end switching network output to be the downlink antenna mapping process on data to be transmitted;
the determination module 602, used for according to the downlink data to be transmitted to the wireless transmission resource, determining multi-antenna mapping information corresponding to the downlink data to be transmitted;
processing module 603, used for according to the multi-antenna mapping information, data to be transmitted

to antenna mapping process for the downlink in the wireless transmission resource, obtaining to-be-sent data via the antenna.
the device for digital front end.
Therefore, the antenna mapping processing to the digital front end, so that the lower multi-antenna configuration, front end switching network does not need to exchange the antenna redundant information caused by the mapping processing so as to reduce data exchange amount of the front end exchange network, reduces the switching bandwidth.
wherein, there may be:
the multi-antenna mapping information comprises corresponding ports, and each port of the ports of the port respectively corresponding to antenna mapping bit map and the beam shaping factor.
wherein the downlink data to be transmitted to the physical layer channel type is broadcast or shared channel, the type of the beam forming weight factors can be the whole shaping factors to broadcast, or
the wireless transmission resource corresponding to the physical layer channel type is special channel of the user terminal, the type of the beam forming weight factors may antenna beamforming factor special for the user terminal.
In addition, further comprises:
a receiving module for receiving the output of the front end switching network antenna mapping information of cell level, the cell antenna mapping information comprises each port of the port to the antenna corresponding to the cell-level bitmap and the beam shaping factor;
the determining module 602 may include:
a first determining unit, which is used for the wireless transmission resource corresponding to the physical layer channel type is a broadcast or common channel according to the downlink data to be transmitted in the physical layer channel transmission mode, determining the ports;
a second determining unit, used for according to each port of the port and the port to the antenna of the cell corresponding to the bitmap, determining the port corresponding to the port of the port respectively corresponding to antenna mapping bitmap;
a third determining unit, used for according to each port of the ports and the cell corresponding to the beam shaping factor, determining the port corresponding to the port of the corresponding beam forming weight factors, respectively.
In addition, the wireless transmission resource may include a time-frequency resource, the physical layer channel corresponding to the time-frequency resource type is shared channel, the port number can be combined with the time-frequency resource of the time-frequency resource block corresponding to the ports corresponding to each port of each port corresponding to the port to antenna mapping bitmap and wave beam forming factor can be the time-frequency resource block corresponding to the respectively corresponding port to antenna mapping bitmap and wave beam forming factor.
In addition, each port may include at least the ports corresponding to the first port and the second port;
The processing module 603 may include:
a fourth determining unit for determining the downlink data to be transmitted first data respectively corresponding to the first port and the second port and the second data;
a fifth determining unit for respectively corresponding to the first port and the second port of the port to antenna bitmap, determines that the first port and the second port are respectively mapped to the antenna;
generating unit, for according to the first data and the second data, respectively corresponding to the first port and the second port of the beam forming weight factors to generate the wireless transmission resource by the respectively mapped to the antennas respectively transmitting data.
wherein the generating unit may include:
first calculating sub-unit for said first data and said first port multiplying to obtain the beam forming weight factors corresponding to the wireless transmission resources by said first port mapped to the antenna transmitting data;
second calculating sub-unit, used for making said second data and said second port multiplying to obtain the beam forming weight factors corresponding to the wireless transmission resource via the second port mapped to the antenna to send data.
In addition, there may be:
the first port and the second port are mapped to antenna comprises at least a first antenna and a second

antenna.
the first port corresponding to the beam shaping factor comprises: respectively mapping to the first beam forming weight factor and the second beam forming weight factor to the first antenna and the second antenna corresponding to the first port;
the second port corresponding to the beam shaping factor comprises: respectively mapping third beam forming weight factor and the fourth beam forming weight factor to the first antenna and the second antenna corresponding to the second port;
the generating unit comprises:
the third calculating sub-unit for transmitting the first data and the second data respectively multiplying with the first beam forming weight factor and the third beamforming factor, then to overlay to get to be the wireless transmission resource is transmitted by said first antenna data;
a fourth calculating sub-unit, used for transmitting the first data and the second data are respectively multiplying with the second beam forming weight factor and the fourth beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by the second antenna data.
The embodiment of the invention further claims a digital front end, the digital front end comprising the above antenna mapping device.
many functional components described in this specification is referred to as module, unit, so as to more particularly emphasize the independence of its implementation.
In the embodiment of the invention, the module can be realized by the software to be executed by various types of processors. For example, one or more physical or logical blocks of an identification of the executable code module may include computer instructions, for example, which can be constructed as an object, procedure or function. Nevertheless, the executable code identified module without physically located together, but may include different instructions stored in different positions; the upper when these instructions are logically combine together, the module and achieve the stated purpose of the module. Actually, the executable code module can be a single instruction or many instructions, and may even distributed across a plurality of different code sections, distributed among different programs, and across several memory devices are distributed. Similarly, operational data may be identified in the module, and can be implemented according to any suitable form and are organized in the data structure of any suitable type. the operation data can be used as a single data set is collected, or can be distributed on different positions (including on the different storage devices), and at least partially can only exist on the system or network as an electronic signal.
the module can be realized by software, considering the level of existing hardware technology, it can implemented in software module, under the condition without considering the cost of, those skilled in the art can build the corresponding hardware circuit to realize the corresponding function, the hardware circuit comprises a conventional very large scale integrated (VLSI) circuit or gate array and logic chip such as, current semiconductor transistors, or other discrete components. module can also use a programmable hardware device, such as a field programmable gate array, programmable array logic, a programmable logic device and the like.
The above are only embodiments of the present invention, should be indicated, for the technical field of common technician, does not separate from the invention principle of premise, also can make several improved and modify, these improved and polish should be regarded as the protection range of the invention.

Claims

1. A antenna mapping method, wherein the digital front end, comprising the following steps: obtaining front end switching network output to be the downlink antenna mapping process on data to be transmitted according to the downlink data to be transmitted to the wireless transmission resource. determining the downlink multi-antenna mapping information to be sent data corresponding to the multi-antenna mapping information includes ports and each port respectively corresponding to the ports corresponding to the port to antenna mapping bitmap and beam forming factor according to the multi-antenna mapping information. the

downlink data to be transmitted to antenna mapping process the wireless transmission resource, obtaining to-be-sent data via the antenna, receiving the front end switching network output antenna mapping information of cell level, the cell antenna mapping information comprises each port of the port to the antenna corresponding to the cell-level bitmap and the beam shaping factor.

2. The method according to claim 1, wherein the wireless transmission resource corresponding to the physical layer channel type is a broadcast or shared channel, type of the beamforming factor is an omni-directional broadcast shaping factors, or the wireless transmission resource corresponding to the physical layer channel type is special channel of the user terminal, the type of the beam forming weight factors of antenna beam shaping factors special for the user terminal.

3. The method according to claim 1, wherein the corresponding wireless transmission resource data to be transmitted according to the downlink, determining multi-antenna mapping information corresponding to the downlink data to be transmitted comprises: the wireless transmission resource corresponding to the physical layer channel type is a broadcast or common channel data to be transmitted in the physical layer channel transmission mode, determining the ports according to the downlink according to each port of the ports and port to the antenna corresponding to the cell-level bitmap. determining the port corresponding to the port of the port respectively corresponding to antenna bitmap, according to each port of the ports and the cell corresponding to the beam shaping factor, determining the port corresponding to the port of the corresponding beam forming weight factors, respectively.

4. The method according to claim 1, wherein the said wireless transmission resource comprises a time-frequency resource, the physical layer channel corresponding to the time-frequency resource type is shared channel, the port and the time-frequency resource of the time-frequency resource block corresponding to each port of the ports corresponding to the ports respectively corresponding to antenna mapping bitmap and wave beam forming factor for each port of the time-frequency resource block corresponding to the respectively corresponding port to antenna mapping bitmap and wave beam forming factor.

5. The method according to claim 1, wherein, corresponding to each port of the ports comprising at least a first port and a second port, according to the multi-antenna mapping information of the downlink data to be transmitted to antenna mapping processing. obtaining the said wireless transmission resource through antenna of transmitting data comprises: determining the downlink data to be transmitted corresponding to the first port and the second port of the first data and the second data respectively corresponding to the first port and the second port of the port to antenna bitmap. determining that the first port and the second port are respectively mapped to the antennas according to the first data, the second data, the first port and the second port respectively corresponding to the beam forming weight factors to generate the wireless transmission resource via the respectively mapped to the antennas respectively transmitting data.

6. The method according to claim 5, wherein, according to said first data, said second data, said first port and said second port are respectively corresponding to the beam shaping factor. generating to the wireless transmission resource by the respectively mapped to the antennas respectively transmitting data comprising the following steps: multiplying the beam forming weight factors corresponding to the first data and the first port of the wireless transmission resource, obtaining to-be-via the first port mapping data sent by the antenna; the port corresponding to the second data and the second beam forming weight factor multiplying to obtain the to be the wireless transmission resources by mapping the second port to antenna transmitting the data.

7. The method according to claim 5, wherein the first port and the second port are mapped to antenna comprises at least a first antenna and a second antenna, the first port corresponding to the beam shaping factor comprises: respectively mapping to the first beam forming weight factor and the second beam forming weight factor to the first antenna and the second antenna corresponding to the first port, the second port of the corresponding beam forming weight factor comprises: mapping the second port respectively third beam forming weight factor and the fourth beam forming weight factors corresponding to the said first antenna and the second antenna; according to said first data, said second data, said first port and said second port are respectively the corresponding beam forming weight factors to generate the wireless transmission resource via the respectively mapped to the antennas respectively transmitting data comprising: the first data and the second data respectively multiplying with the first beam forming weight factor and the third beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by said first antenna data; the first data and the second data respectively multiplying with the second beam

forming weight factor and the fourth beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by the second antenna data.
8. The method according to claim 1, wherein the digital front end is placed at the far end radio frequency unit RRU side.
9. The method according to claim 1, wherein the method for long-term evolution LTE system, said wireless transmission resource is the resource element RE.
10. The method according to claim 1, wherein the method is used for a time division synchronization code division multiple access TD-SCDMA system, said wireless transmission resource is effective sub-frame of spreading code and distributing corresponding resource.
11. An antenna mapping device, wherein the digital front end, comprising an obtaining module for obtaining the front end switching network output to be the downlink antenna mapping process on data to be transmitted, determining module, for according to the downlink data to be transmitted to the wireless transmission resource, determining multi-antenna mapping information corresponding to the downlink data to be transmitted, said information comprises multi-antenna mapping ports and each port respectively corresponding to the ports corresponding to the port to antenna mapping bit map and the beam shaping factor; processing module, used for according to the multi-antenna mapping information, data to be transmitted to antenna mapping process for the downlink in the wireless transmission resource, obtaining to-be-sent data via the antenna, a receiving module for receiving the output of the front end switching network antenna mapping information of cell level, the cell antenna mapping information comprises each port of the port to the antenna corresponding to the cell-level bitmap and the beam shaping factor.
12. The device according to claim 11, wherein the wireless transmission resource corresponding to the physical layer channel type is a broadcast or shared channel, type of the beamforming factor is an omni-directional broadcast shaping factors, or the wireless transmission resource corresponding to the physical layer channel type is special channel of the user terminal, the type of the beam forming weight factors of antenna beam shaping factors special for the user terminal.
13. The device according to claim 11, wherein said determining module comprises a first determining unit for, when the wireless transmission resource corresponding to the physical layer channel type is broadcast or common channel. The downlink data to be transmitted in the transmission mode of physical layer channel, determining the ports, and a second determining unit, used for according to each port of the ports and port to the antenna corresponding to the cell-level bitmap, determining the port corresponding to the port of the port respectively corresponding to antenna mapping bitmap; a third determining unit, used for according to each port of the ports and the cell corresponding to the beam shaping factor, determining the port corresponding to the port of the corresponding beam forming weight factors, respectively.
14. The device according to claim 11, wherein the wireless transmission resource comprises a time-frequency resource, the physical layer channel corresponding to the time-frequency resource type is shared channel, the port and the time-frequency resource of the time-frequency resource block corresponding to each port of the ports corresponding to the ports respectively corresponding to antenna mapping bitmap and wave beam forming factor for each port of the time-frequency resource block corresponding to the respectively corresponding port to antenna mapping bitmap and wave beam forming factor.
15. The device according to claim 11, wherein, corresponding to each port of the ports comprising at least a first port and a second port, the processing module comprises a fourth determining unit; for determining the downlink data to be transmitted corresponding to the first port and the second port of the first data and the second data, a fifth determining unit for respectively corresponding to the first port and the second port of the port to antenna bitmap, determines that the first port and the second port are respectively mapped to the antenna; generating unit, for according to the first data and the second data, respectively corresponding to the first port and the second port of the beam forming weight factors to generate the wireless transmission resource by the respectively mapped to the antennas respectively transmitting data.
16. The device according to claim 15, wherein the generation unit comprises a first calculating sub-unit for transmitting the first data and the first port corresponding to the beam shaping factor multiplying; obtaining the said wireless transmission resource is mapped to by the first port sent by the antenna data, a second calculating sub-unit for the port corresponding to the second data and the second beam forming weight factor multiplying to obtain the to be the wireless transmission resource via the second port mapped to the antenna to send data.

17. The device according to claim 15, wherein the first port and the second port are mapped to antenna comprises at least a first antenna and a second antenna, the first port corresponding to the beam shaping factor comprises: respectively mapping to the first beam forming weight factor and the second beam forming weight factor to the first antenna and the second antenna corresponding to the first port, the second port of the corresponding beam forming weight factor comprises: mapping the second port respectively third beam forming weight factor and the fourth beam forming weight factors corresponding to the said first antenna and the second antenna; said generating unit comprises: a third calculation subunit, used for transmitting the first data and the second data respectively multiplying with the first beam forming weight factor and the third beamforming factor, then performing the superposition, obtaining the said wireless transmission resource is transmitted by said first antenna data, a fourth calculating sub-unit, used for transmitting the first data and the second data respectively multiplying with the second beam forming weight factor and the fourth beamforming factor, then performing the superposition to obtain the said wireless transmission resource is transmitted by the second antenna data.
18. A digital front end, wherein it comprises according to any one of claims 11 to 17 the antenna mapping device.

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(73)专利权人 中国移动通信集团公司
地址 100032 北京市西城区金融大街29号

(72)发明人 段然 袁雁南 孔令斌 易芝玲

(74)专利代理机构 北京银龙知识产权代理有限公司 11243
代理人 黄灿 安利霞

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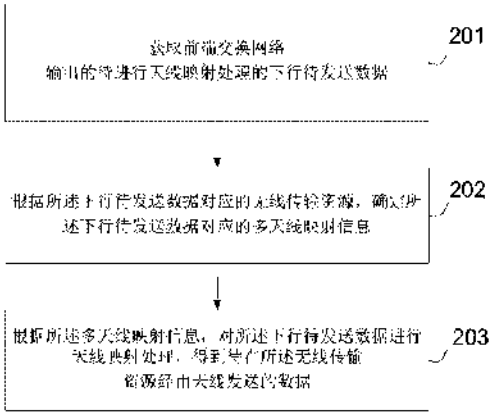
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(54)发明名称

一种天线映射方法、装置及数字前端

(57)摘要

本发明实施例提供一种天线映射方法、装置及数字前端。方法包括：获取前端交换网络输出的待进行天线映射处理的下行待发送数据；根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息；根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据。本发明实施例减少了前端交换网络的数据交换量。



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1.一种天线映射方法，其特征在于，用于数字前端，包括：

获取前端交换网络输出的待进行天线映射处理的下行待发送数据；

根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息，所述多天线映射信息包括端口数和所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形权值因子；

根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据；

接收所述前端交换网络输出的小区级天线映射信息，所述小区级天线映射信息包括小区级的各端口对应的端口至天线映射位图和波束赋形权值因子。

2.根据权利要求1所述的方法，其特征在于，所述无线传输资源对应的物理层信道类型为广播或共享信道时，所述波束赋形权值因子的类型为全向广播赋形因子；或，

所述无线传输资源对应的物理层信道类型为用户终端专用信道时，所述波束赋形权值因子的类型为用户终端专用的天线波束赋形因子。

3.根据权利要求1所述的方法，其特征在于，所述根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息包括：

在所述无线传输资源对应的物理层信道类型为广播或公共信道时，根据所述下行待发送数据在所述物理层信道的发送模式，确定所述端口数；

根据所述端口数和所述小区级的各端口对应的端口至天线映射位图，确定所述端口数对应的各端口所分别对应的端口至天线映射位图；

根据所述端口数和所述小区级的各端口对应的波束赋形权值因子，确定所述端口数对应的各端口所分别对应的波束赋形权值因子。

4.根据权利要求1所述的方法，其特征在于，所述无线传输资源包括时频资源，在所述时频资源对应的物理层信道类型为共享信道时，所述端口数与所述时频资源所在的时频资源块对应，所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形因子为所述时频资源块对应的各端口分别对应的端口至天线映射位图和波束赋形因子。

5.根据权利要求1所述的方法，其特征在于，所述端口数对应的各端口包括至少第一端口和第二端口；

所述根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据包括：

确定所述下行待发送数据在所述第一端口和第二端口分别对应的第一数据和第二数据；

根据所述第一端口和所述第二端口分别对应的端口至天线映射位图，确定所述第一端口和所述第二端口分别映射到的天线；

根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据。

6.根据权利要求5所述的方法，其特征在于，所述根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据包括：

将所述第一数据和所述第一端口对应的波束赋形权值因子相乘，得到待在所述无线传

输资源经由所述第一端口映射到的天线发送的数据；

将所述第二数据和所述第二端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第二端口映射到的天线发送的数据。

7.根据权利要求5所述的方法，其特征在于，所述第一端口和所述第二端口映射到的天线均包括至少第一天线和第二天线；

所述第一端口对应的波束赋形权值因子包括：所述第一端口分别映射到所述第一天线和所述第二天线时对应的第一波束赋形权值因子和第二波束赋形权值因子；

所述第二端口对应的波束赋形权值因子包括：所述第二端口分别映射到所述第一天线和所述第二天线时对应的第三波束赋形权值因子和第四波束赋形权值因子；

所述根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据包括：

将所述第一数据和所述第二数据分别与所述第一波束赋形权值因子和所述第三波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第一天线发送的数据；

将所述第一数据和所述第二数据分别与所述第二波束赋形权值因子和所述第四波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第二天线发送的数据。

8.根据权利要求1所述的方法，其特征在于，所述数字前端放置于远端无线射频单元RRU侧。

9.根据权利要求1所述的方法，其特征在于，所述方法用于长期演进LTE系统，所述无线传输资源为资源元素RE。

10.根据权利要求1所述的方法，其特征在于，所述方法用于时分同步码分多址TD-SCDMA系统，所述无线传输资源为扩频码编码和分配的有效子帧标对应的资源。

11.一种天线映射装置，其特征在于，用于数字前端，包括：

获取模块，用于获取前端交换网络输出的待进行天线映射处理的下行待发送数据；

确定模块，用于根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息，所述多天线映射信息包括端口数和所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形权值因子；

处理模块，用于根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据；

接收模块，用于接收所述前端交换网络输出的小区级天线映射信息，所述小区级天线映射信息包括小区级的各端口对应的端口至天线映射位图和波束赋形权值因子。

12.根据权利要求11所述的装置，其特征在于，所述无线传输资源对应的物理层信道类型为广播或共享信道时，所述波束赋形权值因子的类型为全向广播赋形因子；或，

所述无线传输资源对应的物理层信道类型为用户终端专用信道时，所述波束赋形权值因子的类型为用户终端专用的天线波束赋形因子。

13.根据权利要求11所述的装置，其特征在于，所述确定模块包括：

第一确定单元，用于在所述无线传输资源对应的物理层信道类型为广播或公共信道

时，根据所述下行待发送数据在所述物理层信道的发送模式，确定所述端口数；

第二确定单元，用于根据所述端口数和所述小区级的各端口对应的端口至天线映射位图，确定所述端口数对应的各端口所分别对应的端口至天线映射位图；

第三确定单元，用于根据所述端口数和所述小区级的各端口对应的波束赋形权值因子，确定所述端口数对应的各端口所分别对应的波束赋形权值因子。

14.根据权利要求11所述的装置，其特征在于，所述无线传输资源包括时频资源，在所述时频资源对应的物理层信道类型为共享信道时，所述端口数与所述时频资源所在的时频资源块对应，所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形因子为所述时频资源块对应的各端口分别对应的端口至天线映射位图和波束赋形因子。

15.根据权利要求11所述的装置，其特征在于，所述端口数对应的各端口包括至少第一端口和第二端口；

所述处理模块包括：

第四确定单元，用于确定所述下行待发送数据在所述第一端口和第二端口分别对应的第一数据和第二数据；

第五确定单元，用于根据所述第一端口和所述第二端口分别对应的端口至天线映射位图，确定所述第一端口和所述第二端口分别映射到的天线；

生成单元，用于根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据。

16.根据权利要求15所述的装置，其特征在于，所述生成单元包括：

第一计算子单元，用于将所述第一数据和所述第一端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第一端口映射到的天线发送的数据；

第二计算子单元，用于将所述第二数据和所述第二端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第二端口映射到的天线发送的数据。

17.根据权利要求15所述的装置，其特征在于，所述第一端口和所述第二端口映射到的天线均包括至少第一天线和第二天线；

所述第一端口对应的波束赋形权值因子包括：所述第一端口分别映射到所述第一天线和所述第二天线时对应的第一波束赋形权值因子和第二波束赋形权值因子；

所述第二端口对应的波束赋形权值因子包括：所述第二端口分别映射到所述第一天线和所述第二天线时对应的第三波束赋形权值因子和第四波束赋形权值因子；

所述生成单元包括：

第三计算子单元，用于将所述第一数据和所述第二数据分别与所述第一波束赋形权值因子和所述第三波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第一天线发送的数据；

第四计算子单元，用于将所述第一数据和所述第二数据分别与所述第二波束赋形权值因子和所述第四波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第二天线发送的数据。

18.一种数字前端，其特征在于，包括如权利要求11至17中任一权利要求所述的天线映射装置。

一种天线映射方法、装置及数字前端

技术领域

[0001] 本发明涉及通信、IT技术领域，尤其涉及一种天线映射方法、装置及数字前端。

背景技术

[0002] 面对近几年能源和电力价格的上涨，全球移动通信网络运营商面临日渐严重的成本压力以及电信市场的激烈竞争，单用户平均收入(ARPU)增长缓慢甚至下降等等问题，出于行业持续盈利和长期发展考虑，移动通信产业界提出了绿色演进的新型无线网络架构C-RAN，以引导未来集中式基带处理网络架构技术的发展。

[0003] C-RAN的系统架构，主要是由远端无线射频单元(RRU)与天线组成的分布式无线网络，具备高带宽、低延迟的光传输网络连接远端无线射频单元，通用处理器和实时虚拟技术组成的集中式基带处理池三大部分组成。所有基带处理单元和远端无线射频单元通过高带宽、低延迟的光传输网络连接起来。基带处理单元(BBU)集中在一个物理站点构成基带池。基带池中多个基带处理单元之间通过高带宽、低延迟、灵活拓扑、低成本交叉连接。基带池上需要应用基站虚拟化技术，支持基带池物理资源和计算能力的虚拟分配和组合。

[0004] 集中式基站内多个BBU互联互通构成高容量、低延迟的互联架构。远端的RRU通过互联架构交换到集中式基带池中任一个BBU。这种方式是对现有BBU进行集中化集成，可有效实现载波负载均衡、容灾备份，并达到提高设备利用率、减少基站机房数量、降低能耗的目的。

[0005] 现有技术方案中多以DSP+FPGA的实现方式实现基带池，异或以通用处理CPU替代DSP实现BBU的物理层处理功能。

发明内容

[0006] 有鉴于此，本发明实施例的目的是提供一种天线映射方法、装置及数字前端，以减少前端交换网络的数据交换量。

[0007] 为解决上述技术问题，本发明实施例提供方案如下：

[0008] 本发明实施例提供一种天线映射方法，用于数字前端，包括：

[0009] 获取前端交换网络输出的待进行天线映射处理的下行待发送数据；

[0010] 根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息；

[0011] 根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据。

[0012] 优选地，所述多天线映射信息包括端口数和所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形权值因子。

[0013] 优选地，所述无线传输资源对应的物理层信道类型为广播或共享信道时，所述波束赋形权值因子的类型为全向广播赋形因子；或，

[0014] 所述无线传输资源对应的物理层信道类型为用户终端专用信道时，所述波束赋形

权值因子的类型为用户终端专用的天线波束赋形因子。

[0015] 优选地，还包括：

[0016] 接收所述前端交换网络输出的小区级天线映射信息，所述小区级天线映射信息包括小区级的各端口对应的端口至天线映射位图和波束赋形权值因子；

[0017] 所述根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息包括：

[0018] 在所述无线传输资源对应的物理层信道类型为广播或公共信道时，根据所述下行待发送数据在所述物理层信道的发送模式，确定所述端口数；

[0019] 根据所述端口数和所述小区级的各端口对应的端口至天线映射位图，确定所述端口数对应的各端口所分别对应的端口至天线映射位图；

[0020] 根据所述端口数和所述小区级的各端口对应的波束赋形权值因子，确定所述端口数对应的各端口所分别对应的波束赋形权值因子。

[0021] 优选地，所述无线传输资源包括时频资源，在所述时频资源对应的物理层信道类型为共享信道时，所述端口数与所述时频资源所在的时频资源块对应，所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形因子为所述时频资源块对应的各端口分别对应的端口至天线映射位图和波束赋形因子。

[0022] 优选地，所述端口数对应的各端口包括至少第一端口和第二端口；

[0023] 所述根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据包括：

[0024] 确定所述下行待发送数据在所述第一端口和第二端口分别对应的第一数据和第二数据；

[0025] 根据所述第一端口和所述第二端口分别对应的端口至天线映射位图，确定所述第一端口和所述第二端口分别映射到的天线；

[0026] 根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据。

[0027] 优选地，所述根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据包括：

[0028] 将所述第一数据和所述第一端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第一端口映射到的天线发送的数据；

[0029] 将所述第二数据和所述第二端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第二端口映射到的天线发送的数据。

[0030] 优选地，所述第一端口和所述第二端口映射到的天线均包括至少第一天线和第二天线；

[0031] 所述第一端口对应的波束赋形权值因子包括：所述第一端口分别映射到所述第一天线和所述第二天线时对应的第一波束赋形权值因子和第二波束赋形权值因子；

[0032] 所述第二端口对应的波束赋形权值因子包括：所述第二端口分别映射到所述第一天线和所述第二天线时对应的第三波束赋形权值因子和第四波束赋形权值因子；

[0033] 所述根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据包括：

[0034] 将所述第一数据和所述第二数据分别与所述第一波束赋形权值因子和所述第三波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第一天线发送的数据；

[0035] 将所述第一数据和所述第二数据分别与所述第二波束赋形权值因子和所述第四波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第二天线发送的数据。

[0036] 优选地，所述数字前端放置于远端无线射频单元RRU侧。

[0037] 优选地，所述方法用于长期演进LTE系统，所述无线传输资源为资源元素RE。

[0038] 优选地，所述方法用于时分同步码分多址TD-SCDMA系统，所述无线传输资源为扩频码编码和分配的有效子帧标识对应的资源。

[0039] 本发明实施例还提供一种天线映射装置，用于数字前端，包括：

[0040] 获取模块，用于获取前端交换网络输出的待进行天线映射处理的下行待发送数据，其中，所述下行待发送数据对应一无线传输资源；

[0041] 确定模块，用于根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息；

[0042] 处理模块，用于根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据。

[0043] 优选地，所述多天线映射信息包括端口数、和所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形权值因子。

[0044] 优选地，所述无线传输资源对应的物理层信道类型为广播或共享信道时，所述波束赋形权值因子的类型为全向广播赋形因子；或，

[0045] 所述无线传输资源对应的物理层信道类型为用户终端专用信道时，所述波束赋形权值因子的类型为用户终端专用的天线波束赋形因子。

[0046] 优选地，还包括：

[0047] 接收模块，用于接收所述前端交换网络输出的小区级天线映射信息，所述小区级天线映射信息包括小区级的各端口对应的端口至天线映射位图和波束赋形权值因子；

[0048] 所述确定模块包括：

[0049] 第一确定单元，用于在所述无线传输资源对应的物理层信道类型为广播或公共信道时，根据所述下行待发送数据在所述物理层信道的发送模式，确定所述端口数；

[0050] 第二确定单元，用于根据所述端口数和所述小区级的各端口对应的端口至天线映射位图，确定所述端口数对应的各端口所分别对应的端口至天线映射位图；

[0051] 第三确定单元，用于根据所述端口数和所述小区级的各端口对应的波束赋形权值因子，确定所述端口数对应的各端口所分别对应的波束赋形权值因子。

[0052] 优选地，所述无线传输资源包括时频资源，在所述时频资源对应的物理层信道类型为共享信道时，所述端口数与所述时频资源所在的时频资源块对应，所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形因子为所述时频资源块对应的各端

口分别对应的端口至天线映射位图和波束赋形因子。

[0053] 优选地，所述端口数对应的各端口包括至少第一端口和第二端口；

[0054] 所述处理模块包括：

[0055] 第四确定单元，用于确定所述下行待发送数据在所述第一端口和第二端口分别对应的第一数据和第二数据；

[0056] 第五确定单元，用于根据所述第一端口和所述第二端口分别对应的端口至天线映射位图，确定所述第一端口和所述第二端口分别映射到的天线；

[0057] 生成单元，用于根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据。

[0058] 优选地，所述生成单元包括：

[0059] 第一计算子单元，用于将所述第一数据和所述第一端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第一端口映射到的天线发送的数据；

[0060] 第二计算子单元，用于将所述第二数据和所述第二端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第二端口映射到的天线发送的数据。

[0061] 优选地，所述第一端口和所述第二端口映射到的天线均包括至少第一天线和第二天线；

[0062] 所述第一端口对应的波束赋形权值因子包括：所述第一端口分别映射到所述第一天线和所述第二天线时对应的第一波束赋形权值因子和第二波束赋形权值因子；

[0063] 所述第二端口对应的波束赋形权值因子包括：所述第二端口分别映射到所述第一天线和所述第二天线时对应的第三波束赋形权值因子和第四波束赋形权值因子；

[0064] 所述生成单元包括：

[0065] 第三计算子单元，用于将所述第一数据和所述第二数据分别与所述第一波束赋形权值因子和所述第三波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第一天线发送的数据；

[0066] 第四计算子单元，用于将所述第一数据和所述第二数据分别与所述第二波束赋形权值因子和所述第四波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第二天线发送的数据。

[0067] 本发明实施例还提供一种包括以上所述的天线映射装置的数字前端。

[0068] 从以上所述可以看出，本发明实施例至少具有如下有益效果：

[0069] 由于天线映射处理移到了数字前端，从而使得在多天线配置下，前端交换网络不需要交换因天线映射处理所带来的冗余信息，从而减少了前端交换网络的数据交换量，降低了交换带宽。

附图说明

[0070] 图1A、1B表示描述数字前端与服务器间的连接关系的描述图；

[0071] 图2表示本发明实施例提供的一种天线映射方法的步骤流程图；

[0072] 图3表示本发明实施例的较佳实施方式的实施例1的下行链路的天线映射处理的相关接口和数据流图；

[0073] 图4表示本发明实施例的较佳实施方式的实施例1的天线映射流程示意图；

[0074] 图5表示本发明实施例的较佳实施方式的实施例2的编码扩频过程示意图；

[0075] 图6表示本发明实施例提供的一种天线映射装置的结构框图。

具体实施方式

[0076] 为使本发明实施例的目的、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实施例进行详细描述。

[0077] 现有技术中的这两类方案均不能完全解决基带池的动态载波迁移、高性能备份的问题。基于此，提出一种基于加速器板卡的基带池迁移方案。在此方案中，整体系统由4部分组成：1)通用处理器平台；2)物理层加速板卡(数字前端板卡)；3)通用交换单元；4)高速以太网交换机。而其中的核心部分，物理层加速板卡应具有三方面的功能：物理层处理或部分物理层处理；CPRI接口终结；对外交换数据功能。我们将板卡的对外交换功能定义为前端交换网络。这三个功能构成了此加速板卡的标准要素。

[0078] 其中，将数字基带的部分物理层(L1)处理分离出来，放到RRU侧，其余L1/L2/L3协议栈在基带池进行处理，RRU及数字前端负责射频收发和部分物理层处理。

[0079] 图1A、1B都是描述数字前端与服务器间的连接关系的描述图，服务器就是处理剩余部分L1/L2/L3的基带主处理单元，而FE(数字前端板卡)实现了部分L1，本发明实施例描述了数字前端的部分L1和基带主处理的部分L1之间的功能划分方法，实现了二者之间的交换网络降低交换带宽的目的。数字前端例如可以为板卡的形式。具体地，图1A中，数字前端板卡与服务器之间通过PCIe接口连接，数字前端板卡之间通过以太网前端交换网络相连，通过数字前端板卡的转发，可实现任一服务器与任一数字前端板卡之间的数据交互前端交换网络；图1B中，数字前端板卡与服务器之间通过10GE交换机(Switch)前端交换网络进行数据交互。

[0080] 针对多天线系统，我们发现由于波束赋形带来的传输冗余度非常高。例如，TDD-LTE系统相比较LTE FDD系统，TDD-LTE实现了下行多天线数据的联合发送从而实现了波束赋形等智能天线功能，在下行发送模式TM7和TM8下，需要有8天线的数据量在下行发送，按照粗略描述，共需要10Gbps带宽，在基带池的多小区配置下数据交换量过大，将会造成全系统交换成本的大幅度上升。因此迫切需要找到一种降低下行传输带宽的传输方法。

[0081] 图2表示本发明实施例提供的一种天线映射方法的步骤流程图，参照图2，本发明实施例提供一种天线映射方法，包括如下步骤：

[0082] 步骤201，获取前端交换网络输出的待进行天线映射处理的下行待发送数据；

[0083] 步骤202，根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息；

[0084] 步骤203，根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据。

[0085] 所述方法用于数字前端。

[0086] 可见，由于天线映射处理移到了数字前端，从而使得在多天线配置下，前端交换网络不需要交换因天线映射处理所带来的冗余信息，从而减少了前端交换网络的数据交换量，降低了交换带宽。

[0087] 其中，所述前端交换网络可以包括：以太网交换机及其对外接口；或者，以太网交换机及其对外接口、和与以太网交换机连接的其它数字前端装置及其连接的PCIe接口。

[0088] 所述无线传输资源可以包括：时域资源、频域资源、码分资源中的至少一种。具体到LTE系统，所述无线传输资源例如：资源元素(Resource Element，RE)，其为时频域资源。具体到TD-SCDMA系统，所述无线传输资源例如：扩频码编码和分配的有效子帧标识对应的资源，其为码分和时域资源。

[0089] 本发明实施例中，所述多天线映射信息可以包括端口数、和所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形权值因子。

[0090] 其中，所述无线传输资源对应的物理层信道类型为广播或共享信道时，所述波束赋形权值因子的类型可以为全向广播赋形因子；或，

[0091] 所述无线传输资源对应的物理层信道类型为用户终端专用信道时，所述波束赋形权值因子的类型可以为用户终端专用的天线波束赋形因子。

[0092] 此外，还可以包括：

[0093] 接收所述前端交换网络输出的小区级天线映射信息，所述小区级天线映射信息包括小区级的各端口对应的端口至天线映射位图和波束赋形权值因子；

[0094] 所述根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息可以包括：

[0095] 在所述无线传输资源对应的物理层信道类型为广播或公共信道时，根据所述下行待发送数据在所述物理层信道的发送模式，确定所述端口数；

[0096] 根据所述端口数和所述小区级的各端口对应的端口至天线映射位图，确定所述端口数对应的各端口所分别对应的端口至天线映射位图；

[0097] 根据所述端口数和所述小区级的各端口对应的波束赋形权值因子，确定所述端口数对应的各端口所分别对应的波束赋形权值因子。

[0098] 此外，所述无线传输资源可以包括时频资源，在所述时频资源对应的物理层信道类型为共享信道时，所述端口数可以与所述时频资源所在的时频资源块对应，所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形因子可以为所述时频资源块对应的各端口分别对应的端口至天线映射位图和波束赋形因子。

[0099] 此外，可以有：

[0100] 所述端口数对应的各端口包括至少第一端口和第二端口；

[0101] 所述根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据包括：

[0102] 确定所述下行待发送数据在所述第一端口和第二端口分别对应的第一数据和第二数据；

[0103] 根据所述第一端口和所述第二端口分别对应的端口至天线映射位图，确定所述第一端口和所述第二端口分别映射到的天线；

[0104] 根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据。

[0105] 其中，所述根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别

对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据可以包括：

[0106] 将所述第一数据和所述第一端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第一端口映射到的天线发送的数据；

[0107] 将所述第二数据和所述第二端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第二端口映射到的天线发送的数据。

[0108] 这里，波束赋形权值因子的类型可以为全向广播赋形因子。

[0109] 另外，所述第一端口和所述第二端口映射到的天线均可以包括至少第一天线和第二天线；

[0110] 所述第一端口对应的波束赋形权值因子可以包括：所述第一端口分别映射到所述第一天线和所述第二天线时对应的第一波束赋形权值因子和第二波束赋形权值因子；

[0111] 所述第二端口对应的波束赋形权值因子可以包括：所述第二端口分别映射到所述第一天线和所述第二天线时对应的第三波束赋形权值因子和第四波束赋形权值因子；

[0112] 所述根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据可以包括：

[0113] 将所述第一数据和所述第二数据分别与所述第一波束赋形权值因子和所述第三波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第一天线发送的数据；

[0114] 将所述第一数据和所述第二数据分别与所述第二波束赋形权值因子和所述第四波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第二天线发送的数据。

[0115] 这里，波束赋形权值因子的类型可以为用户终端专用的天线波束赋形因子。

[0116] 本发明实施例中，所述数字前端放置于远端无线射频单元RRU侧。

[0117] 由此，还降低了基带池与RRU之间的下行链路传送带宽。

[0118] 本发明实施例中，所述方法可以用于长期演进LTE系统或TD-SCDMA系统。对于前一种情况，所述无线传输资源可以为资源元素RE，属于资源块(RB，Resource Block)。对于后一种情况，所述无线传输资源可以为扩频码编码和分配的有效子帧标识对应的资源。

[0119] <较佳实施方式>

[0120] 为将本发明实施例阐述得更加清楚明白，下面提供本发明实施例的较佳实施方式。

[0121] 本较佳实施方式涉及一种数字前端交换结构下的下行天线发送权值映射的方法及实现装置以及一种前端交换结构下利用天线相关性降低交换带宽的方法及实现装置。

[0122] 本较佳实施方式提出的下行天线权值映射方案及装置，是在基带池总体交换框架之下，利用多天线系统的下行链路的多天线相关性，仅发送待发送数据并配合发送天线映射因子及天线发送权值，在数字前端实现天线映射过程。这将大幅度降低交换带宽。另外，若数字前端放置于RRU侧，则天线映射过程放置于RRU侧，也可以降低BBU与RRU间的下行链路传送带宽，这是另外一个应用场景。

[0123] 针对TD-LTE的下行链路，实施例1：

[0124] 如图3所示，PDSCH信道、公共信道、广播类信道进行分类别的天线映射处理，并根据天线映射方法定义了相关接口和数据流图：

[0125] 下行链路的天线映射处理子系统由主要由3部分组成：

[0126] 1)接收缓存分发模块

[0127] 此模块用于接收并缓存从PCIe和Ethernet获得的前一级物理层算法输出的数据包信息。由于本较佳实施方式仅关注天线映射及波束成形过程，对于接收的下行待发送数据格式和形式不做要求。而重点规定了与天线映射相关的数据结构定义。接收缓存分发模块接收数据，按照类型分五类A)～E)进行缓存：

[0128] A)小区级控制参数：带宽、PhyCellID、子帧上下行配比、特殊子帧配置、子帧号(每毫秒更新)、PHICH信道配置、端口个数、小区级天线映射位图和全向权值因子、各信道的功率配置信息等：

[0129] 其中，小区级天线映射和天线全向权值因子的定义如表1所示：

[0130] 表1

[0131]

接口名称	英文缩写	取值解释
端口数	PortNo	CRS 天线端口数[1:4]
物理天线个数	AntChannel	天线物理通道数 00：1 天线 01：2 天线 10：4 天线 11：8 天线
端口至天线映射位图	Port0Mapping	天线端口 0~3 与天线物理通道 i 映射关系[i]：（i=0~7） 天线物理通道映射关系 0：天线端口不映射到物理通道 i 1：天线端口映射到物理通道 i
	Port1Mapping	
	Port2Mapping	
	Port3Mapping	
各物理天线的全向映射因子	ps_schWval0	天线物理通道 i（i=0~7）的固定全向权重系数，在ps_schWeightEn[i]字段为固定权重系数映射时有效 [15:0]：实部 [31:16]：虚部
	ps_schWval1	
	ps_schWval2	
	ps_schWval3	
	ps_schWval4	
	ps_schWval5	
	ps_schWval6	
	ps_schWval7	

[0132] 小区级全向天线映射信息用于实现CRS/PSS/SSS/PBCH/PDCCH/PCFICH/PHICH等信道的天线映射过程。

[0133] B)小区级数据缓存：缓存CRS待发送数据、PBCH待发送数据、PSS、SSS待发送数据等

[0134] C)共享信道映射信息：此数据每毫秒更新，指示各个RB(频率资源)被PDSCH占用的映射关系和下行发送模式(协议规定的Trans Mode)。

[0135] D)公共信道数据缓存：此数据每毫秒更新，用于暂存PCFICH/PDCCH/PHICH下行发送的数据。

[0136] E)共享信道数据及天线映射缓存：此数据每毫秒更新，按传输端口数量缓存PDSCH信道的各端口待发送数据，并缓存天线映射参数。天线映射参数指示当前RB发送的端口数量，也包括了BF因子，可用于单UE的TM7/TM8发送模式，也可用于小区间双UE的协作化数据发送。

[0137] 如表2所示，每个RB所对应的端口数和映射BF因子：

[0138] 表2

[0139]

接口名称	英文缩写	取值解释
端口数 3bit	PortNo	天线端口数[1:4]，定义 0x7 表示当前 RB 并非 TM7/TM8 模式，无 BF
端口至天线映射位图（16bit）	Port0Mapping	TM7/TM8 模式下天线物理通道映射关系 0：天线端口不映射到物理通道 i 1：天线端口映射到物理通道 i
	Port1Mapping	
物理天线的映射因子 For Port0 (8x32bit,UE 定向)	ps_schWval0	天线物理通道 i（i=0~7）的固定全向权重系数，在 ps_schWeightEn[i]字段为固定权重系数映射时有效 [15:0]：实部 [31:16]：虚部
	ps_schWval1	
	ps_schWval2	
	ps_schWval3	
	ps_schWval4	
	ps_schWval5	
	ps_schWval6	
	ps_schWval7	
各物理天线的映射因子 For Port1 (8x32bit,UE 定向)	ps_schWval0	同上
	ps_schWval1	
	ps_schWval2	
	ps_schWval3	
	ps_schWval4	
	ps_schWval5	
	ps_schWval6	
	ps_schWval7	
注：以 RB 为单位描述每一个 RB Block 占用天线的情况		

[0140] 2)资源映射表生成子模块

[0141] 根据当前小区配置信息和子帧号得到CRS/PBCH/PSS/SSS/PHICH/PCFICH/PDCCH对应的RE位置，并以此生成以RE为颗粒度的资源映射表，所有的公共信道的天线映射模式均为公共模式。而后综合共享信道(PDSCH)映射信息，同样将共享信道映射资源映射信息填入此表，并标明各RE资源的天线映射模式：专用模式和公共模式。资源映射表以RE为颗粒度，描述每个RE资源被什么类型的信道占用，并标明天线映射的模式。专用模式：即当前RE为具体的UE所占用(1个或2个)，并需要采用UE专用的波束赋形(TM7/TM8)方式提升UE的接收质量。公共模式：即当前RE为公共信道或非TM7/TM8模式传输的PDSCH信道所占用，此时天线映射采用小区级的端口至天线的映射方式，并采用全向波束赋形权值因子。

[0142] 3)天线映射子模块

[0143] 本较佳实施方式并未规定缓存内的广播类信道数据和控制类信道数据的存储格

式，即：可存储下行预编码前的数据，也可存储预编码后的端口数据。若采用预编码前的数据方式存储，可使用星座点位图的方式存储而节省内存的使用量。因此，在这个子模块中，需要先将公共和广播信道的数据进行部分物理层处理而得到预编码后数据，同理，也可得到共享信道数据的预编码后结果，天线映射的流程如图4所示。

[0144] 如图中描述，具体操作步骤：

[0145] 步骤一，建立资源映射表与缓存数据的映射关系。例如：当判断某一个RE为CRS占用时，可获取此CRS的实际待发数据。或，当判断某一个RE为PDSCH占用时，则可查询PDSCH信道在此RE上发送的实际数据，并得到其天线映射参数；

[0146] 步骤二，RE索引初始化为0（启动循环处理每一个RE对应的数据映射过程）；

[0147] 步骤三，判断RE的天线映射模式，当判断为公共模式的时，跳转入步骤四，判断为专用模式时，跳转入步骤六；

[0148] 步骤四，公共模式发送有两类，其一是CRS/PSS/SSS类信道，这类信道数据发送仅有单层发送的概念。PSS/SSS为单端口映射并全向波束赋形权值发送，CRS为单端口映射并根据端口映射位图选择部分天线全向权值发送。其二是PBCH/PHICH/PDCCH/PCFICH/PDSCH（非BF类），遵循端口数进行预编码并将预编码后数据按照端口到天线映射关系进行数据分发。根据两类不同的发送方式，变换小区级天线映射和天线全向权值因子信息，得到数据向天线映射所需端口数量和每端口对应的波束赋形权值因子；

[0149] 步骤五，逐端口，按照端口映射天线的位图指示，将本端口数据与天线波束赋形权值因子相乘，得到天线上的实际待发数据。跳转至步骤八；

[0150] 步骤六，获取专用模式下的当前RE所在RB的端口数和映射BF因子；

[0151] 步骤七，按照端口数循环，将每层循环对应的端口预编码后数据与相应的映射BF因子相乘，并将得到的结果按照天线进行累加，从而得到多层端口数据叠加于同一天线发送的最终空口发送数据。跳转至步骤八；

[0152] 步骤八，累加RE索引号，判断是否处理了全部的RE。若未完成所有RE的轮训，跳转至步骤二，否则处理流程结束。

[0153] 针对TD-SCDMA的下行链路，实施例2：

[0154] 参照图5，简要描述TD-SCDMA系统的编码扩频过程：首先，取当前码道数据；其次，取当前码道的扩频序列，并扩频；再次，一组数据分别乘多天线的BF因子；然后，按照天线进行数据累加；然后，判断是否还有未处理的码道，如果有，则返回取当前码道数据的步骤，否则该过程结束。

[0155] 根据上述过程可知，由于TD-SCDMA的区分用户码道用的是扩频码，因此每个用户都按照上图所示的流程进行扩频，并乘以各天线对应的天线映射权值得到各个码道的在各个天线上的实际发送数据，而后针对同一根天线的不同码道映射值进行多码道数据的累加，从而得到每根天线的实际发送多码道数据。

[0156] 同理，天线映射过程也可以移动到数字前端的位置，与实施例1一致。这里就不再赘述了。

[0157] 本较佳实施方式提出了采用仅传输天线端口映射数据和下行天线权值映射权值的方法，达到了压缩下行数据发送带宽目的。

[0158] 本方案的关键点：

[0159] 1)主机与数字前端通信，在下行链路方向上，利用天线相关性的特点，仅传输天线映射之前的待发送数据(或更之前的下行链路处理点上的数据)；

[0160] 2)配合待发送数据，主机发送给数字前端的天线映射信息，包括：端口数、端口至天线映射位图、BF赋形权值因子(包括全向和UE定向)。天线映射信息未来有可能定义为标准化接口。

[0161] 3)天线映射区分信道类型(公共/广播信道和共享信道)，选择不同类型的波束赋形权值因子。针对某一具体用户的信道可以选择UE专用的波束赋形因子，而公共/广播信道则采用全向广播赋形因子。

[0162] 4)特定TD-LTE系统，数字前端除需要根据信道类型判断外，还需要根据信道发送模式，选择映射方式和波束赋形因子实现端口到天线的映射，并最终在空口发送数据。

[0163] 5)端口到天线的映射过程，针对信道类型区分了“公共模式”和“专用模式”两类不同的映射过程。公共模式下，使用小区级的端口映射位图和全向天线波束赋形BF因子实现映射处理。专用模式下，使用UE定向天线波束赋形BF因子实现映射处理流程，并进一步判断发送模式实现多层映射，从而实现TM7/TM8/小区间协作化数据发送。

[0164] 关于上述子模块的划分和处理流程的描述，仅为两个具体的实施例。本较佳实施方式重点保护利用天线相关性减少多天线数据传输，并保护天线映射信息接口的内容定义，在这一前提下，还可以有更多的具体实施方法和流程。未来的系统也可能采用类似的方法。

[0165] 相比较完整传输下行天线端口数据的方式，本较佳实施方式要求仅传输：1)天线映射前待发送数据，2)传送端口至天线的映射信息，这可以：

[0166] 1)降低下行方向上，主机向数字前端发送的数据量；

[0167] 2)灵活地实现多小区间协作化地联合发送数据；

[0168] 3)按信道类型分类处理的机制，可简化处理的整体复杂度，提升处理逻辑的复用性。

[0169] 图6表示本发明实施例提供的一种天线映射装置的结构框图，参照图6，本发明实施例提供一种天线映射装置，包括：

[0170] 获取模块601，用于获取前端交换网络输出的待进行天线映射处理的下行待发送数据；

[0171] 确定模块602，用于根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息；

[0172] 处理模块603，用于根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据。

[0173] 所述装置用于数字前端。

[0174] 可见，由于天线映射处理移到了数字前端，从而使得在多天线配置下，前端交换网络不需要交换因天线映射处理所带来的冗余信息，从而减少了前端交换网络的数据交换量，降低了交换带宽。

[0175] 其中，可以有：

[0176] 所述多天线映射信息包括端口数、和所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形权值因子。

[0177] 其中，所述下行待发送数据对应的物理层信道类型为广播或共享信道时，所述波束赋形权值因子的类型可以为全向广播赋形因子；或，

[0178] 所述无线传输资源对应的物理层信道类型为用户终端专用信道时，所述波束赋形权值因子的类型可以为用户终端专用的天线波束赋形因子。

[0179] 此外，还可以包括：

[0180] 接收模块，用于接收所述前端交换网络输出的小区级天线映射信息，所述小区级天线映射信息包括小区级的各端口对应的端口至天线映射位图和波束赋形权值因子；

[0181] 所述确定模块602可以包括：

[0182] 第一确定单元，用于在所述无线传输资源对应的物理层信道类型为广播或公共信道时，根据所述下行待发送数据在所述物理层信道的发送模式，确定所述端口数；

[0183] 第二确定单元，用于根据所述端口数和所述小区级的各端口对应的端口至天线映射位图，确定所述端口数对应的各端口所分别对应的端口至天线映射位图；

[0184] 第三确定单元，用于根据所述端口数和所述小区级的各端口对应的波束赋形权值因子，确定所述端口数对应的各端口所分别对应的波束赋形权值因子。

[0185] 此外，所述无线传输资源可以包括时频资源，在所述时频资源对应的物理层信道类型为共享信道时，所述端口数可以与所述时频资源所在的时频资源块对应，所述端口数对应的各端口所分别对应的端口至天线映射位图和波束赋形因子可以为所述时频资源块对应的各端口分别对应的端口至天线映射位图和波束赋形因子。

[0186] 此外，所述端口数对应的各端口可以包括至少第一端口和第二端口；

[0187] 所述处理模块603可以包括：

[0188] 第四确定单元，用于确定所述下行待发送数据在所述第一端口和第二端口分别对应的第一数据和第二数据；

[0189] 第五确定单元，用于根据所述第一端口和所述第二端口分别对应的端口至天线映射位图，确定所述第一端口和所述第二端口分别映射到的天线；

[0190] 生成单元，用于根据所述第一数据、所述第二数据、所述第一端口和所述第二端口分别对应的波束赋形权值因子，生成待在所述无线传输资源经由所述分别映射到的天线所分别发送的数据。

[0191] 其中，所述生成单元可以包括：

[0192] 第一计算子单元，用于将所述第一数据和所述第一端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第一端口映射到的天线发送的数据；

[0193] 第二计算子单元，用于将所述第二数据和所述第二端口对应的波束赋形权值因子相乘，得到待在所述无线传输资源经由所述第二端口映射到的天线发送的数据。

[0194] 另外，可以有：

[0195] 所述第一端口和所述第二端口映射到的天线均包括至少第一天线和第二天线；

[0196] 所述第一端口对应的波束赋形权值因子包括：所述第一端口分别映射到所述第一天线和所述第二天线时对应的第一波束赋形权值因子和第二波束赋形权值因子；

[0197] 所述第二端口对应的波束赋形权值因子包括：所述第二端口分别映射到所述第一天线和所述第二天线时对应的第三波束赋形权值因子和第四波束赋形权值因子；

[0198] 所述生成单元包括：

[0199] 第三计算子单元，用于将所述第一数据和所述第二数据分别与所述第一波束赋形权值因子和所述第三波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第一天线发送的数据；

[0200] 第四计算子单元，用于将所述第一数据和所述第二数据分别与所述第二波束赋形权值因子和所述第四波束赋形权值因子相乘，然后进行叠加，得到待在所述无线传输资源经由所述第二天线发送的数据。

[0201] 本发明实施例还提供一种数字前端，所述数字前端包括以上所述的天线映射装置。

[0202] 此说明书中所描述的许多功能部件都被称为模块、单元，以便更加特别地强调其实现方式的独立性。

[0203] 本发明实施例中，模块可以用软件实现，以便由各种类型的处理器执行。举例来说，一个标识的可执行代码模块可以包括计算机指令的一个或多个物理或者逻辑块，举例来说，其可以被构建为对象、过程或函数。尽管如此，所标识模块的可执行代码无需物理地位于一起，而是可以包括存储在不同位里上的不同的指令，当这些指令逻辑上结合在一起时，其构成模块并且实现该模块的规定目的。

[0204] 实际上，可执行代码模块可以是单条指令或者是许多条指令，并且甚至可以分布在多个不同的代码段上，分布在不同程序当中，以及跨越多个存储器设备分布。同样地，操作数据可以在模块内被识别，并且可以依照任何适当的形式实现并且被组织在任何适当类型的数据结构内。所述操作数据可以作为单个数据集被收集，或者可以分布在不同位置上(包括在不同存储设备上)，并且至少部分地可以仅作为电子信号存在于系统或网络上。

[0205] 在模块可以利用软件实现时，考虑到现有硬件工艺的水平，所以可以以软件实现的模块，在不考虑成本的情况下，本领域技术人员都可以搭建对应的硬件电路来实现对应的功能，所述硬件电路包括常规的超大规模集成(VLSI)电路或者门阵列以及诸如逻辑芯片、晶体管之类的现有半导体或者是其它分立的元件。模块还可以用可编程硬件设备，诸如现场可编程门阵列、可编程阵列逻辑、可编程逻辑设备等实现。

[0206] 以上所述仅是本发明实施例的实施方式，应当指出，对于本技术领域的普通技术人员来说，在不脱离本发明实施例原理的前提下，还可以作出若干改进和润饰，这些改进和润饰也应视为本发明实施例的保护范围。

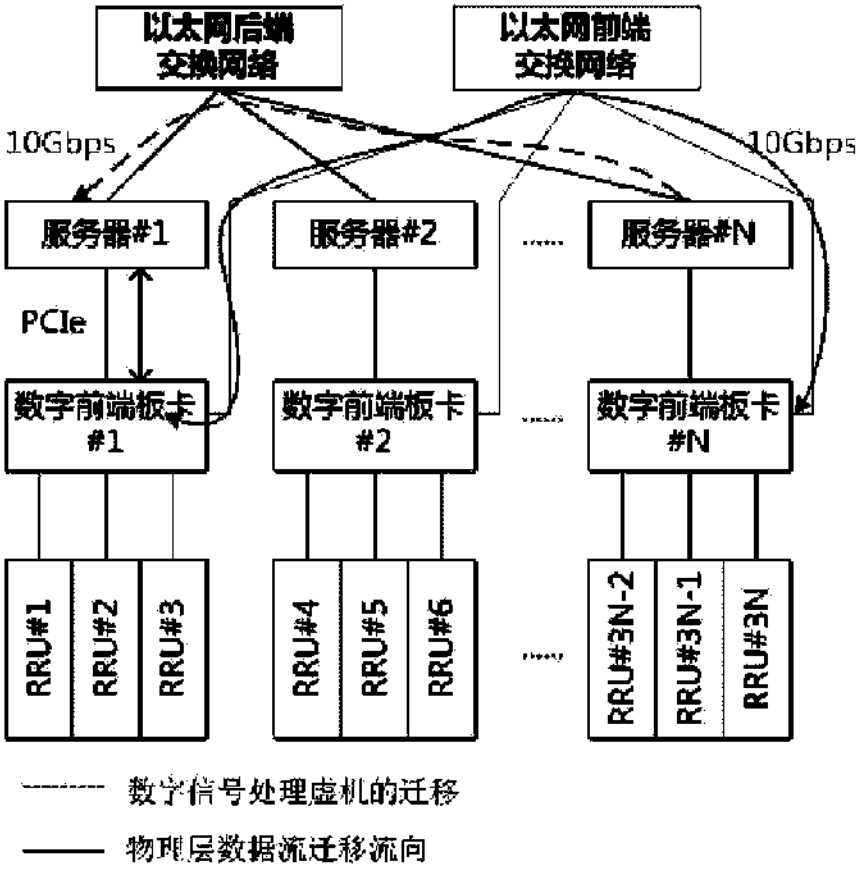

以太网后端交换网络
以太网前端交换网络
10Gbps
10Gbps
服务器#1
服务器#2
服务器#N
PCIe
数字前端板卡#1
数字前端板卡#2
数字前端板卡#N
RRU#1
RRU#2
RRU#3
RRU#4
RRU#5
RRU#6
RRU#3N-2
RRU#3N-1
RRU#3N
数字信号处理虚机的迁移
物理层数据流迁移流向

图1A

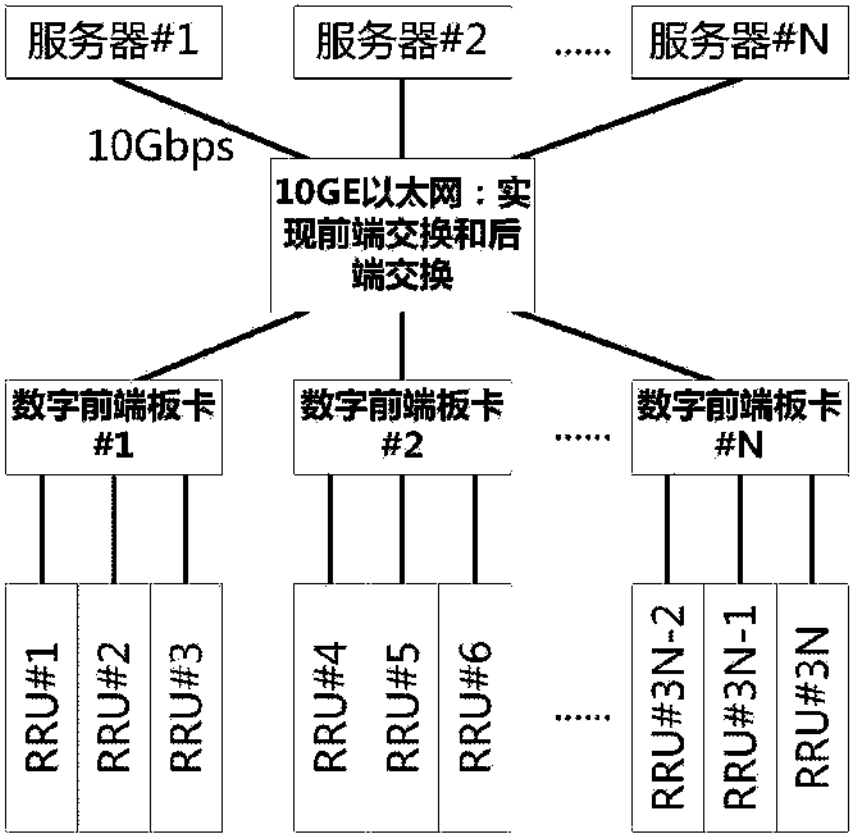

服务器#1
服务器#2
.....
服务器#N
10Gbps
10GE以太网：实现前端交换和后端交换
数字前端板卡#1
数字前端板卡#2
.....
数字前端板卡#N
RRU#1
RRU#2
RRU#3
RRU#4
RRU#5
RRU#6
.....
RRU#3N-2
RRU#3N-1
RRU#3N

图1B

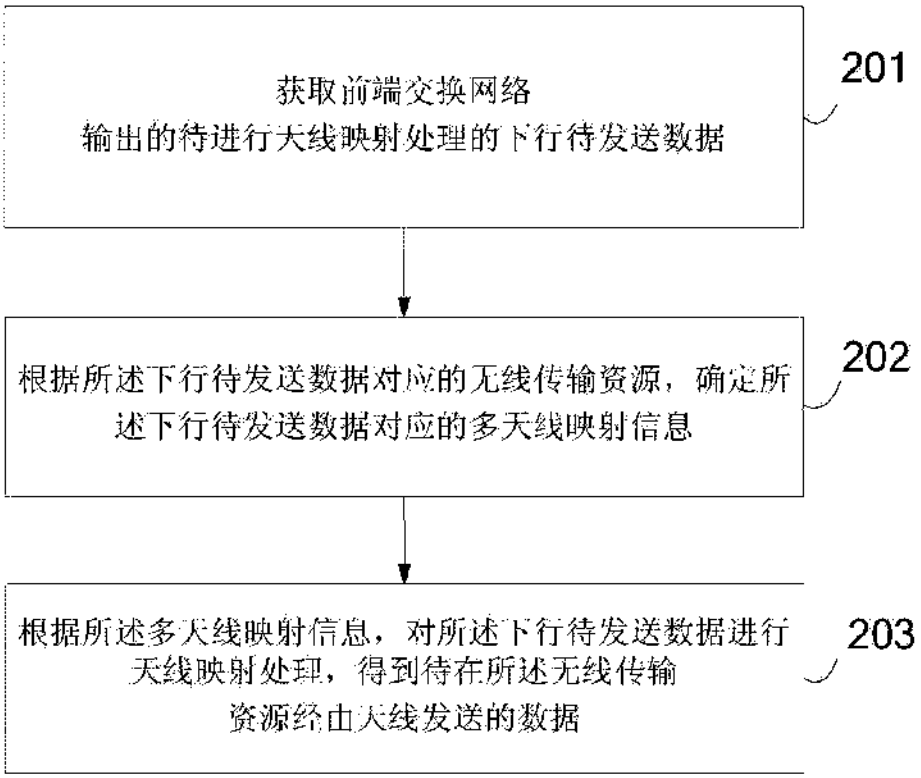

获取前端交换网络
输出的待进行天线映射处理的下行待发送数据
201
根据所述下行待发送数据对应的无线传输资源，确定所述下行待发送数据对应的多天线映射信息
202
根据所述多天线映射信息，对所述下行待发送数据进行天线映射处理，得到待在所述无线传输资源经由天线发送的数据
203

图2

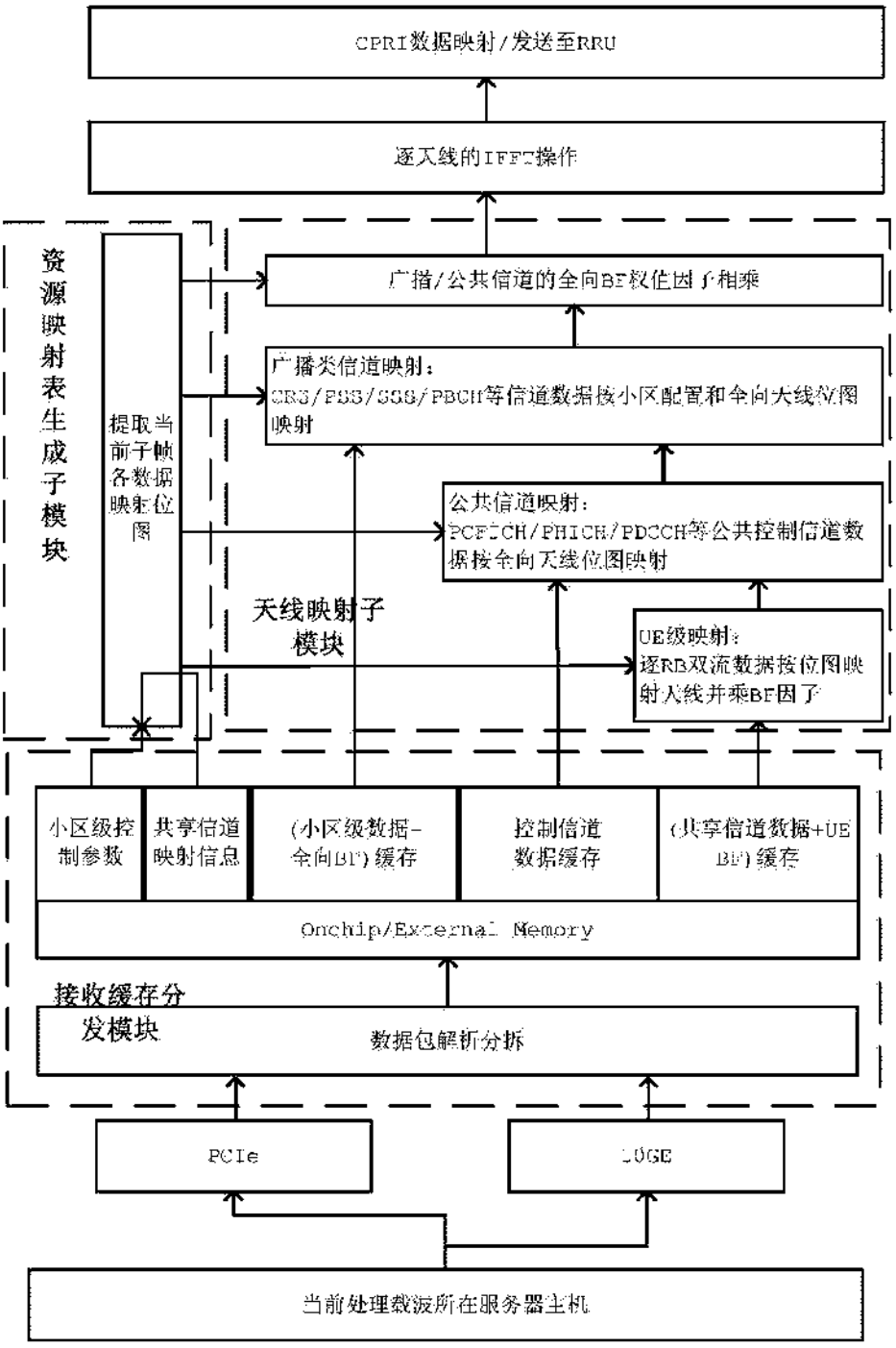

CPRI数据映射/发送至RRU
逐天线的IFFT操作
资源映射表生成子模块
提取当前子帧各数据映射位图
广播/公共信道的全向BF权值因子相乘
广播类信道映射：
CRS/PSS/SSS/PBCH等信道数据按小区配置和全向天线位图映射
公共信道映射：
PCFICH/PHICH/PDCCH等公共控制信道数据按全向天线位图映射
天线映射子模块
UE级映射：
逐RB双流数据按位图映射天线并乘BF因子
小区级控制参数
共享信道映射信息
(小区级数据-全向BF)缓存
控制信道数据缓存
(共享信道数据+UE BF)缓存
Onchip/External Memory
接收缓存分发模块
数据包解析分拆
PCIe
LOGE
当前处理载波所在服务器主机

图3

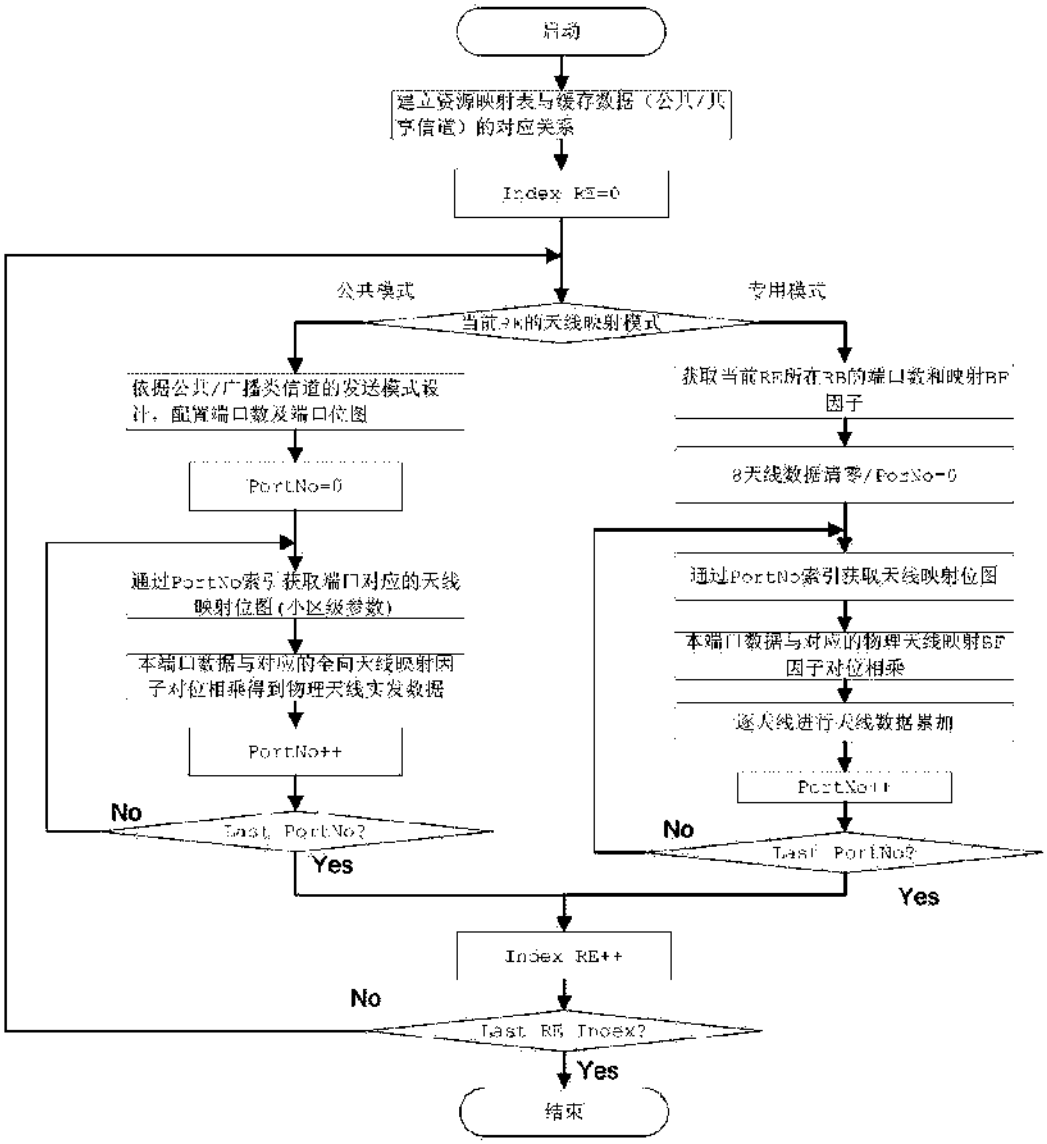

启动
建立资源映射表与缓存数据（公共/共享信道）的对应关系
Index RE=0
公共模式
专用模式
当前RE的天线映射模式
依据公共/广播类信道的发送模式设计，配置端口数及端口位图
PortNo=0
通过PortNo索引获取端口对应的天线映射位图（小区级参数）
本端口数据与对应的全向天线映射因子对位相乘得到物理天线实发数据
PortNo++
No
Last PortNo?
Yes
获取当前RE所在RB的端口数和映射BF因子
8天线数据清零/PortNo=0
通过PortNo索引获取天线映射位图
本端口数据与对应的物理天线映射BF因子对位相乘
逐天线进行天线数据累加
PortNo++
No
Last PortNo?
Yes
Index RE++
No
Last RE Index?
Yes
结束

图4

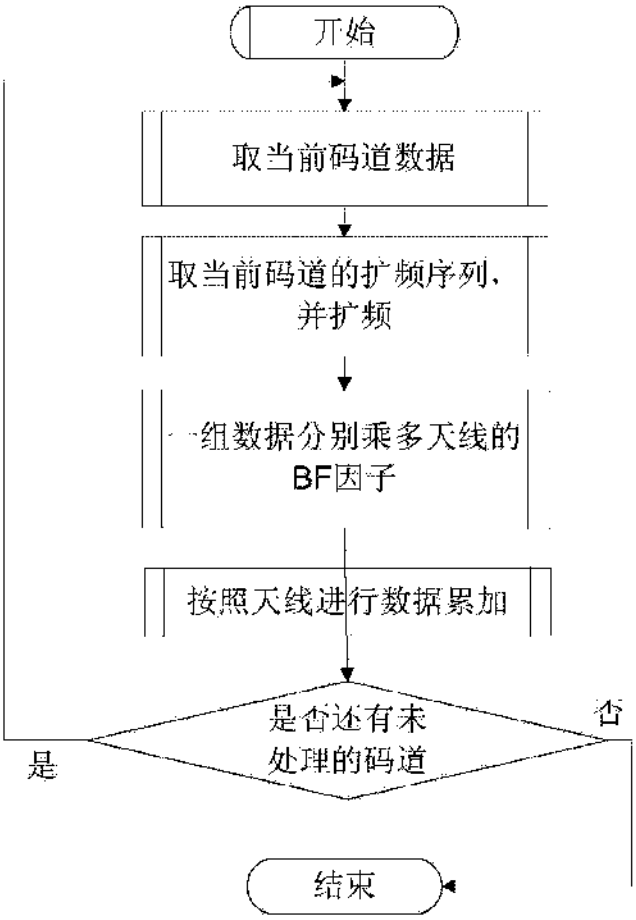

开始
取当前码道数据
取当前码道的扩频序列，并扩频
一组数据分别乘多天线的BF因子
按照天线进行数据累加
是否还有未处理的码道
否
是
结束

图5

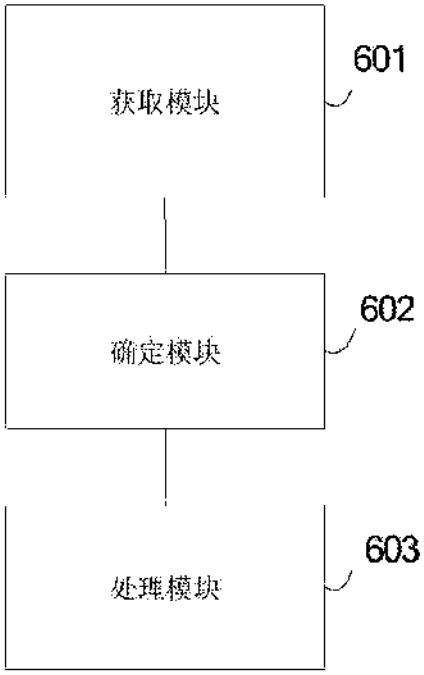


图6

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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(Not for submission under 37 CFR 1.99)

Application Number	17143180
Filing Date	2021-01-07
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	ZL0205-0002-PCT-US-CON1

	1	TSG RAN WG1, "R1-1608690 Remaining issues on aperiodic CSI-RS," 3GPP20161001, 2016, pp. 1-5	

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Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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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	/Jialin Zhong/	Date (YYYY-MM-DD)	2022-03-11
Name/Print	Jialin Zhong	Registration Number	62937

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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.

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EFS ID:	45205479
Application Number:	17143180
International Application Number:	
Confirmation Number:	3253
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	155075
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1	Information Disclosure Statement (IDS) Form (SB08)	ZL0205-0002-PCT-US-CON1_IDS.pdf	1034409 3afd65d721d99109880f47da6a275c12e65e6ff	no	4
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Application Number	17143180
Filing Date	2021-01-07
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	BELUR, DEEPA
Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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	1	105207705	CN	A	2015-12-30	Zhang et al.		☒
	2	101447815	CN	A	2009-06-03	Shiqiang et al.		☒
	3	105656607	CN	A	2016-06-08	Xiaobo Zhang		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
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	First Named Inventor	Xiaobo ZHANG
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	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	ZL0205-0002-PCT-US-CON1

	4	2016077584	WO	A1	2016-05-19	Lee et al.		☐

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	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	BELUR, DEEPA
	Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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Signature	/Jialin Zhong/	Date (YYYY-MM-DD)	2022-02-28
Name/Print	Jialin Zhong	Registration Number	62937

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Espacenet

CN105207705A Reference signal sending method, reference signal receiving method, reference signal sending device and reference signal receiving device in active antenna system

Applicant: BEIJING SAMSUNG TELECOM R&D CT;SAMSUNG ELECTRONICS CO LTD

Inventors: ZHANG RANRAN;YANG XIAOHUI;CHEN CHENJI;HAO;SHEN ZHICHUN

Classifications:

IPC ***H04B7/06, H04L1/06;***

CPC **H04B7/0456 (EP,US); H04B7/0617 (EP,US); H04B7/0626 (EP,US); H04B7/0684 (EP,US); H04L1/0041 (EP,US); H04L1/06 (EP,US); H04L5/0005 (US); H04L5/0023 (EP,US); H04L5/0048 (US); H04L5/0091 (EP,US); H04L5/0073 (US); H04W24/08 (US); H04W72/042 (US); H04W72/046 (US); H04L1/0061 (EP,US); H04L5/0091 (EP,US);**

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Publication: CN105207705A 2015-12-30

Published as: CN105207705A;**US10148400B2; US2017214500A1; WO2015196414A1**

Reference signal sending method, reference signal receiving method, reference signal sending device and reference signal receiving device in active antenna system

Abstract

The invention discloses a reference signal sending method, a reference signal receiving method, a reference signal sending device and a reference signal receiving device in an active antenna system. CRS multi-antenna ports are enabled, and different CRS multi-antenna ports adopt different vertical-dimension beam forming vectors to realize antenna virtualization. A terminal reports CRS multi-antenna port information while reporting the RSRP value, and therefore, poor reporting of CRS signal coverage and RSRP in an active antenna system is avoided. Specifically, the beneficial effects as follows are achieved: (1) CRS and data transmission signal coverage difference based on CSI-RS or UE-RS are avoided or reduced; (2) the problem that a terminal accesses an inappropriate cell because CSI-RS or UE-RS and CRS adopt different vertical-dimension beam forming technologies is avoided or reduced; and (3) a terminal at a specific antenna height can be prevented from being in a spatial deep fading state of vertical-dimension antenna gain when receiving CRS, data signals modulated based on CRS, and control signals.

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(71)申请人 北京三星通信技术研究有限公司
地址 100028 北京市朝阳区太阳宫中路12号楼15层1503
申请人 三星电子株式会社

(72)发明人 张然然 杨晓辉 陈晨 倪浩 沈志春

(74)专利代理机构 北京德琦知识产权代理有限公司 11018
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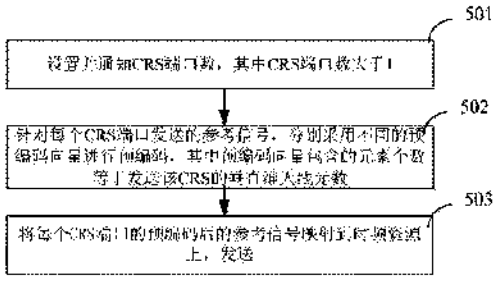
权利要求书3页 说明书11页 附图7页

(54)发明名称

有源天线系统中的参考信号收发方法及设备

(57)摘要

本发明公开了一种有源天线系统中的参考信号收发方法及设备，通过使用CRS多个天线端口且不同的CRS多个天线端口采用不同的垂直维波束赋形向量实现天线虚拟化，终端上报RSPR值时同时上报CRS多个天线端口信息，从而避免有源天线系统中CRS信号覆盖和RSRP上报不住问题，具体地，解决以下问题：1)避免或减小CRS及基于CSI-RS或UE-RS的数据传输信号覆盖的差异；2)避免或减小CSI-RS或UE-RS与CRS所采用的垂直维波束赋形技术的不同使得终端接入小区的不合适问题；3)避免特定天线高度的终端在接收CRS、基于CRS进行解调的数据信号和控制信号时处于垂直维天线增益的空间深衰落状态。



CN 105207705 A

1. 一种有源天线系统中的参考信号发送方法，其特征在于，该方法包括：

设置并通知下行公共参考信号 CRS 端口数，其中 CRS 端口数大于 1；

针对每个 CRS 端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该 CRS 的垂直维天线元数；

将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送。

2. 如权利要求 1 所述的发送方法，其特征在于，所述方法还包括：

接收参考信号接收功率 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1。

3. 如权利要求 2 所述的发送方法，其特征在于，所述 RSRP 信息及 CRS 端口信息为：

各 CRS 端口中最大的 RSRP 值及相应的 CRS 端口编号；

或者各端口的 RSRP 值；

或者 CRS 端口 0 的 RSRP 值以及其他端口相对 CRS 端口 0RSRP 值的相对值；

或者 N 个 CRS 端口的 RSRP 值，N 大于 1 小于总 CRS 天线端口数，相应 CRS 端口编号信息。

4. 如权利要求 2 所述的发送方法，其特征在于，根据所述 RSRP 信息及 CRS 端口信息确定终端专属信息。

5. 如权利要求 4 所述的发送方法，其特征在于，所述终端专属信息为终端服务小区信息、上行功率控制的路损值和 CSI-RS 资源配置信息中的一种或多种组合。

6. 如权利要求 5 所述的发送方法，其特征在于，所述终端专属信息为终端服务小区信息时，根据所述 RSRP 信息及 CRS 端口信息确定终端专属信息为：

基于各 CRS 端口中所对应的最大的 RSRP 值确定终端服务小区。

7. 如权利要求 5 所述的发送方法，其特征在于，所述终端专属信息为上行功率控制的路损值时，根据所述 RSRP 信息及 CRS 端口信息确定终端专属信息为：

基于最大的 RSRP 值确定上行功率控制的路损值。

8. 如权利要求 5 所述的发送方法，其特征在于，所述终端专属信息为 CSI-RS 资源配置信息时，根据所述 RSRP 信息及 CRS 端口信息确定终端专属信息为：

基于 CSI-RS 资源和 CRS 端口垂直维赋形向量的相关性、RSRP 信息及 CRS 端口信息确定用户专属的 CSI-RS 资源配置信息。

9. 如权利要求 8 所述的发送方法，其特征在于，所述确定用户专属的 CSI-RS 资源配置信息为：

按照 CSI-RS 资源所对应的垂直维赋形向量和 CRS 端口垂直维赋形向量的相关性，将有源天线系统内的 CSI-RS 资源分组；

接收到上报的 RSRP 信息和 CRS 端口信息后，将各 CRS 端口中所对应 RSRP 值最大的 CRS 端口，所对应的 CSI-RS 资源组内的 CSI-RS 资源确定为用户专属的 CSI-RS 资源配置信息；

或将各 CRS 端口中所对应的 RSRP 值最大和第二大两个 CRS 端口，所对应的 CSI-RS 资源组内的 CSI-RS 资源确定为用户专属的 CSI-RS 资源配置信息。

10. 如权利要求 1 所述的发送方法，其特征在于，在所述将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送之前，还包括：

基于每个 CRS 端口所采用的预编码向量，分别预编码对应于每个 CRS 端口的数据信号

或控制信号；

在所述将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送的同时，该方法还包括：

将预编码后的数据信号或控制信号映射到时频资源上，发送。

11. 一种有源天线系统中的参考信号接收方法，其特征在于，该方法包括：

接收 CRS 端口数通知，其中 CRS 端口数大于 1；

接收映射到时频资源的预编码后的参考信号。

12. 如权利要求 11 所述的接收方法，其特征在于，还包括：

解析该参考信号后，得到 RSRP 信息及 CRS 端口信息后，发送 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1。

13. 如权利要求 11 所述的接收方法，其特征在于，所述 RSRP 信息及 CRS 端口信息为：

各 CRS 端口中最大的 RSRP 值和相应的 CRS 端口编号；

或者各端口的 RSRP 值；

或者 CRS 端口 0 的 RSRP 值以及其他端口相对 CRS 端口 0RSRP 值的相对值；

或者 N 个 CRS 端口的 RSRP 值，N 大于 1 小于总 CRS 天线端口数，相应 CRS 端口编号信息。

14. 如权利要求 11 所述的接收方法，其特征在于，还包括：

接收映射到时频资源的预编码后的数据信号或控制信号。

15. 一种有源天线系统中的参考信号发送设备，其特征在于，包括：

通知模块，用于设置并通知 CRS 端口数，其中 CRS 端口数大于 1；

垂直维预编码模块，用于针对每个 CRS 端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该 CRS 的垂直维天线元数；

发送模块，用于将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送。

16. 如权利要求 15 所述的发送设备，其特征在于，

还包括 RSRP 接收模块，用于接收 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1。

17. 如权利要求 16 所述的发送设备，其特征在于，RSRP 接收模块，还用于根据所述 RSRP 信息及 CRS 端口信息确定终端专属信息。

18. 如权利要求 15 所述的发送设备，其特征在于，

垂直维预编码模块，还用于基于每个 CRS 端口所采用的预编码向量，分别预编码对应于每个 CRS 端口的数据信号或控制信号；

发送模块，还用于将预编码后的数据信号或控制信号映射到时频资源上，发送。

19. 一种有源天线系统中的参考信号接收设备，其特征在于，包括：

信令接收模块，用于接收 CRS 端口数通知，其中 CRS 端口数大于 1；

信号接收模块，用于接收映射到时频资源的预编码后的参考信号。

20. 如权利要求 19 所述的接收设备，其特征在于，还包括：

测量上报模块，用于解析接到的该参考信号后，得到 RSRP 信息及 CRS 端口信息后，发送 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1。

21. 如权利要求 19 所述的接收设备，其特征在于，信号接收模块，还用于接收映射到时

频资源的预编码后的数据信号或控制信号。

有源天线系统中的参考信号收发方法及设备

技术领域

[0001] 本发明涉及移动通信系统领域，特别涉及一种有源天线系统中的参考信号收发方法及设备。

背景技术

[0002] 在移动通信系统中，无线衰落信道具有时变性的特征，为了有效检测发送信号，需要获取信道信息，以实现相关检测。为了获取信道信息，诸如基站的发送端通过信道发送预先与接收端约定的已知信号或序列，诸如终端的接收端通过对信道中的已知信号或序列进行检测获得信道信息。这些已知信号或序列被称为导频信号或参考信号。

[0003] 下一代演进 (LTE/LTE-A) 系统是典型的相关检测系统，根据导频信号或参考信号的导频功能的划分，分为 7 种导频信号或参考信号，如下所述：

[0004] 下行公共参考信号 (CRS, cell-specific reference signal)，用于广播信道、下行控制信道的数据解调，下行共享信道传输模式 1 ～ 8 的信道状态信息测量和传输模式 1 ～ 6 的数据解调；

[0005] 多媒体广播/多播单频网参考信号 (MBSFN RS, multimedia broadcast multicast service single frequency network reference signal)，用于多播信道的数据解调；

[0006] 下行用户专用参考信号 (UE-RS, user equipment specific reference signal)，下行共享信道传输模式 7 ～ 10 的数据解调；

[0007] 信道状态信息参考信号 (CSI-RS, channel state information reference signal)，用于下行共享信道传输模式 9 ～ 10 的信道状态信息测量；

[0008] 定位导频 (PRS, Positioning reference signal)，用于终端定位功能；

[0009] 上行解调导频 (DMRS, demodulation reference signal)，用于上行共享信道和上行控制信道的数据解调；

[0010] 上行探测导频 (SRS, sounding reference signal)，用于上行信道状态信息的测量，同时可以利用信道互易性得到下行信道信息。

[0011] 除了物理层信道状态信息测量、数据解调和同步辅助等功能外，CRS 还用于进行参考信号接收功率 (RSRP, reference signal receive power) 的测量，以实现路损测量、小区选择和小区切换等功能。

[0012] 在对 RSRP 测量中，一般采用 CRS 的端口 0。在终端可以确定 CRS 端口 1 可靠的情况下，可以同时参考 CRS 端口 1 确定 RSRP 信号。

[0013] 参考信号与天线端口对应，即不同天线端口上的参考信号相互正交。从发射端看，天线端口是一个逻辑概念，即天线端口与物理天线不一定是一一对应的关系：每个天线端口信号可由一个物理天线或多个物理天线发送的信号合成，此过程称为天线虚拟化。

[0014] 随着天线技术尤其是有源天线阵列技术的发展，物理天线元不仅仅在水平方维度分布，而是在垂直和水平两个维度都分布，形成 2 维 (2-D) 天线阵列，如图 1 和图 2 所示，图 1 为现有技术提供的有源天线交叉极化 2-D 天线阵列结构示意图，图 2 为现有技术提供的单

极化 2-D 天线阵列结构示意图，其中 N 代表水平单极化方向的天线个数，M 表示垂直维天线的个数。

[0015] 2-D 天线阵列的出现使得有源天线系统中的天线垂直维波束赋形、动态垂直维扇区化成为可能。通过对垂直维天线元给予不同的加权因子，在垂直维方向上形成直接指向用户或避免对同时频终端干扰的窄波束，可有效提高接收信号功率、避免对同时频终端的干扰。

[0016] 目前，LTE/LTE-A 系统虽然支持不同的参考信号采用不同的天线虚拟化方法，但是由于 LTE/LTE-A 系统在制定标准过程中仅考虑对无源天线阵列的优化，未将有源天线阵列的特性考虑在内。

[0017] 在配置了有源天线阵列的无线通信系统中，为了方便叙述，以下将配置了有源天线阵列的无线通信系统称为有源天线系统，为了获得垂直维波束赋形的增益，需要采用终端专属垂直维波束赋形技术；为了保证小区范围内终端都可以接收到 CRS，需要在垂直维采用小区专属垂直维波束赋形向量；这就会导致 CRS 及基于 CSI-RS 测量基于 UE-RS 解调的数据传输在垂直维有不同的天线阵列增益，从而导致不同的信号接收强度，图 3 为现有技术 CRS 及基于 CSI-RS 或 UE-RS 采用不同的垂直维波束赋形示意图。

[0018] 在终端接入过程中，采用基于 CRS 端口 0 上报的 RSRP 值判断接入小区，由于 CRS 及基于 CSI-RS 测量基于 UE-RS 解调的数据采用不同的垂直维波束赋形技术传输，导致终端接入的小区可能对于基于 CSI-RS 或 UE-RS 的数据传输并不合适。

[0019] 图 4 为现有技术传输 CRS 的示意图，如图 4 所示，CRS 采用固定且单一的垂直维波束赋形向量传输，一般为了控制对临区干扰需要形成下倾角，如在典型的城区宏蜂窝场景下，基站天线高度为 25 米，小区基站间距为 500 米，用户终端分布于室外或 18 ～ 24 米的低矮建筑物内，90 度表示水平方向，0 度垂直指向天空，180 度垂直指向地面，这时其中的波束指向 102 度方向，这会造成天线高度高于等于基站的终端所接收的 CRS 垂直维天线阵列增益很小，无论接入哪个小区，终端接收到的 CRS 信号强度都较弱，终端的 CRS 信号接收处于空间上的深衰落。

[0020] 从另一方面说，采用基于 CRS 端口 0 上报的 RSRP 值会被用于上行功率控制中的路损计算，不合适的 RSRP 上报会影响有源天线系统的上行控制效果。在 LTE/LTE-A 系统中的标准中，假设上下行路损近似对称，这是因为在无源天线系统里，上下行信道经历近似的大尺度衰落和近似的收发天线增益。然而在使用了垂直维波束赋形的有源天线系统中，若 CRS 采用固定垂直维波束赋形，而上行接收中采用最大比合并 (MRC, maximal ratio combining) 接收，会造成上下行的收发天线增益不对称，进而造成由 RSRP 值估算的下行路损与实际的上行路损之间的显著差异，进而影响上行功率控制的效果。

发明内容

[0021] 有鉴于此，本发明实施例提供一种有源天线系统中的参考信号收发方法，该方法能够避免有源天线系统中 CRS 信号覆盖和 RSRP 上报不佳问题。

[0022] 本发明实施例还提供一种有源天线系统中的参考信号收发设备，该装置能够避免有源天线系统中 CRS 信号覆盖和 RSRP 上报不佳问题。

[0023] 根据上述目的，本发明是这样实现的：

[0024] 一种有源天线系统中的参考信号发送方法，该方法包括：

[0025] 设置并通知下行公共参考信号 CRS 端口数，其中 CRS 端口数大于 1；

[0026] 针对每个 CRS 端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该 CRS 的垂直维天线元数；

[0027] 将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送。

[0028] 一种有源天线系统中的参考信号接收方法，该方法包括：

[0029] 接收 CRS 端口数通知，其中 CRS 端口数大于 1；

[0030] 接收映射到时频资源的预编码后的参考信号。

[0031] 一种有源天线系统中的参考信号发送设备，包括：

[0032] 通知模块，用于设置并通知 CRS 端口数，其中 CRS 端口数大于 1；

[0033] 垂直维预编码模块，用于针对每个 CRS 端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该 CRS 的垂直维天线元数；

[0034] 发送模块，用于将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送。

[0035] 一种有源天线系统中的参考信号接收设备，包括：

[0036] 信令接收模块，用于接收 CRS 端口数通知，其中 CRS 端口数大于 1；

[0037] 信号接收模块，用于接收映射到时频资源的预编码后的参考信号。

[0038] 由上述方案可以看出，本发明实施例通过使用 CRS 多个天线端口且不同的 CRS 多个天线端口采用不同的垂直维波束赋形向量实现天线虚拟化，终端上报 RSPR 值时同时上报 CRS 天线端口信息，从而解决有源天线系统中 CRS 信号覆盖和 RSRP 上报不佳问题，具体地，可以解决以下问题：1) 避免或减小 CRS 及基于 CSI-RS 或 UE-RS 的数据传输信号覆盖的差异；2) 避免或减小 CSI-RS 或 UE-RS 与 CRS 所采用的垂直维波束赋形技术的不同使得终端接入小区的不合适问题；3) 避免特定天线高度的终端在接收 CRS、基于 CRS 进行解调的数据信号和控制信号时处于垂直维天线阵列增益的空间深衰落状态。

附图说明

[0039] 图 1 为现有技术提供的有源天线交叉极化 2-D 天线阵列结构示意图；

[0040] 图 2 为现有技术提供的单极化 2-D 天线阵列结构示意图；

[0041] 图 3 为现有技术 CRS 及基于 CSI-RS 或 UE-RS 采用不同的垂直维波束赋形示意图；

[0042] 图 4 为现有技术传输 CRS 的示意图；

[0043] 图 5 为本发明实施例提供的有源天线系统中的参考信号发送方法流程图；

[0044] 图 6 为本发明实施例提供的有源天线系统中的参考信号接收方法流程图；

[0045] 图 7 为本发明实施例提供的有源天线系统中的参考信号发送设备结构示意图；

[0046] 图 8 为本发明实施例提供的有源天线系统中的参考信号接收设备结构示意图；

[0047] 图 9 为本发明实施例提供的有源天线系统中的参考信号发送方法具体例子一的流程图；

[0048] 图 10 为本发明具体例子一提供的 CRS 发送物理层过程示意图；

[0049] 图 11 为本发明具体例子一提供的 CRS 时频资源图样示意图；

[0050] 图 12 为本发明实施例提供的有源天线系统中的参考信号发送方法具体例子二的

流程图；

[0051] 图 13 为本发明具体例子二提供的基于 CRS 解调的数据信号或控制信号的物理层处理过程示意图；

[0052] 图 14 为本发明实施例提供的有源天线系统中的参考信号接收方法具体例子三的流程图；

[0053] 图 15 为本发明具体例子二提供的 CRS 时频资源图样示意图；

[0054] 图 16 本发明实施例提供的有源天线系统中的参考信号发送方法具体例子四的流程图；

[0055] 图 17 为本发明具体例子四提供的确定终端专属信息例子一流程图；

[0056] 图 18 为本发明具体例子四提供的确定终端专属信息例子二流程图；

[0057] 图 19 为本发明具体例子四提供的利用 RSRP 值确定终端专属 CSI-RS 资源配置的示意图；

[0058] 图 20 为本发明具体例子四提供的确定终端专属信息例子三流程图。

具体实施方式

[0059] 为使本发明的目的、技术方案及优点更加清楚明白，以下参照附图并举实施例，对本发明作进一步详细说明。

[0060] 在有源天线系统中进行参考信号的收发会产生以下问题：1)CRS 及基于 CSI-RS 或 UE-RS 的数据传输信号覆盖的差异；2)CSI-RS 或 UE-RS 与 CRS 所采用的垂直维波束赋形技术的不同使得终端接入小区的不合适问题；3) 特定天线高度的终端在接收 CRS、基于 CRS 进行解调的数据信号和控制信号时处于垂直维天线增益的空间深衰落状态。而产生上述问题的主要原因是有源天线系统中 CRS 信号覆盖问题和 RSRP 上报不佳问题。因此，为了避免有源天线系统中 CRS 信号覆盖和 RSRP 上报不佳问题，本发明实施例通过使用 CRS 多个天线端口且不同的 CRS 多个天线端口采用不同的垂直维波束赋形向量实现天线虚拟化，终端上报 RSPR 值时同时上报 CRS 多个天线端口信息。

[0061] 更进一步地，本发明实施例提供的方法及设备还可以在相同信道测量效果情况下减少终端进行信道估计的 CSI-RS 配置个数；以及减小 RSRP 值估算的路损与上行实际路损之间的差异，改善上行功率控制性能。

[0062] 图 5 为本发明实施例提供的有源天线系统中的参考信号发送方法流程图，其具体步骤为：

[0063] 步骤 501、设置并通知 CRS 端口数，其中 CRS 端口数大于 1；

[0064] 步骤 502、针对每个 CRS 端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该 CRS 的垂直维天线元数；

[0065] 步骤 503、将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送。

[0066] 在该方法之后，还包括：

[0067] 接收 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1。

[0068] 在步骤 502 之后，在步骤 503 之前，该方法还包括：

[0069] 基于每个 CRS 端口所采用的预编码向量，分别预编码对应于每个 CRS 端口的数据

信号或控制信号；

[0070] 在步骤503的同时，将预编码后的数据信号或控制信号映射到时频资源上，发送。

[0071] 图6为本发明实施例提供的有源天线系统中的参考信号接收方法流程图，其具体步骤为：

[0072] 步骤601、接收CRS端口数通知，其中CRS端口数大于1；

[0073] 步骤602、接收映射到时频资源的预编码后的参考信号。

[0074] 在该方法中，还包括：解析接到的该参考信号后，得到RSRP信息及CRS端口信息后，发送RSRP信息及CRS端口信息，其中RSRP信息中包含的RSRP值的个数大于等于1。

[0075] 在该方法中，还包括：接收映射到时频资源的预编码后的数据信号或控制信号。

[0076] 图7为本发明实施例提供的有源天线系统中的参考信号发送设备结构示意图，如图所示，包括：通知模块、垂直维预编码模块及发送模块，其中，

[0077] 通知模块，用于设置并通知CRS端口数，其中CRS端口数大于1；

[0078] 垂直维预编码模块，用于针对每个CRS端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该CRS的垂直维天线元数；

[0079] 发送模块，用于将每个CRS端口的预编码后的参考信号映射到时频资源上，发送。

[0080] 在该设备中，还包括RSRP接收模块，用于接收RSRP信息及CRS端口信息，其中RSRP信息中包含的RSRP值的个数大于等于1。

[0081] 在该设备中，垂直维预编码模块，还用于基于每个CRS端口所采用的预编码向量，分别预编码对应于每个CRS端口的数据信号或控制信号；

[0082] 发送模块，还用于将预编码后的数据信号或控制信号映射到时频资源上，发送。

[0083] 在该设备中，RSRP接收模块，还用于根据所述RSRP信息及CRS端口信息确定终端专属信息。

[0084] 图8为本发明实施例提供的有源天线系统中的参考信号发送设备结构示意图，如图所示，包括：信令接收模块及信号接收模块，其中，

[0085] 信令接收模块，用于接收CRS端口数通知，其中CRS端口数大于1；

[0086] 信号接收模块，用于接收映射到时频资源的预编码后的参考信号。

[0087] 该设备还包括测量上报模块，用于解析接到的该参考信号后，得到RSRP信息及CRS端口信息后，发送RSRP信息及CRS端口信息，其中RSRP信息中包含的RSRP值的个数大于等于1。

[0088] 该设备中，信号接收模块，还用于接收映射到时频资源的预编码后的数据信号或控制信号。

[0089] 以下举几个具体实施例对本发明进行详细说明。

[0090] 实施例一

[0091] 图9为本发明实施例提供的有源天线系统中的参考信号发送方法具体例子一的流程图，其具体步骤为：

[0092] 步骤901、设置并通知CRS端口数，其中CRS端口数大于1；

[0093] 在本步骤中，通过隐式方式通知CRS端口数，具体地，采用物理广播信道(PBCH，Physical broadcast channel)的循环冗余校验(CRC，Cyclic Redundancy Check)加扰的

不同方式隐式通知 CRS 端口数，如表 1 所示，表 1 为 CRS 端口数与 PBCH CRC 加扰码的关系表：

[0094]

发送天线端口数	PBCH CRC 加扰码 $<x_{ant,0}, x_{ant,1}, \cdots, x_{ant,15}>$
1	<0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0>
2	<1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1>
4	<0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1>

[0095] 表 1

[0096] 在有源天线系中，CRS 端口数为大于 1 的正整数。基站侧根据该系统内的终端天线高度的统计分布，考虑 CRS 开销影响等因素，确定 CRS 端口数并进行通知；如在典型的城区宏蜂窝 (UMa, Urban Marco) 场景下，基站天线高度为 25 米，小区站间距为 500 米，终端分布于室外或 18 ~ 24 米的低矮建筑物内，考虑到终端的垂直维离开角均高于 90 度 (90 度表示水平方向，0 度垂直指向天空，180 度垂直指向地面)，同时考虑 CRS 开销影响等因素，选定 CRS 端口数为 2。

[0097] 步骤 902、针对每个 CRS 端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该 CRS 的垂直维天线元数；

[0098] 在该步骤中，各 CRS 端口采用不同的预编码向量实现天线虚拟化，具体地，各天线端口的信号经过预编码处理之后加载到相应的物理天线元，如图 10 所示，图 10 为本发明具体例子一提供的 CRS 发送物理层过程示意图，其中，所谓天线虚拟化即对 CRS 端口参考信号分别采用预编码向量进行预编码实现端口信号到垂直维物理天线元的映射，其中预编码向量包含的元素个数等于发送同一 CSR 信号的垂直维天线元数；

[0099] 以典型的城区宏蜂窝为例，假设物理天线配置为 M = 10，N = 1 的交叉极化 2-D 天线阵列，两个极化方向各包含 M 个垂直维分布的天线组，分别即为天线组 0 和天线组 1，假设垂直维度天线元的间距为半波长；CRS 端口 0 的信号通过预编码向量 $W_0 = \left[w_0^{(0)} \quad w_1^{(0)} \quad \cdots \quad w_{M-1}^{(0)}\right]^T$ 实现到天线组 0 的虚拟化，CRS 端口 1 的信号通过预编码向量 $W_1 = \left[w_0^{(1)} \quad w_1^{(1)} \quad \cdots \quad w_{M-1}^{(1)}\right]^T$ 实现到天线组 1 的虚拟化，其中 $w_m^{(p)} = \frac{1}{\sqrt{M}} \exp(-j\frac{2\pi}{\lambda} m \cdot d_v \cdot \cos\theta_p)$，其中 dv 表示垂直维天线间距，p 表示天线端口编号，m 表示预编码向量的第 m 个元素，θ_p 表示第 p 个端口所对应的下倾角，如端口 0 所对应的下倾角为 102 度，端口 1 所对应的下倾角为 95 度；

[0100] 步骤 903、将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送；

[0101] 在本步骤中，如图 11 所示，图 11 为本发明具体例子一提供的 CRS 时频资源图样示意图；

[0102] 步骤 904、接收 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1；

[0103] 在本步骤中，RSRP 信息及 CRS 端口信息可以是各端口中最大的 RSRP 值和相应的 CRS 天线端口编号，如在 RSRP 值上报量中增加 4 种状态用于指示 CRS 天线端口编号，如表 2 所示：

[0104]

上报值	测量数值	单位
RSRP_00	RSRP < -140	dBm
RSRP_01	-140 ≤ RSRP < -139	dBm
RSRP_02	-139 ≤ RSRP < -138	dBm

[0105]

…	…	…
RSRP_95	-46 ≤ RSRP < -45	dBm
RSRP_96	-45 ≤ RSRP < -44	dBm
RSRP_97	-44 ≤ RSRP	dBm
RSRP_98	Port 0	
RSRP_99	Port 1	
RSRP_100	Port 2	
RSRP_101	Port 3	

[0106] 表 2

[0107] RSRP 信息及 CRS 端口信息还可以是端口的 RSRP 值，如表 3 所示：

[0108]

上报值	测量数值	单位
RSRP_00	Port0RSRP < -140	dBm
RSRP_01	Port0-140 ≤ RSRP<-139	dBm
RSRP_02	Port0-139 ≤ RSRP<-138	dBm
…	…	…
RSRP_95	Port0-46 ≤ RSRP<-45	dBm
RSRP_96	Port0-45 ≤ RSRP<-44	dBm
RSRP_97	Port0-44 ≤ RSRP	dBm

RSRP_98	Port1RSRP < -140	dBm
RSRP_99	Port1-140 ≤ RSRP<-139	dBm
RSRP_100	Port1 139 ≤ RSRP< 138	dBm
…	…	…
RSRP_183	Port1-46 ≤ RSRP<-45	dBm
RSRP_184	Port1 45 ≤ RSRP< 44	dBm
RSRP_185	Port1-44 ≤ RSRP	dBm
…	…	…

[0109] 表 3

[0110] RSRP 信息及 CRS 端口信息还可以是 CRS 端口 0 的 RSRP 值以及其他端口相对 CRS 端口 0 的 RSRP 值的相对值，

[0111] RSRP 信息及 CRS 端口信息还可以是 K 个 CRS 端口的 RSRP 值，K 大于 1 小于总 CRS 天线端口数，并上报相应天线端口编号信息。

[0112] 通过以上处理，由于 CRS 的不同端口采用不同的垂直维波束赋形，一个不在 CRS 端口 0 的波束覆盖范围内的终端可能处于另一个 CRS 端口的波束覆盖范围之内，从而减少或避免特定天线高度的终端在接收 CRS 信号长期处于垂直维天线增益的空间深衰落状态。

[0113] 在该例子中，所接收的 RSRP 信息及 CRS 端口信息，不仅提供各端口的最大 RSRP 值信息，还提供最大 RSRP 值所对应的端口信息，基站侧利用这些信息可以对后续的数据信号、参考信号的发送，小区选择，上行功率控制等做优化处理。

[0114] 实施例二

[0115] 图 12 为本发明实施例提供的有源天线系统中的参考信号发送方法具体例子二的流程图，其具体步骤为：

[0116] 步骤 1201、设置并通知 CRS 端口数，其中 CRS 端口数大于 1；

[0117] 步骤 1202、针对每个 CRS 端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该 CRS 的垂直维天线元数；

[0118] 步骤 1203、基于每个 CRS 端口所采用的预编码向量，分别预编码对应于每个 CRS 端口的数据信号或控制信号，其中预编码向量包含的元素个数等于发送该数据信号或控制信号的垂直维天线元数；

[0119] 在该步骤中，利用 CRS 端口相应的预编码向量对基于 CRS 解调的数据信号或控制信号进行天线虚拟化处理，基于 CRS 解调的数据信号或控制信号的物理层处理过程如图 13 所示，图 13 为本发明具体例子二提供的基于 CRS 解调的数据信号或控制信号的物理层处理过程示意图，如 CRS 端口 0 采用预编码向量 W0 实现天线虚拟化，数据信号的端口 0 也采用相同的预编码向量实现天线虚拟化，其他端口类似处理，其中，控制信号可以是物理下行控制信道 (PDCCH, physical downlink control channel)，数据信号可以是采用传输模式 2～

6 的物理下行共享信道 (PDSCH, physical downlink control channel)；

[0120] 步骤 1204、将每个 CRS 端口的预编码后的参考信号、及每个 CRS 端口的预编码后的数据信号或控制信号映射到时频资源上，发送；

[0121] 步骤 1205、接收 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1。

[0122] 通过图 12 的方法，由于 CRS 的各端口的参考信号和数据 / 控制信号都采用不同的垂直维波束赋形，一个不在 CRS 端口 0 的波束覆盖范围内的终端可能处于另一个 CRS 端口的波束覆盖范围之内，从而减少或避免特定天线高度的终端在接收 CRS 信号和基于 CRS 解调的数据 / 控制信号长期处于垂直维天线增益的空间深衰落状态，从而改善基于 CRS 解调的数据信号或控制信号的覆盖。

[0123] 实施例二

[0124] 图 14 为本发明实施例提供的有源天线系统中的参考信号接收方法具体例子三的流程图，其具体步骤为：

[0125] 步骤 1401、接收 CRS 端口数通知，其中 CRS 端口数大于 1；

[0126] 在该步骤中，可以通过解码 PBCH 在 CRS 端口 0 上的信号，根据 PBCH 加扰信号确定天线端口数；

[0127] 步骤 1402、接收映射到时频资源的预编码后的参考信号；

[0128] 在该步骤专用，可以根据图 15 所示的 CRS 时频资源图样示意图接收预编码后的参考信号，图 15 为本发明具体例子二提供的 CRS 时频资源图样示意图；

[0129] 步骤 1403、解析接到的该参考信号后，得到 RSRP 信息及 CRS 端口信息后，发送 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1；

[0130] 在该步骤中，发送的方式可以为：上报各 CRS 端口中最大的 RSRP 值和相应的 CRS 天线端口编号，如在 RSRP 值上报量中增加 4 种状态用于指示 CRS 天线端口编号，如表 2 所示；或者同时上报各端口的 RSRP 值，如表 3 所示；或者上报 CRS 端口 0 的 RSRP 值以及其他端口相对 CRS 端口 0RSRP 值的相对值；或者上报 N 个 CRS 端口的 RSRP 值，N 大于 1 小于总 CRS 天线端口数，并上报相应天线端口编号信息。

[0131] 通过以上处理，可以使基站侧获知更多的 CRS 端口的 RSRP 信息，从而便于网络侧做进一步的处理获得相应增益。

[0132] 实施例四

[0133] 图 16 本发明实施例提供的有源天线系统中的参考信号发送方法具体例子四的流程图，其具体步骤为：

[0134] 步骤 1601、设置并通知 CRS 端口数，其中 CRS 端口数大于 1；

[0135] 在本步骤中，如在典型的城区微蜂窝 (UMi, Urban Mirco) 场景下，基站天线高度为 10 米，小区站间距为 200 米，终端分布于室外或 18 ～ 21 米的低矮建筑物内，考虑到终端的垂直维离开角分布范围较大，同时考虑 CRS 开销影响等因素，选定 CRS 端口数为 4；

[0136] 步骤 1602、各个 CRS 端口采用不同的预编码向量实现天线虚拟化；

[0137] 在该步骤中，如采用 4 个不同的预编码向量实现 4 个 CRS 端口的天线虚拟化，CRS 端口 0 的信号通过预编码向量 $W_0=\left[w_0^{(0)}\quad w_1^{(0)}\quad \cdots\quad w_{M-1}^{(0)}\right]^T$ 实现到天线组 0 的虚拟化，

CRS 端口 1 的信号通过预编码向量 $W_1=\left[w_0^{(1)}\quad w_1^{(1)}\quad\cdots\quad w_{M-1}^{(1)}\right]^T$ 实现到天线组 1 的虚拟化，其中 $w_m^{(p)}=\frac{1}{\sqrt{M}}\exp(-j\frac{2\pi}{\lambda}m\cdot d_v\cdot\cos\theta_p)$，其中 dv 表示垂直维天线间距，p 表示天线端口编号，m 表示预编码向量的第 m 个元素，θ_p 表示第 p 个端口所对应的下倾角，如端口 0 所对应的下倾角为 102 度，端口 1 所对应的下倾角为 95 度，端口 2 所对应的下倾角为 85 度，端口 3 所对应的下倾角为 75 度；

[0138] 步骤 1603、将每个 CRS 端口的预编码后的参考信号映射到时频资源上，发送；

[0139] 步骤 1604、接收 RSRP 信息及 CRS 端口信息，其中 RSRP 信息中包含的 RSRP 值的个数大于等于 1；

[0140] 在本步骤中，RSRP 信息可以是最大 CRS 端口的 RSRP 值，相应端口信息为最大 RSRP 值所对应的 CRS 端口编号；RSRP 信息可以包含各 CRS 端口的 RSRP 值；RSRP 信息可以包含部分 CRS 端口的 RSRP 值，和所述部分 CRS 端口的编号信息；

[0141] 步骤 1605、在接收到 RSRP 信息和 CRS 端口信息后，确定终端专属信息；

[0142] 在本步骤中，终端专属信息包括：所述终端专属信息为终端服务小区信息、上行功率控制的路损值和 CSI-RS 资源配置信息中的一种或多种组合。

[0143] 具体地说，如图 17 所示，图 17 为本发明具体例子四提供的确定终端专属信息例子一流程图，包括：

[0144] 步骤 1701、接收到 RSRP 信息和 CRS 端口信息；

[0145] 步骤 1702、基于 RSRP 信息确定终端服务小区；

[0146] 在本步骤中，由于 CRS 的各端口采用不同的垂直维波束，而 RSRP 信息上报为各垂直维波束赋形方向中最优的一个，则 RSRP 信息与采用终端专属垂直维波束赋形后的 CSI-RS 和 UE-RS 的信号增益差异相对减小，进而使得所选小区更加符合终端实际数据传输。

[0147] 如图 18 所示，图 18 为本发明具体例子四提供的确定终端专属信息例子二流程图，包括：

[0148] 步骤 1801、接收到 RSRP 信息和 CRS 端口信息；

[0149] 步骤 1802、基于 RSRP 信息确定终端专属 CSI-RS 资源配置；

[0150] 在本步骤中，基于 CSI-RS 资源和 CRS 端口垂直维赋形向量的相关性、RSRP 信息及 CRS 端口信息确定用户专属的 CSI-RS 资源配置信息；按照 CSI-RS 资源所对应的垂直维赋形向量和 CRS 端口垂直维赋形向量的相关性，将有源天线系统内的 CSI-RS 资源分组；接收到上报的 RSRP 信息和 CRS 端口信息后，将各 CRS 端口中所对应 RSRP 值最大的 CRS 端口所对应的 CSI-RS 资源组内的 CSI-RS 资源确定为用户专属的 CSI-RS 资源配置信息；或将各 CRS 端口中所对应的 RSRP 值最大和第二大两个 CRS 端口所对应的 CSI-RS 资源组内的 CSI-RS 资源确定为用户专属的 CSI-RS 资源配置信息；

[0151] 举一个具体例子说明，假设 CRS 的 2 个端口采用 2 个不同的较宽波束的垂直维波束，在使用 CSI-RS 测量和 UE-RS 解调的传输模式中，如 LTE/LTE-A 的传输模式 10，通过为终端配置多个 CSI-RS 资源和 CSI 反馈进程可以实现终端专属的垂直维波束赋形，图 19 为本发明具体例子四提供的利用 RSRP 值确定终端专属 CSI-RS 资源配置的示意图，如图 19 所

示，有源天线系统中配置有9种不同的CSI-RS资源，每个CSI-RS资源采用不同的垂直维波束进行赋形，这9种CSI-RS资源分成3组，每组包含3个CSI-RS资源，采用相邻的垂直维波束实现天线虚拟化。第一组CSI-RS垂直波束的在垂直维的覆盖范围与CRS波束0接近，第3组CSI-RS的垂直维覆盖与CRS波束1接近，第2组CSI-RS的的垂直维覆盖介于两个CRS波束之间；

[0152] 如上报的RSRP值最大的端口为端口0，则为终端分配第1组CSI-RS资源，若上报的RSRP值最大的端口为端口01，则为终端分配第3组CSI-RS资源，所上报的两个端口的RSRP值比较接近，则为终端分配第2组CSI-RS资源。

[0153] 终端基于所配置的一个组内的3个CSI-RS资源进行3个CSI进程的反馈，如第2组内的CSI-RS资源2-1、2-2、和2-3，基站侧根据CSI反馈选择最优的垂直维赋形方向，如CSI-RS资源2-3所对应的垂直维波束赋形方向作为用户终端数据传输中所使用的波束赋形方向。

[0154] 在上述例子二中，显然如果没有CRS端口信息的上报，终端要实现从9个垂直维波束中选择最优的波束需要测量9种不同的CSI-RS配置，同时完成9个CSI上报进程；而采用了CRS端口信息上报的辅助后，仅需要3个CSI-RS配置的测量和相应地3个CSI上报进程即可实现。

[0155] 如图20所示，图20为本发明具体例子四提供的确定终端专属信息例子三流程图，包括：

[0156] 步骤2001、接收到RSRP信息和CRS端口信息；

[0157] 步骤2002、基于RSRP信息确定终端的上行功率控制的路损值；

[0158] 在该步骤中，由于CRS的各端口采用不同的垂直维波束，而RSRP值上报为各垂直维波束赋形方向中最优的一个，则RSRP值与采用接收机处理后的上行信号增益差异相对减小，进而减小RSRP估算的路损与上行实际路损之间的差异，从而改善上行功率控制性能。

[0159] 从本发明实施例提供的方法及设备可以看出，本发明避免或减小CRS和基于CSI-RS/UE-RS的数据传输信号覆盖的差异；本发明避免或减小由于CRS和基于CSI-RS/UE-RS的数据参数采用不同的垂直维波束赋形导致的小区接入的不合适问题；本发明避免特定天线高度的终端在接收CRS信号、基于CRS进行解调的数据信号和控制信号时长期处于空间深衰落状态；本发明在相同信道测量效果情况下减少用户终端进行信道估计的CSI-RS配置个数；本发明减小RSRP估算的路损与上行实际路损之间的差异，改善上行功率控制性能。

[0160] 以上举较佳实施例，对本发明的目的、技术方案和优点进行了进一步详细说明，所应理解的是，以上所述仅为本发明的较佳实施例而已，并不用以限制本发明，凡在本发明的精神和原则之内，所作的任何修改、等同替换和改进等，均应包含在本发明的保护范围之内。

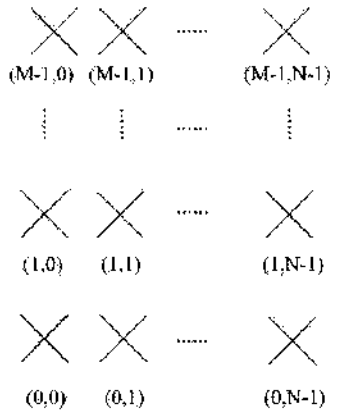


图 1

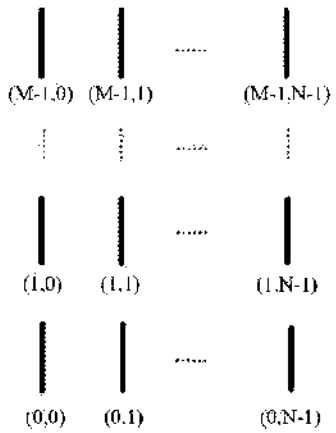


图 2

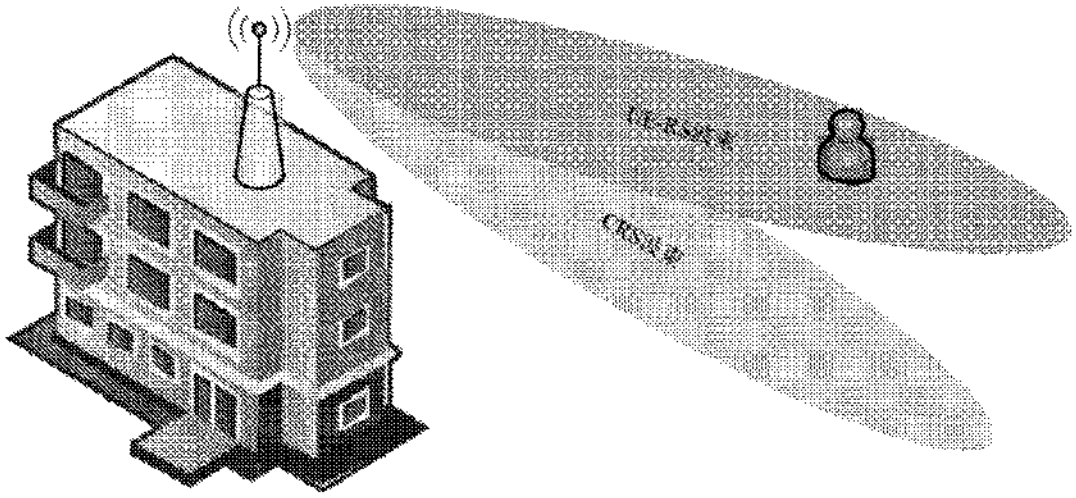


图 3

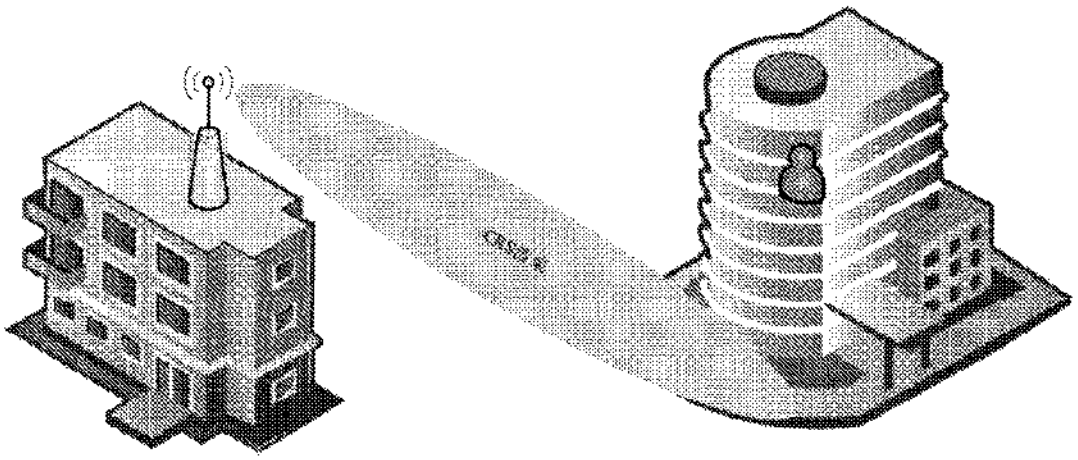


图 4

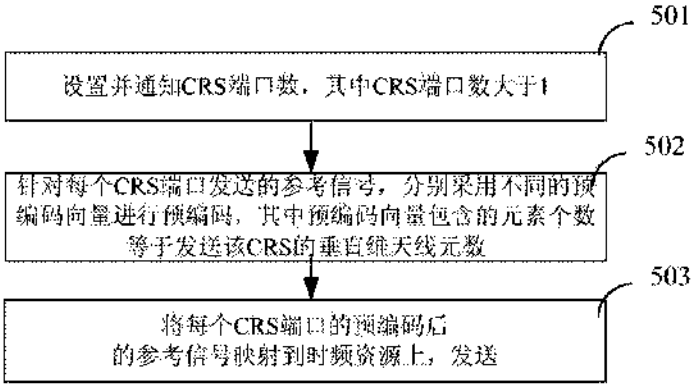

501
设置并通知CRS端口数，其中CRS端口数大于1
502
针对每个CRS端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该CRS的垂直维天线元数
503
将每个CRS端口的预编码后的参考信号映射到时频资源上，发送

图 5

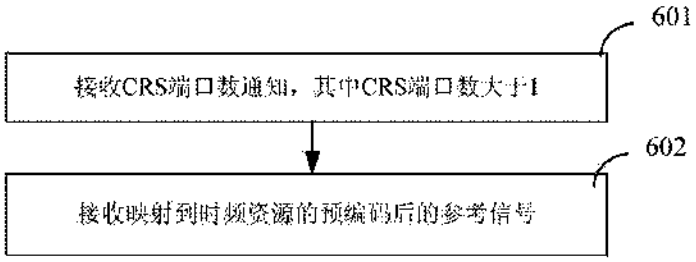

601
接收CRS端口数通知，其中CRS端口数大于1
602
接收映射到时频资源的预编码后的参考信号

图 6

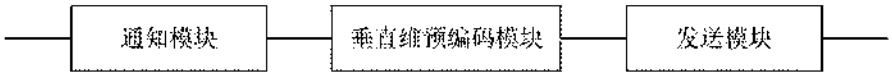

通知模块
垂直维预编码模块
发送模块

图 7

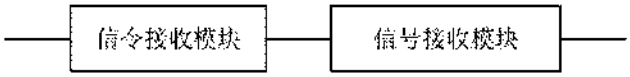

信令接收模块
信号接收模块

图 8

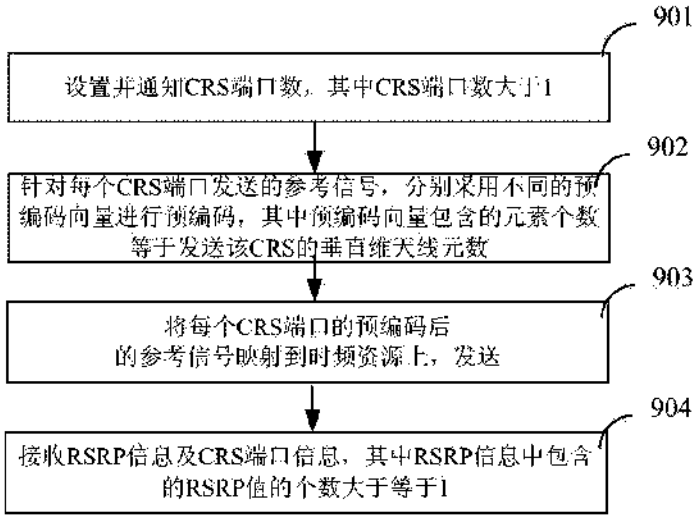

901
设置并通知CRS端口数，其中CRS端口数大于1
902
针对每个CRS端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该CRS的垂直维天线元数
903
将每个CRS端口的预编码后的参考信号映射到时频资源上，发送
904
接收RSRP信息及CRS端口信息，其中RSRP信息中包含的RSRP值的个数大于等于1

图 9

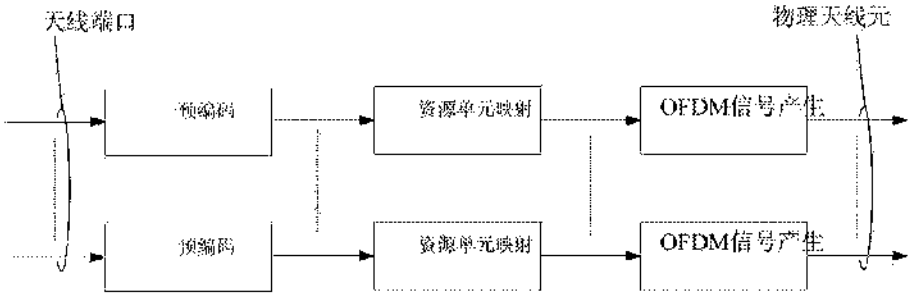

天线端口
物理天线元
预编码
资源单元映射
OFDM信号产生
预编码
资源单元映射
OFDM信号产生

图 10

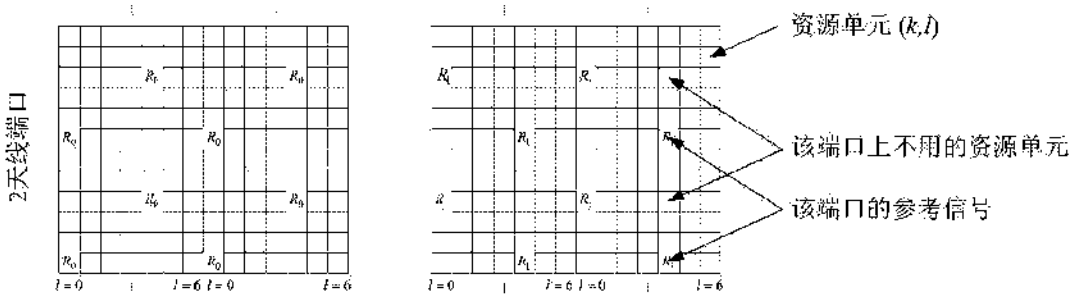

2天线端口
资源单元 (k,l)
该端口上不用的资源单元
该端口的参考信号

图 11

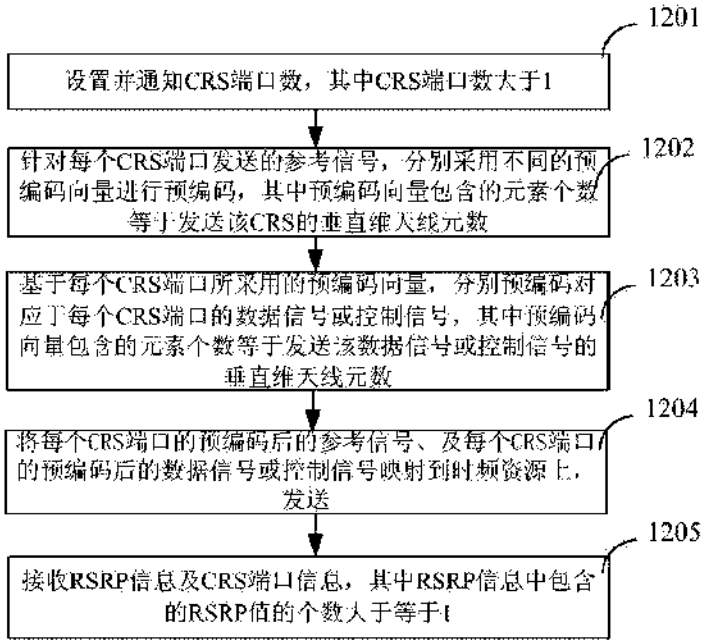

1201
设置并通知CRS端口数，其中CRS端口数大于1
1202
针对每个CRS端口发送的参考信号，分别采用不同的预编码向量进行预编码，其中预编码向量包含的元素个数等于发送该CRS的垂直维天线元数
1203
基于每个CRS端口所采用的预编码向量，分别预编码对应于每个CRS端口的数据信号或控制信号，其中预编码向量包含的元素个数等于发送该数据信号或控制信号的垂直维天线元数
1204
将每个CRS端口的预编码后的参考信号、及每个CRS端口的预编码后的数据信号或控制信号映射到时频资源上，发送
1205
接收RSRP信息及CRS端口信息，其中RSRP信息中包含的RSRP值的个数大于等于1

图 12

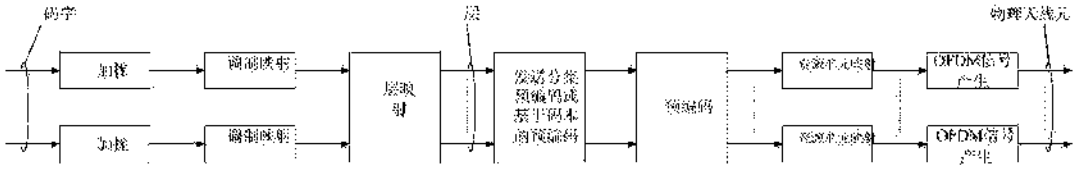

码字
层
物理天线元
加扰
调制映射
层映射
预编码
OFDM信号产生
加扰
调制映射
OFDM信号产生

图 13

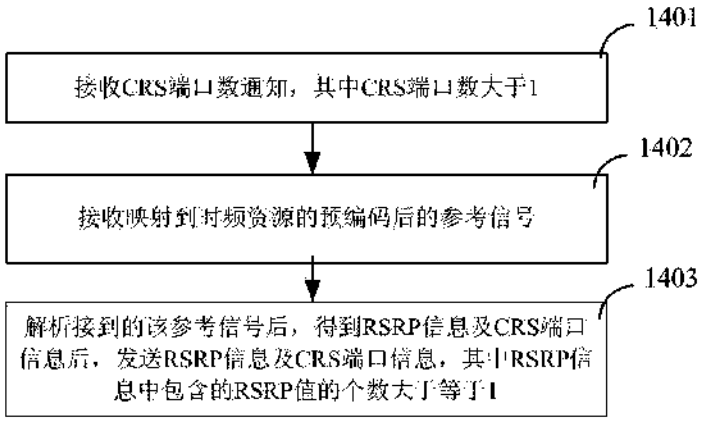

1401
接收CRS端口数通知，其中CRS端口数大于1
1402
接收映射到时频资源的预编码后的参考信号
1403
解析接到的该参考信号后，得到RSRP信息及CRS端口信息后，发送RSRP信息及CRS端口信息，其中RSRP信息中包含的RSRP值的个数大于等于1

图 14

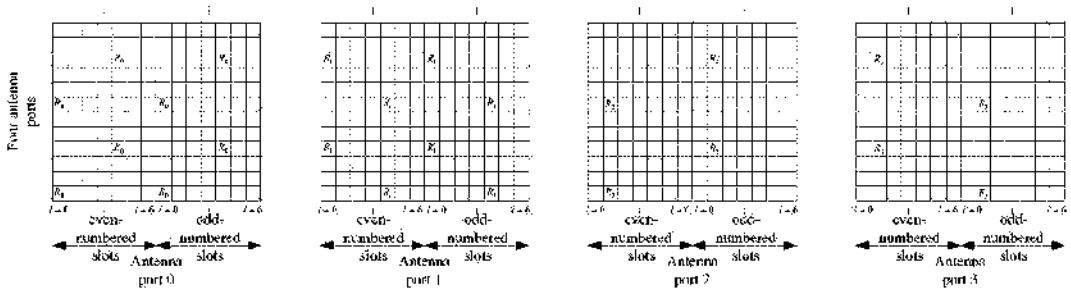

Four antenna ports
even-numbered slots
Antenna port 0
odd-numbered slots
even-numbered slots
Antenna port 1
odd-numbered slots
even-numbered slots
Antenna port 2
odd-numbered slots
even-numbered slots
Antenna port 3
odd-numbered slots

图 15

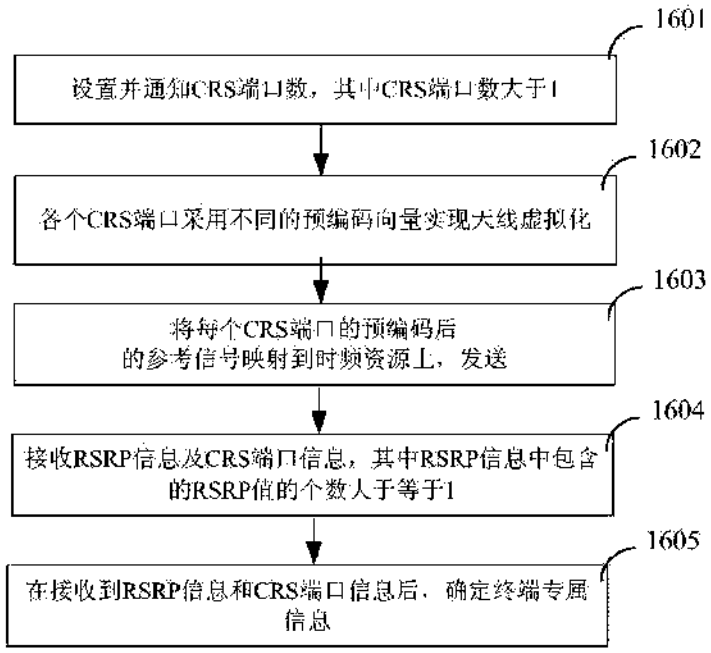

1601
设置并通知CRS端口数，其中CRS端口数大于1
1602
各个CRS端口采用不同的预编码向量实现天线虚拟化
1603
将每个CRS端口的预编码后的参考信号映射到时频资源上，发送
1604
接收RSRP信息及CRS端口信息，其中RSRP信息中包含的RSRP值的个数大于等于1
1605
在接收到RSRP信息和CRS端口信息后，确定终端专属信息

图 16

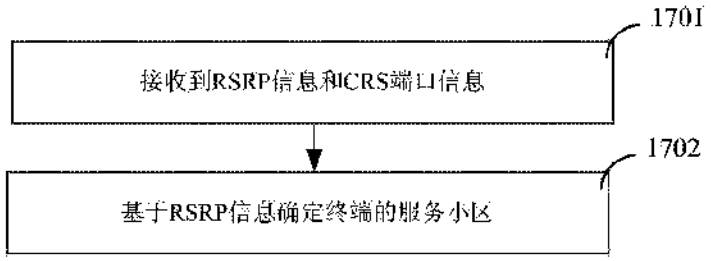

1701
接收到RSRP信息和CRS端口信息
1702
基于RSRP信息确定终端的服务小区

图 17

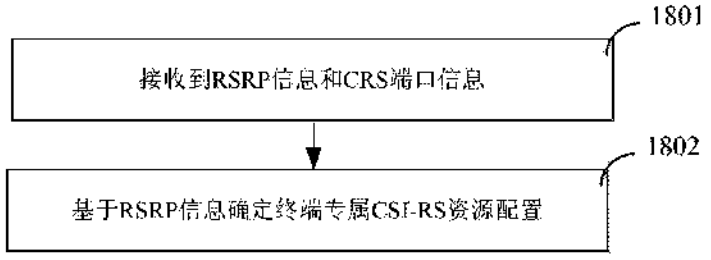

1801
接收到RSRP信息和CRS端口信息
1802
基于RSRP信息确定终端专属CSI-RS资源配置

图 18

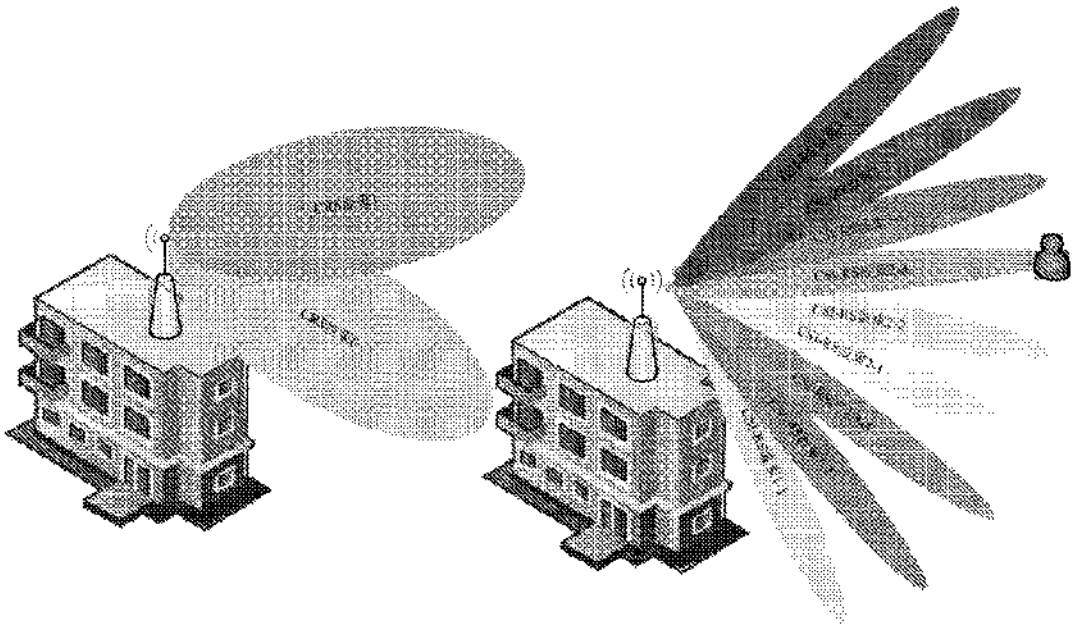


图 19

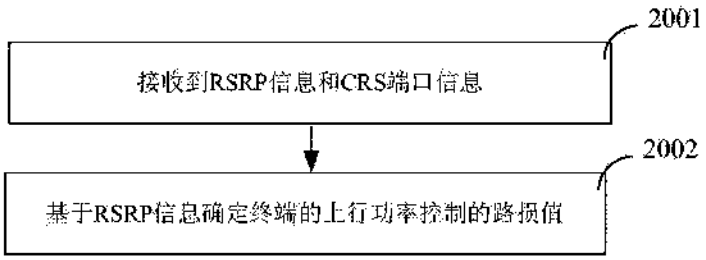


图 20

Espacenet

CN101447815A Shaped-beam transmission method and shaped-beam transmission device

Applicant: DATANG MOBILE COMM EQUIP CO [CN]

Inventors: SHUQIANG SUO [CN]; YANAN LIN [CN]; DESHAN MIAO [CN]

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Shaped-beam transmission method and shaped-beam transmission device

Abstract

The invention discloses a shaped-beam transmission method which comprises the following steps: a system sets a subframe structure for performing shaped-beam transmission, wherein, the step further comprises the sub-steps of setting previous n OFDM symbols in the subframe for purpose of transmitting a control signaling and setting the number of OFDM symbols, which are not the previous n OFDM symbols and are used by user exclusive reference signals, and frequency domain spaces of the reference signals on the same data layer, wherein, n is not less than 1 and mapping positions of the reference signals on different data layers are not overlapped with each other; and when the system judges to perform the shaped-beam transmission, the subframe structure is dispatched to map and transmit the reference signals. The invention also discloses a shaped-beam transmission device which comprises a subframe structure setting module, a shaped-beam judging module and a mapping and transmission executing module. In the invention, the subframe structure is newly set so that the transmission of the user exclusive reference signals can be supported and the shaped-beam transmission can be performed, and meanwhile, resource consumption of the system is reduced and the method and the device are easy to be realized.

[19] 中华人民共和国国家知识产权局

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[71] 申请人 大唐移动通信设备有限公司
地址 100083 北京市海淀区学院路 29 号
[72] 发明人 索士强 林亚男 缪德山

[74] 专利代理机构 北京德琦知识产权代理有限公司
代理人 宋志强 麻海明

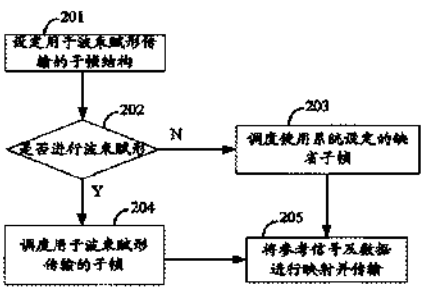
权利要求书 2 页 说明书 10 页 附图 12 页

[54] 发明名称

一种波束赋形传输的方法和装置

[57] 摘要

本发明公开了一种波束赋形传输的方法，该方法包括：系统设定用于进行波束赋形传输的子帧结构，包括：设定所述子帧中的前 n 个 OFDM 符号用于传输控制信令，$n \geq 1$，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数和同一数据层参考信号间的频域间隔，且不同数据层的参考信号的映射位置互不重叠；当系统判定进行波束赋形传输时，调度使用所述子帧结构进行参考信号的映射并进行传输。本发明还同时公开了一种波束赋形传输的装置，该装置包括：子帧结构设置模块，波束赋形判定模块和映射传输执行模块。本发明重新设定了新的子帧结构，能够支持传输用户专属参考信号并进行波束赋形传输，同时减小了系统的资源开销，且实现简单。



1、一种波束赋形传输的方法，其特征在于，该方法包括：

设定用于进行波束赋形传输的子帧结构，包括：设定所述子帧中的前 n 个正交频分复用 OFDM 符号用于传输控制信令，n 为自然数且 n≥1，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数和同一数据层参考信号间的频域间隔，且不同数据层的参考信号的映射位置互不重叠；

当判定进行波束赋形传输时，调度使用所述子帧结构进行参考信号的映射并进行传输。

2、根据权利要求 1 所述的方法，其特征在于，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数和同一数据层参考信号间的频域间隔的方法包括：

设定波束赋形传输的用户专属参考信号在单频网络运行多媒体广播服务 MBSFN 参考信号的映射位置上进行映射，设定同一数据层参考信号间的频域间隔为 6 个子载波。

3、根据权利要求 1 所述的方法、其特征在于，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数和同一数据层参考信号间的频域间隔的方法包括：

设定波束赋形传输的用户专属参考信号占用子帧中第 n 个 OFDM 符号之后的任意多个 OFDM 符号进行映射，设定同一数据层参考信号间的频域间隔为任意多个子载波。

4、根据权利要求 1 所述的方法，其特征在于，所述 n 个 OFDM 符号中还可以进一步包括小区专属参考信号。

5、一种波束赋形传输的装置，其特征在于，该装置包括：子帧结构设置模块，波束赋形判定模块和映射传输执行模块；

子帧结构设置模块，用于存储系统设定的预定信息，将该预定信息发送给映射传输执行模块；所述预定信息为：设定所述子帧中的前 n 个 OFDM 符号用于传输控制信令，n 为自然数且 n≥1，在所述前 n 个 OFDM 符号之外设定用户

专属参考信号占用的OFDM符号个数和同一数据层参考信号间的频域间隔，且不同数据层的参考信号的映射位置互不重叠；

波束赋形判定模块，判断进行波束赋形传输时，通知映射传输执行模块采用预定信息中设定的子帧结构进行参考信号的映射；

映射传输执行模块，接收波束赋形判定模块的通知，根据子帧结构设置模块发送的预定信息中的子帧结构进行波束赋形传输时的参考信号映射并进行传输。

6、根据权利要求5所述的装置，其特征在于，所述子帧结构设置模块中包括：OFDM符号占用个数设定单元，频域间隔设定单元和映射位置记录单元；

OFDM符号占用个数设定单元，设定所述子帧中的前n个OFDM符号用于传输控制信令，$n \geq 1$，在所述前n个OFDM符号之外设定用户专属参考信号占用的OFDM符号个数，将所述设定信息发送给频域间隔设定单元；

频域间隔设定单元，接收OFDM符号占用个数设定单元发送的一个数据层的参考信号映射时所占用的OFDM符号的个数，进一步设定同一层参考信号间的频域间隔，将所述设定信息发送给映射位置记录单元；

所述映射位置记录单元，接收频域间隔设定单元发送的设定信息，根据设定信息得到系统设定的用于波束赋形传输的子帧结构，当判定进行波束赋形传输时，将所述子帧结构作为预定信息发送给映射传输执行模块。

7、根据权利要求5所述的装置，其特征在于，所述OFDM符号占用个数设定单元进一步用于设定所述n个OFDM符号中包括小区专属参考信号，将所述设定信息发送给频域间隔设定单元。

一种波束赋形传输的方法和装置

技术领域

本发明涉及移动通信技术，具体涉及一种波束赋形传输的方法和装置。

背景技术

目前，第三代移动通信系统标准化组织（3GPP）启动了3G无线接口技术的长期演进（LTE）研究项目。根据研究进展，当前的LTE标准版本中定义了小区专属参考信号（Cell-specified Reference Signal，CsRS）的映射方案。

子帧结构中所有正交频分复用（Orthogonal Frequency Division Multiplexing, OFDM）符号都用于单播传输，不支持广播传输，此时子帧中除了数据符号和控制信令外，还可以有两种参考信号，包括CsRS和用户专属参考信号（UE-specified Reference Signal，UsRS），其中CsRS占用4个天线端口进行传输，所述的天线端口序号为0、1、2、3。此时子帧的时频域结构示意图如图1所示，图中Ri（i=0、1、2、3）表示第i个天线端口上的CsRS的映射位置，D表示数据信号的映射位置。

当循环前缀（CP）设置为短CP配置时，一个子帧中包含14个OFDM符号，如图1所示，此时端口0、1上的CsRS在时域上占用第1、5、8、12个OFDM符号，端口2、3上的CsRS则占用第2、9个OFDM符号；频域上同一个天线端口上的参考信号间的间隔为6个子载波。

当CP设置为长CP配置时，一个子帧中包含12个OFDM符号，如图1所示，此时端口0、1上的CsRS在时域上占用第1、4、7、10个OFDM符号，端口2、3上的CsRS则占用第2、8个OFDM符号；频域上同一个天线端口上的参考信号间的间隔为6个子载波。

现有的LTE系统支持进行波束赋形传输，但是进行波束赋形所需要的

UsRS 的映射方式并没有提出具体的方案。利用上述子帧结构进行波束赋形传输时，同时存在 CsRS 和 UsRS，此时，由于图 1 中 Ri 为 CsRS 的映射位置，UsRS 只能够放置在数据符号所在位置（图 1 中 D 所占据的位置）中，相应的就会导致能够用于传输数据符号的资源位置减少，显然，这样会导致子帧中用于参考信号传输的资源开销比较大。

另一方面，当进行波束赋形传输时，并非必须传输 CsRS，为了降低资源开销，可以先设置图 1 中 Ri 表示的位置进行数据符号的传输，然后在所述 Ri 所在位置以外的资源中再设置用于传输 UsRS 的资源位置，这样虽然可以降低资源开销，但是需要根据是否进行波束赋形传输在两种映射方法间进行切换，因此会大大增加系统设计的复杂度。

由上可见，现有技术无法提供一种实现简单且参考信号映射占用资源较少的波束赋形传输的方法。

发明内容

本发明实施例提供一种参考信号映射的方法和装置，使得进行波束赋形传输时资源消耗低且实现简单。

为达到上述目的，本发明的技术方案具体是这样实现的：

一种波束赋形传输的方法，该方法包括：

设定用于进行波束赋形传输的子帧结构，包括：设定所述子帧中的前 n 个正交频分复用 OFDM 符号用于传输控制信令，n 为自然数且 $n \geq 1$，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数和同一数据层参考信号间的频域间隔，且不同数据层的参考信号的映射位置互不重叠；

当判定进行波束赋形传输时，调度使用所述子帧结构进行参考信号的映射并进行传输。

一种波束赋形传输的装置，该装置包括：子帧结构设置模块，波束赋形判定模块和映射传输执行模块；

子帧结构设置模块，用于存储系统设定的预定信息，将该预定信息发送给映射传输执行模块；所述预定信息为：设定所述子帧中的前 n 个 OFDM 符号用于传输控制信令，n 为自然数且 $n \geq 1$，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数和同一数据层参考信号间的频域间隔，且不同数据层的参考信号的映射位置互不重叠；

波束赋形判定模块，判断进行波束赋形传输时，通知映射传输执行模块采用预定信息中设定的子帧结构进行参考信号的映射；

映射传输执行模块，接收波束赋形判定模块的通知，根据子帧结构设置模块发送的预定信息中的子帧结构进行波束赋形传输时的参考信号映射并进行传输。

由上述的技术方案可见，本发明实施例中的波束赋形传输的方法和装置，重新设定了新的子帧结构，能够支持传输用户专属参考信号并进行波束赋形，同时减小了系统的资源开销，且实现简单。

附图说明

图 1 为现有技术中下行子帧结构的示意图。

图 2 为本发明实施例中波束赋形传输的方法的流程示意图。

图 3(a)为本发明实施例中使用短 CP 配置时的新的子帧结构的示意图。

图 3(b)为本发明实施例中使用长 CP 配置时的新的子帧结构的示意图。

图 3(c)为本发明实施例中使用混合 CP 配置时的新的子帧结构的示意图。

图 4(a)为本发明实施例中当存在一个数据层时，长 CP 配置下的 UsRS 参考信号重用 MBSFN 参考信号映射位置的示意图。

图 4(b)为本发明实施例中当存在一个数据层时，短 CP 配置下的 UsRS 参考信号重用 MBSFN 参考信号映射位置的示意图。

图 4(c)为本发明实施例中当存在 2 个数据层时，长 CP 配置下的 UsRS 参考信号重用 MBSFN 参考信号映射位置的示意图。

图 4(d)为本发明实施例中当存在 2 个数据层时，短 CP 配置下的 UsRS 参考信号重用 MBSFN 参考信号映射位置的示意图。

图 4(e)为本发明实施例中当存在 3 个数据层时，长 CP 配置下的 UsRS 参考信号重用 MBSFN 参考信号映射位置的示意图。

图 4(f)为本发明实施例中当存在 3 个数据层时，短 CP 配置下的 UsRS 参考信号重用 MBSFN 参考信号映射位置的示意图。

图 5（a）为本发明实施例中存在一个数据层，长 CP 配置下的 UsRS 参考信号占用 3 个 OFDM 符号，频域间隔为 4 个子载波时的映射位置的示意图。

图 5（b）为本发明实施例中存在一个数据层，短 CP 配置下的 UsRS 参考信号占用 3 个 OFDM 符号，频域间隔为 4 个子载波时的映射位置的示意图。

图 5（c）为本发明实施例中存在一个数据层，长 CP 配置下的 UsRS 参考信号占用 4 个 OFDM 符号，频域间隔为 6 个子载波时的映射位置的示意图。

图 5（d）为本发明实施例中存在一个数据层，短 CP 配置下的 UsRS 参考信号占用 4 个 OFDM 符号，频域间隔为 6 个子载波时的映射位置的示意图。

图 6（a）为本发明实施例中存在 2 个数据层，长 CP 配置下的 UsRS 参考信号占用 3 个 OFDM 符号，同一数据层的参考信号的频域间隔为 4 个子载波时的映射位置的示意图。

图 6（b）为本发明实施例中存在 2 个数据层，短 CP 配置下的 UsRS 参考信号占用 3 个 OFDM 符号，同一数据层的参考信号的频域间隔为 4 个子载波时的映射位置的示意图。

图 6（c）为本发明实施例中存在 2 个数据层，长 CP 配置下的 UsRS 参考信号占用 4 个 OFDM 符号，同一数据层的参考信号的频域间隔为 6 个子载波时的映射位置的示意图。

图 6（d）为本发明实施例中存在 2 个数据层，短 CP 配置下的 UsRS 参考信号占用 4 个 OFDM 符号，同一数据层的参考信号的频域间隔为 6 个子载波时的映射位置的示意图。

图 7（a）为本发明实施例中存在 3 个数据层，长 CP 配置下的 UsRS 参考信号占用 3 个 OFDM 符号，同一数据层的参考信号的频域间隔为 4 个子载波时的映射位置的示意图。

图 7（b）为本发明实施例中存在 3 个数据层，短 CP 配置下的 UsRS 参考信号占用 3 个 OFDM 符号，同一数据层的参考信号的频域间隔为 4 个子载波时的映射位置的示意图。

图 7（c）为本发明实施例中存在 3 个数据层，长 CP 配置下的各数据层的 UsRS 参考信号占用不同个数的 OFDM 符号，同一数据层的参考信号的频域间隔为 6 个子载波时的一种映射位置的示意图。

图 7（d）为本发明实施例中存在 3 个数据层，短 CP 配置下的各数据层的 UsRS 参考信号占用不同个数的 OFDM 符号，同一数据层的参考信号的频域间隔为 6 个子载波时的一种映射位置示意图。

图 8 为本发明实施例中波束赋形传输的装置的组成结构示意图。

具体实施方式

为使本发明的目的、技术方案及优点更加清楚明白，以下参照附图并举实施例，对本发明进一步详细说明。

进行波束赋形时，终端需要使用 UsRS 进行信道估计，此时子帧中同时包括两种参考信号：CsRS 和 UsRS。由于使用了 UsRS，因此可以适当减少 CsRS 甚至不使用 CsRS 以减小系统的资源开销。这种情况下，系统定义一种新的子帧结构，用于进行波束赋形传输。

本发明实施例提供一种波束赋形传输的方法，该方法的流程如图 2 所示，包括：

步骤 201、系统定义一种新的子帧结构用于波束赋形传输，系统中缺省

设置使用现有技术中的子帧结构进行非波束赋形时的传输。

所述新的子帧可以用于单频网络运行多媒体广播服务（Multimedia Broadcast/Multicast Service Over Single Frequency Network，MBSFN），此时只使用长 CP 配置，所述子帧中使用的参考信号同时包括 CsRS 和 MBSFN 参考信号；也可以用于单播传输，进行波束赋形传输，此时根据小区覆盖范围的大小选择具体的 CP 配置类型，所述子帧中使用的参考信号同时包括 CsRS 和 UsRS；此外，当同时使用单播和广播传输时，还可以混合使用长 CP 和短 CP 配置。因此，本发明实施例中的下行新的子帧结构既支持进行单播传输，也支持进行广播传输。

图 3 所示为所述新的子帧结构的一种结构图，其中 C 表示控制信令占用的位置，R 表示 UsRS 参考信号占用的位置，D 表示数据符号占用的位置。如图 3 所示，控制信令总是占用子帧中的前 n（n≥1）个 OFDM 符号进行传输，如果要传输 CsRS，则 CsRS 也在所述的 n 个 OFDM 符号中进行传输。其中，图 3（a）示出了短 CP 配置下的子帧结构，用于单播传输；图 3（b）示出了长 CP 配置下的子帧结构，可用于单播或 MBSFN 传输；图 3（c）表示混合使用长、短 CP 配置，即单播和广播传输同时存在时的子帧结构，其中所述的前 n 个 OFDM 符号中使用短 CP 配置，用于单播传输，其余的 OFDM 符号使用长 CP 配置，用于 MBSFN 传输。

步骤 202、判断是否进行波束赋形传输，若是，执行步骤 204，否则继续执行步骤 203。

步骤 203、若用户不进行波束赋形传输，则系统使用缺省的子帧结构进行传输。

步骤 204、若用户进行波束赋形传输，则系统调度使用新的子帧结构进行传输。

步骤 205、根据系统使用的子帧结构，进行参考信号及数据符号的映射并进行传输。

上述流程中所述当不进行波束赋形传输时，系统使用缺省的子帧结构进

行传输，此时的参考符号映射方式及传输方式与现有技术相同，故不再详述；

当用户进行波束赋形传输时，系统使用新的子帧结构进行波束赋形传输，可以采取两种方式得到新的参考信号的映射图样，包括：

① 部分重用现有标准中 MBSFN 参考信号的映射图样。

由于 UsRS 的频域密度要求比 MBSFN 参考信号的要求低，因此可以在现有标准中 MBSFN 参考信号的映射位置上映射 UsRS。如图 4 所示，其中 S1 表示数据层 1 上的 UsRS 的映射位置，S2 表示数据层 2 上的 UsRS 的映射位置，S3 表示数据层 3 上的 UsRS 的映射位置，D 表示数据符号占用的位置。图 4（a）示出了存在一个数据层时，长 CP 配置下的参考信号映射图样，图 4（b）为采用短 CP 配置时的参考信号映射图样；当存在两个数据层时，图 4（c）示出了长 CP 配置下的参考信号映射图样，而图 4（d）为采用短 CP 配置的参考信号映射图样；当存在三个数据层时，图 4（e）为长 CP 配置下的参考信号映射图样，图 4（f）为采用短 CP 配置的参考信号映射图样。

由图 4 可见，上述各参考信号映射图样的子帧结构中，UsRS 的映射位置为 MBSFN 参考信号的映射位置；同时，保持同一数据层的参考信号之间的频域间隔为 6 个子载波，参考信号占用 3 个 OFDM 符号。可见，此时的频域间隔和参考信号所占用的 OFDM 符号个数都是重用了 MBSFN 参考信号的映射图样。

② 重新设计 UsRS 的映射图样。

还可以对参考信号的映射方式进行重新设计，将同一数据层的参考信号之间的频域间隔进行重新设置，参考信号所占用的 OFDM 符号的个数也进行重新设置。

例如：图 5 中示出了存在一个数据层时参考信号的映射图样，图 5（a）所示为长 CP 配置的帧结构中，参考信号占用 3 个 OFDM 符号，且参考信号间的频域间隔为 4 个子载波时，参考信号的映射图样。图 5（b）表示短 CP 配置下，参考信号占用 3 个 OFDM 符号，频域间隔为 4 个子载波时的映射图样。图 5（c）示出了在长 CP 配置下的参考信号的映射图样，此时设置参

考信号占用 4 个 OFDM 符号，频域间隔为 6 个子载波。而图 5（d）则表示短 CP 配置下的参考信号的映射图样，设置参考信号占用 4 个 OFDM 符号，频域间隔为 6 个子载波。

当存在多个数据层，比如当存在 2 个数据层时，参考信号的映射图样如图 6 所示。图 6（a）表示长 CP 配置下，每层参考信号占用 3 个 OFDM 符号，设置同一层参考信号的频域间隔为 4 个子载波。图 6（b）为短 CP 配置下，每层参考信号占用 3 个 OFDM 符号，设置同一层频域间隔为 4 个子载波。图 6（c）为长 CP 配置下，设置每层参考信号占用 4 个 OFDM 符号，频域间隔为 6 个子载波。图 6（d）为短 CP 配置下，设置每层参考信号占用 4 个 OFDM 符号，频域间隔为 6 个子载波。

再比如存在 4 个数据层时，参考信号的映射图样如图 7 所示。S1 表示数据层 1 上的 UsRS 的映射位置，S2 表示数据层 2 上的 UsRS 的映射位置，S3 表示数据层 3 上的 UsRS 的映射位置，S4 表示数据层 4 上的 UsRS 的映射位置。

图 7（a）表示长 CP 配置下，每层参考信号占用 3 个 OFDM 符号（所有的参考信号共占用 6 个 OFDM 符号），设置同一层参考信号的频域间隔为 4 个子载波。图 7（b）为短 CP 配置下，每层的参考信号占用 3 个 OFDM 符号（所有的参考信号共占用 6 个 OFDM 符号），设置同一层参考信号的频域间隔为 4 个子载波。图 7（c）表示在长 CP 配置下，设置每层的参考信号占用多个 OFDM 符号，同一层参考信号的频域间隔为 6 个子载波。图 7（d）为短 CP 配置下，设置每层的参考信号占用多个 OFDM 符号，同一层参考信号的频域间隔为 6 个子载波。

需要说明的是，本发明实施例中所述的所有多层数据的映射图样仅为示意图。在实际应用中，每一层的数据在时域上都是相互独立的。每一层的参考信号进行映射时，不一定占据的 OFDM 符号个数相同。以图 7（c）为例：当进行第一层数据的映射时，在所述 S1 表示的位置中映射参考信号，而 S2、S3、S4 所表示的位置此时都用于数据映射；类似地，当进行第二层数据的

映射时，在所述 S2 表示的位置中映射参考信号，而 S1、S3、S4 所表示的位置此时都用于数据映射。同时，S1 和 S2 占据了 4 个 OFDM 符号，而 S3 和 S4 占据了 2 个 OFDM 符号。图 7（c）只是将 4 个数据层中所有可能的映射位置都标识在一张图上进行说明，并不表示在一次映射过程时需要按照该图样进行映射。容易理解，对于本发明实施例中其它多层数据的映射图样，上述说明也同样适用。

此外，所述重新设计 UsRS 的映射图样时，原则上只要保证不同数据层的参考信号不被映射到重叠的位置上即可，至于参考信号占用的 OFDM 符号的个数，以及同一层参考信号的频域间隔都可以在满足所述原则的基础上随意设定。在实际应用中，通常设定参考信号占用 3~4 个 OFDM 符号位，同一层参考信号的频域间隔可以为 3~6 个子载波，并且将参考信号的映射位置在一个子帧的时频范围内尽量均匀的分布。

由以上可见，本发明实施例中的波束赋形传输的方法，能够支持传输用户专属参考信号并进行波束赋形，由于所述前 n 个 OFDM 符号中不必须传输 CsRS，因此资源消耗也更低，并且实现简单。

本发明实施例还提供一种波束赋形传输的装置，如图 8 所示，该装置包括：子帧结构设置模块 810，波束赋形判定模块 820 和映射传输执行模块 830；

子帧结构设置模块 810，用于存储系统设定的预定信息，将该预定信息发送给映射传输执行模块 820；所述预定信息为：设定所述子帧中的前 n 个 OFDM 符号用于传输控制信令，$n \geq 1$，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数和同一数据层参考信号间的频域间隔，且不同数据层的参考信号的映射位置互不重叠；

波束赋形判定模块 820，判断进行波束赋形传输时，通知映射传输执行模块 830 采用预定信息中设定的子帧结构进行参考信号的映射；

映射传输执行模块 830，接收波束赋形判定模块 820 的通知，根据子帧结构设置模 810 块发送的预定信息中的子帧结构进行波束赋形传输时的参考信号映射并进行传输。

所述子帧结构设置模块 810 中包括：OFDM 符号占用个数设定单元 811，频域间隔设定单元 812 和映射位置记录单元 813；

OFDM 符号占用个数设定单元 811，设定所述子帧中的前 n 个 OFDM 符号用于传输控制信令，n 为自然数且 $n \geqslant 1$，在所述前 n 个 OFDM 符号之外设定用户专属参考信号占用的 OFDM 符号个数，将所述设定信息发送给频域间隔设定单元 812；

频域间隔设定单元 812，接收 OFDM 符号占用个数设定单元 811 发送的一个数据层的参考信号映射时所占用的 OFDM 符号的个数，进一步设定同一层参考信号间的频域间隔，将所述设定信息发送给映射位置记录单元 813；

所述映射位置记录单元 813，接收频域间隔设定单元 812 发送的设定信息，根据设定信息得到系统设定的用于波束赋形传输的子帧结构，当判定进行波束赋形传输时，将所述子帧结构作为预定信息发送给映射传输执行模块 830。

较佳地，所述 OFDM 符号占用个数设定单元 811 还可以进一步用于设定所述 n 个 OFDM 符号中包括 CsRS，将所述设定信息发送给频域间隔设定单元 812。

本发明实施例对于具体的映射规则不做限定，容易理解，以上所述仅为本发明的较佳实施例，并非用于限定本发明的精神和保护范围，任何熟悉本领域的技术人员所做出的等同变化或替换，都应视为涵盖在本发明的保护范围之内。

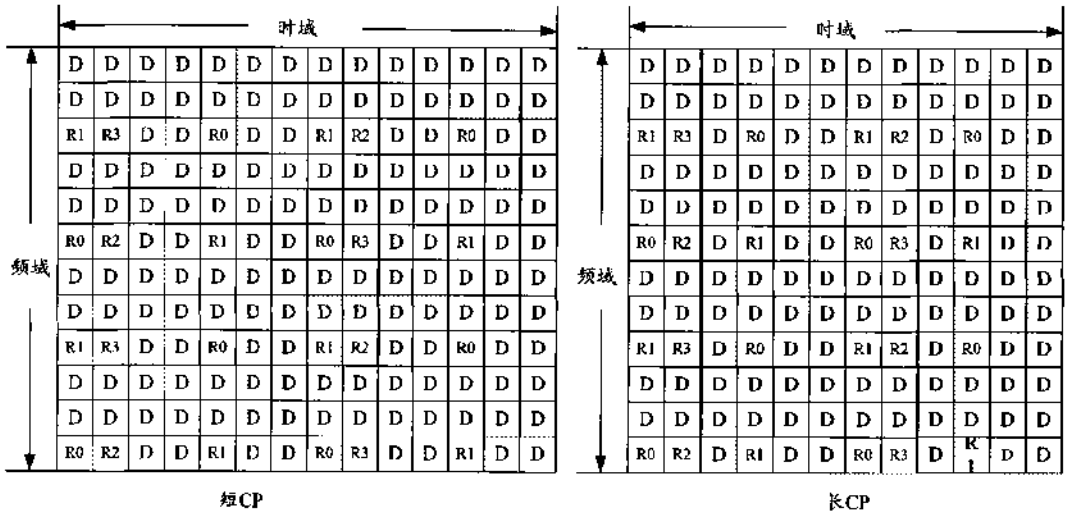

时域
频域
短CP
时域
频域
长CP

图 1

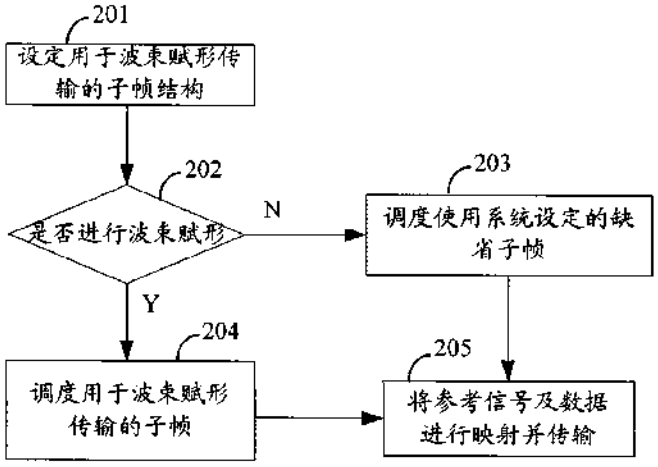

201
设定用于波束赋形传输的子帧结构
202
是否进行波束赋形
N
Y
203
调度使用系统设定的缺省子帧
204
调度用于波束赋形传输的子帧
205
将参考信号及数据进行映射并传输

图 2

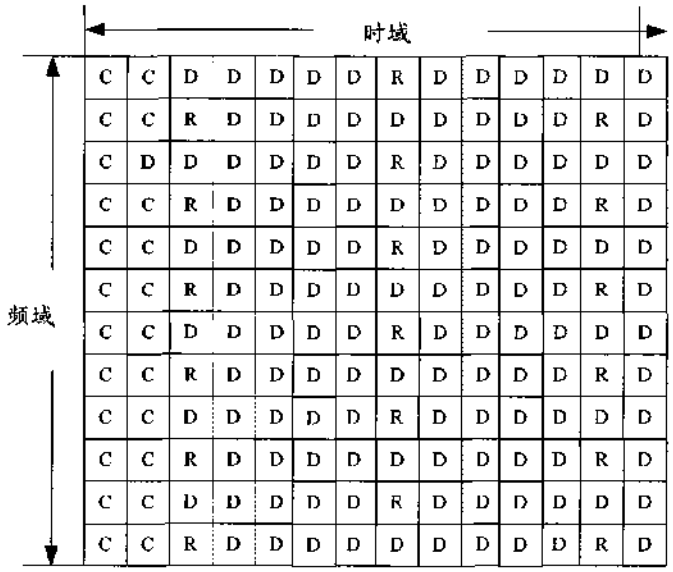

时域
频域
C C D D D D D R D D D D D D
C C R D D D D D D D D D R D
C D D D D D D R D D D D D D
C C R D D D D D D D D D R D
C C D D D D D R D D D D D D
C C R D D D D D D D D D R D
C C D D D D D R D D D D D D
C C R D D D D D D D D D R D
C C D D D D D R D D D D D D
C C R D D D D D D D D D R D
C C D D D D D R D D D D D D
C C R D D D D D D D D D R D

图 3（a）

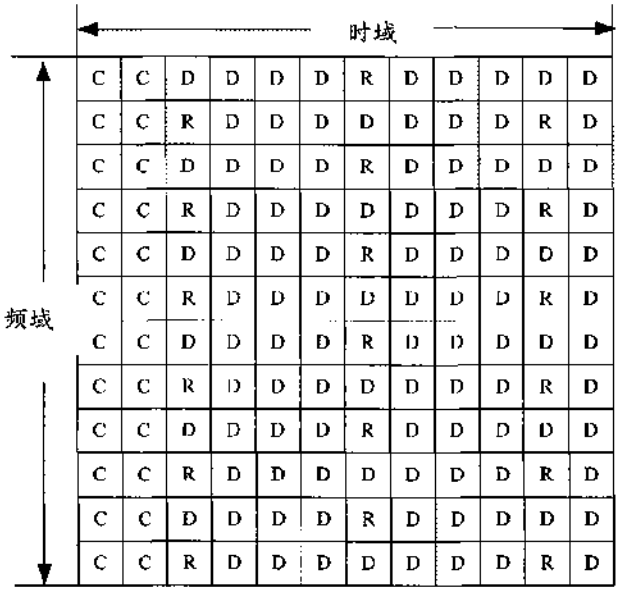

时域
频域
C C D D D D R D D D D D
C C R D D D D D D D R D
C C D D D D R D D D D D
C C R D D D D D D D R D
C C D D D D R D D D D D
C C R D D D D D D D R D
C C D D D D R D D D D D
C C R D D D D D D D R D
C C D D D D R D D D D D
C C R D D D D D D D R D
C C D D D D R D D D D D
C C R D D D D D D D R D

图 3（b）

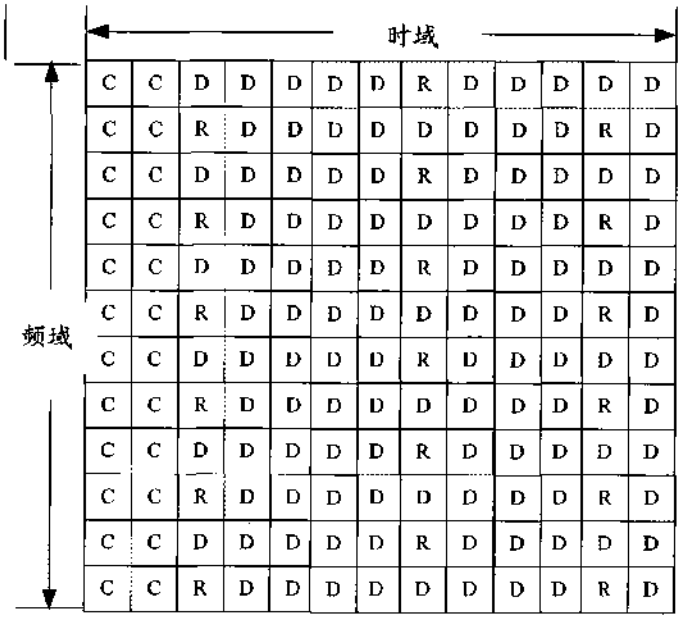

时域
频域
C C D D D D D R D D D D D
C C R D D D D D D D D R D
C C D D D D D R D D D D D
C C R D D D D D D D D R D
C C D D D D D R D D D D D
C C R D D D D D D D D R D
C C D D D D D R D D D D D
C C R D D D D D D D D R D
C C D D D D D R D D D D D
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C C D D D D D R D D D D D
C C R D D D D D D D D R D

图 3（c）

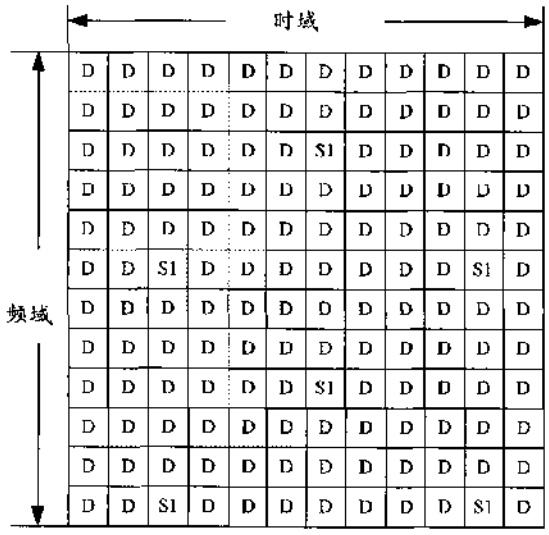

时域
频域
D D D D D D D D D D D D
D D D D D D D D D D D D
D D D D D D S1 D D D D D
D D D D D D D D D D D D
D D D D D D D D D D D D
D D S1 D D D D D D D S1 D
D D D D D D D D D D D D
D D D D D D D D D D D D
D D D D D D S1 D D D D D
D D D D D D D D D D D D
D D D D D D D D D D D D
D D S1 D D D D D D D S1 D

图 4（a）

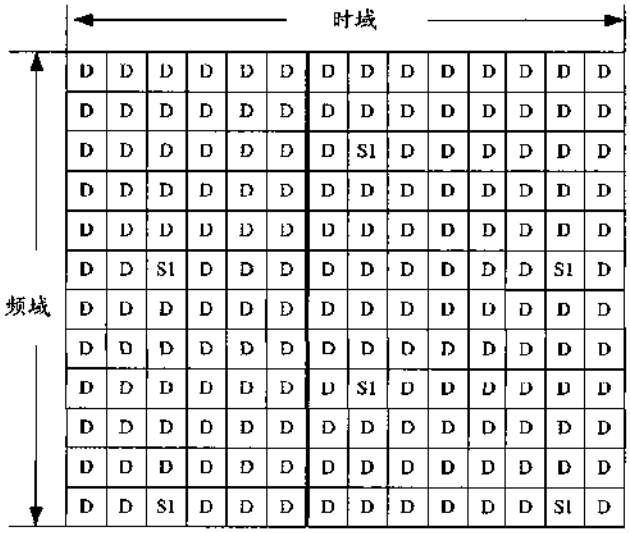


图 4（b）

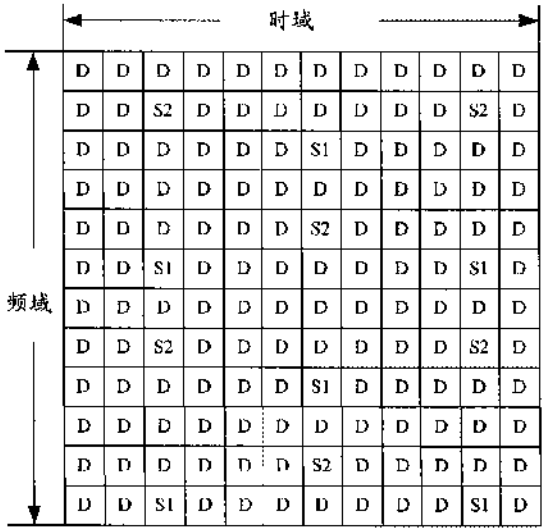


图 4（c）

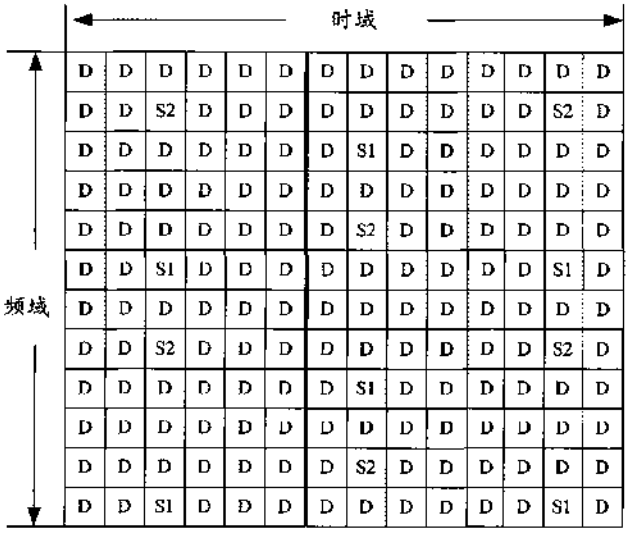

时域
频域
D D D D D D D D D D D D D D
D D S2 D D D D D D D D D S2 D
D D D D D D D S1 D D D D D D
D D D D D D D D D D D D D D
D D D D D D D S2 D D D D D D
D D S1 D D D D D D D D D S1 D
D D D D D D D D D D D D D D
D D S2 D D D D D D D D S2 D
D D D D D D D S1 D D D D D D
D D D D D D D D D D D D D D
D D D D D D D S2 D D D D D D
D D S1 D D D D D D D D S1 D

图 4（d）

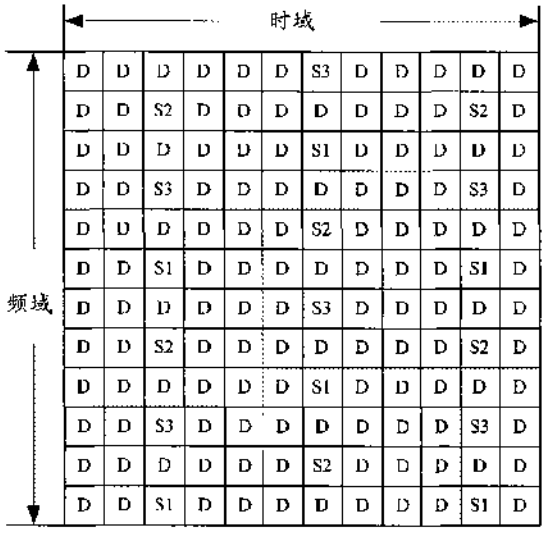

时域
频域
D D D D D D S3 D D D D D
D D S2 D D D D D D D S2 D
D D D D D D S1 D D D D D
D D S3 D D D D D D D S3 D
D D D D D D S2 D D D D D
D D S1 D D D D D D D S1 D
D D D D D D S3 D D D D D
D D S2 D D D D D D D S2 D
D D D D D D S1 D D D D D
D D S3 D D D D D D D S3 D
D D D D D D S2 D D D D D
D D S1 D D D D D D D S1 D

图 4（e）

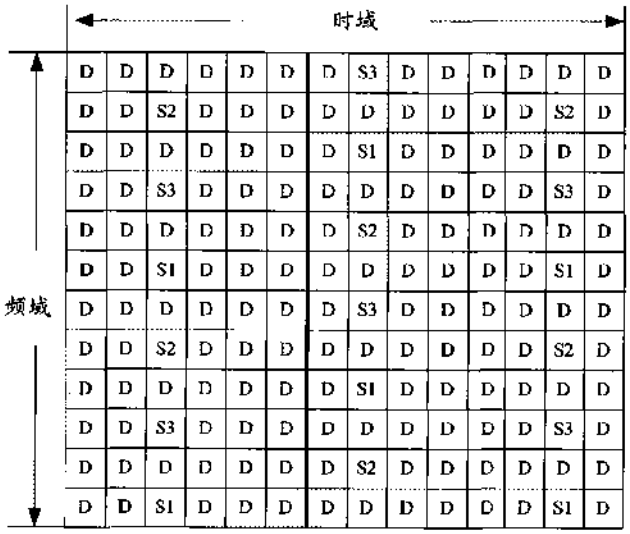

时域
频域
D D D D D D D S3 D D D D D D
D D S2 D D D D D D D D D S2 D
D D D D D D D S1 D D D D D D
D D S3 D D D D D D D D D S3 D
D D D D D D D S2 D D D D D D
D D S1 D D D D D D D D D S1 D
D D D D D D D S3 D D D D D D
D D S2 D D D D D D D D S2 D
D D D D D D D S1 D D D D D D
D D S3 D D D D D D D D D S3 D
D D D D D D D S2 D D D D D D
D D S1 D D D D D D D D D S1 D

图 4（f）

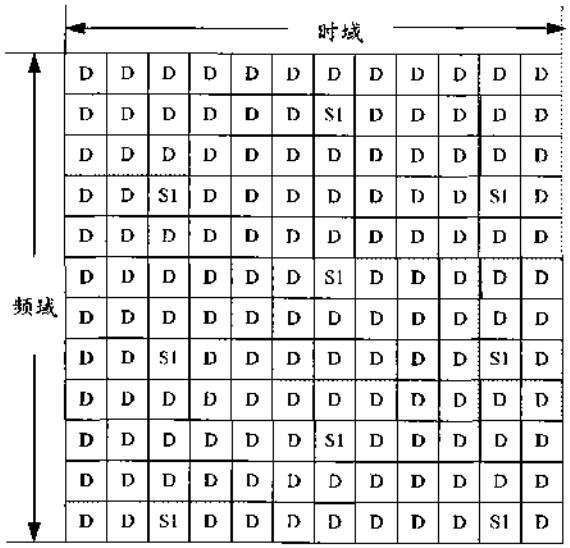

时域
频域
D D D D D D D D D D D D
D D D D D D S1 D D D D D
D D D D D D D D D D D D
D D S1 D D D D D D D S1 D
D D D D D D D D D D D D
D D D D D D S1 D D D D D
D D D D D D D D D D D D
D D S1 D D D D D D D S1 D
D D D D D D D D D D D D
D D D D D D S1 D D D D D
D D D D D D D D D D D D
D D S1 D D D D D D D S1 D

图 5（a）

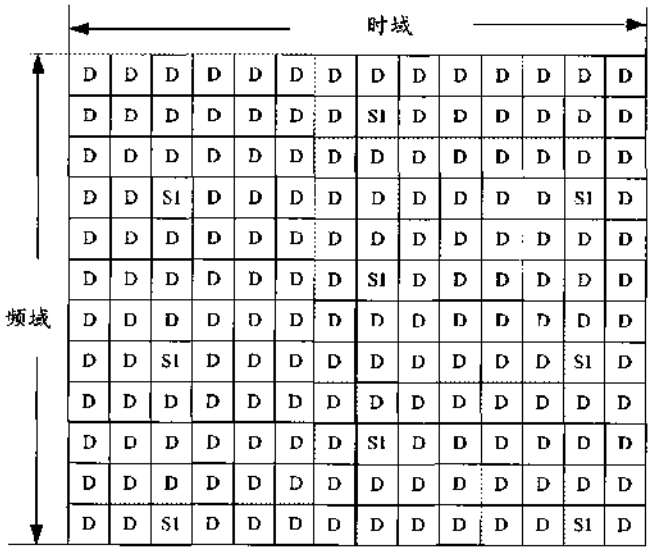


图 5（b）

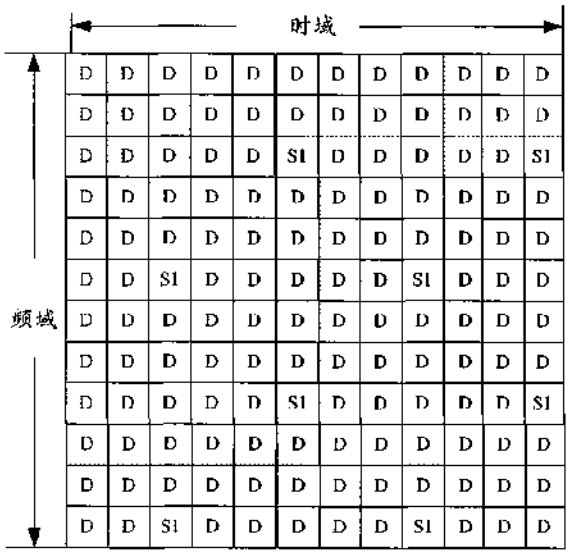


图 5（c）

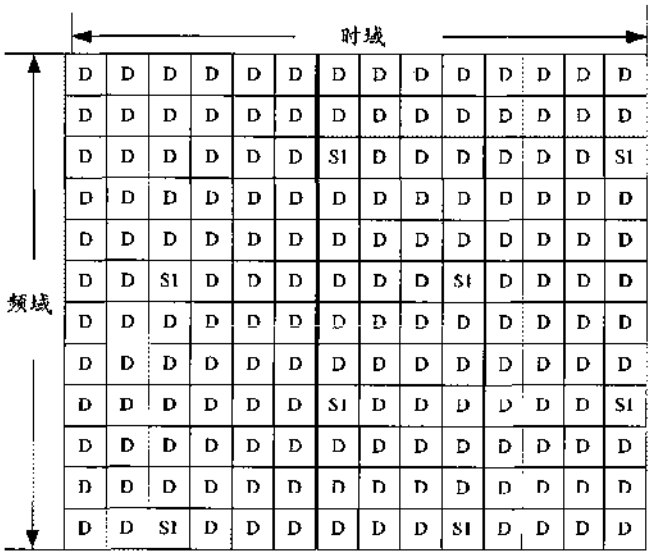


图 5（d）

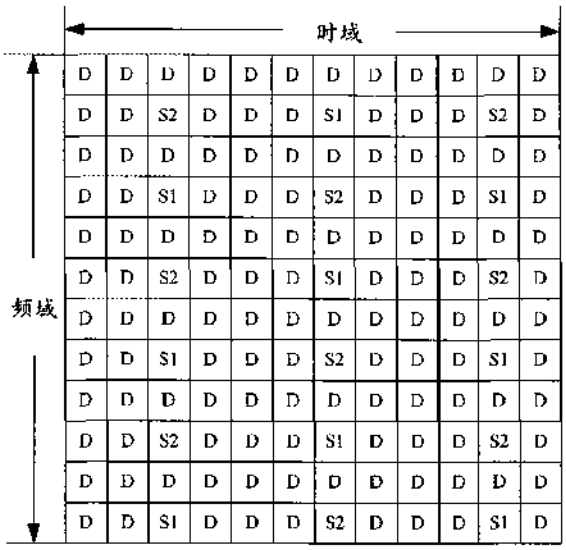


图 6（a）

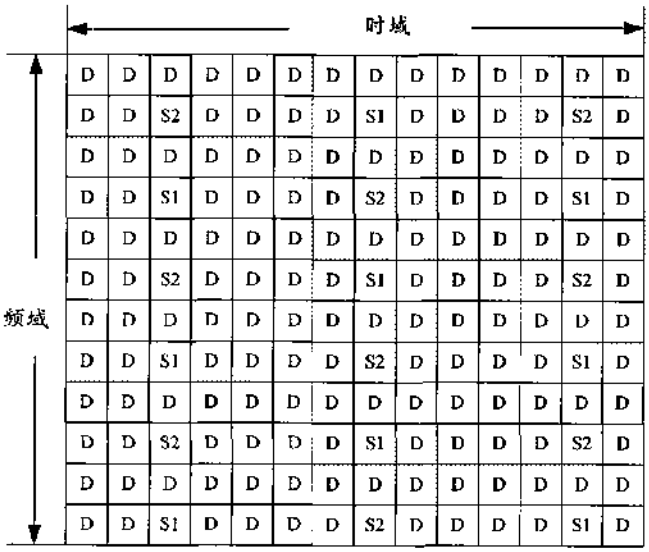

时域
频域
D D D D D D D D D D D D D D
D D S2 D D D D S1 D D D D S2 D
D D D D D D D D D D D D D D
D D S1 D D D D S2 D D D D S1 D
D D D D D D D D D D D D D D
D D S2 D D D D S1 D D D D S2 D
D D D D D D D D D D D D D D
D D S1 D D D D S2 D D D D S1 D
D D D D D D D D D D D D D D
D D S2 D D D D S1 D D D D S2 D
D D D D D D D D D D D D D D
D D S1 D D D D S2 D D D D S1 D

图 6（b）

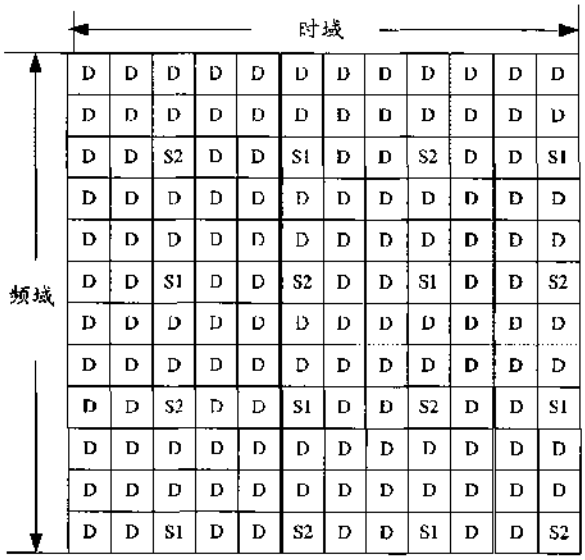

时域
频域
D D D D D D D D D D D D D
D D D D D D D D D D D D D
D D S2 D D S1 D D S2 D D S1
D D D D D D D D D D D D D
D D D D D D D D D D D D D
D D S1 D D S2 D D S1 D D S2
D D D D D D D D D D D D D
D D D D D D D D D D D D D
D D S2 D D S1 D D S2 D D S1
D D D D D D D D D D D D D
D D D D D D D D D D D D D
D D S1 D D S2 D D S1 D D S2

图 6（c）

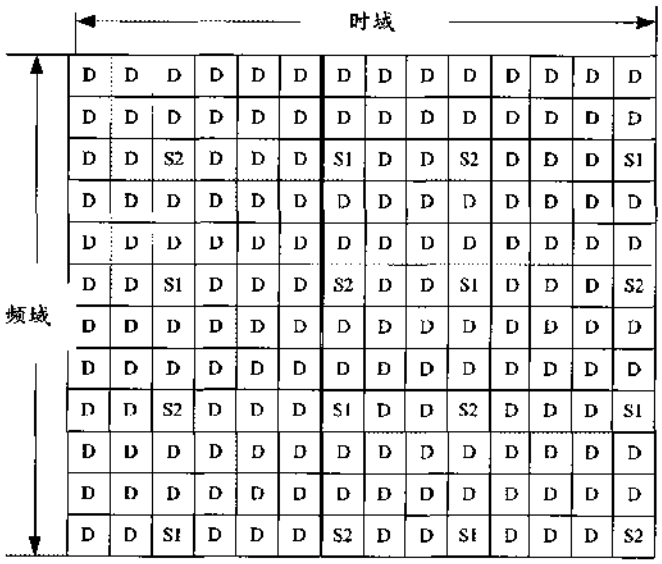


图 6（d）

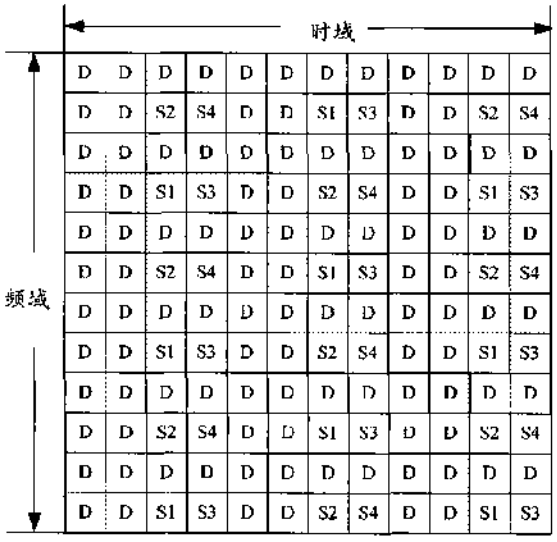


图 7（a）

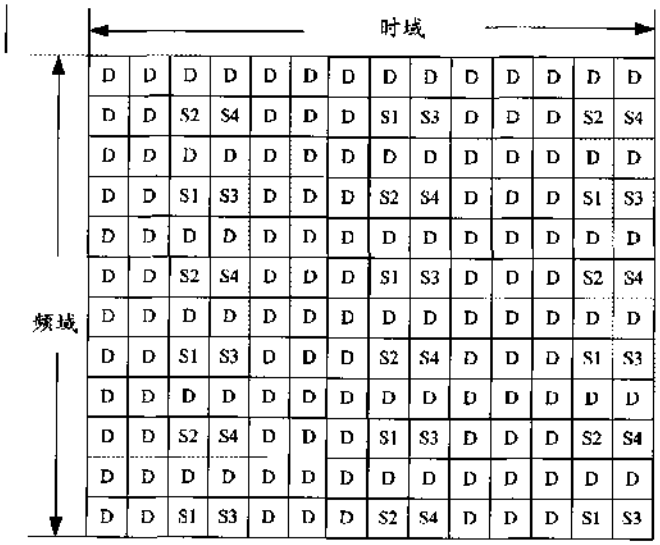

时域
频域
D D D D D D D D D D D D D D
D D S2 S4 D D D S1 S3 D D D S2 S4
D D D D D D D D D D D D D D
D D S1 S3 D D D S2 S4 D D D S1 S3
D D D D D D D D D D D D D D
D D S2 S4 D D D S1 S3 D D D S2 S4
D D D D D D D D D D D D D D
D D S1 S3 D D D S2 S4 D D D S1 S3
D D D D D D D D D D D D D D
D D S2 S4 D D D S1 S3 D D D S2 S4
D D D D D D D D D D D D D D
D D S1 S3 D D D S2 S4 D D D S1 S3

图 7（b）

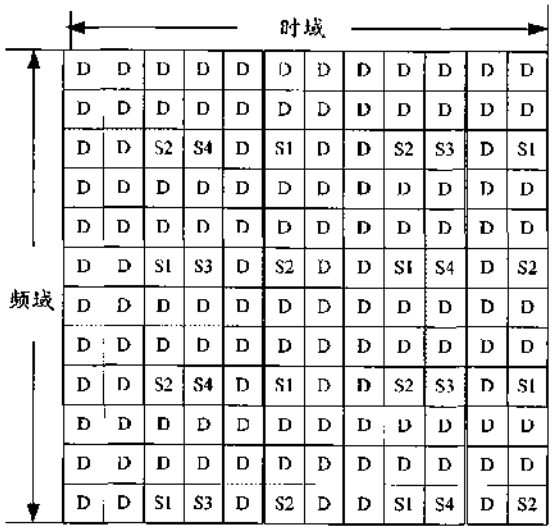

时域
频域
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S2 S4 D S1 D D S2 S3 D S1
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S1 S3 D S2 D D S1 S4 D S2
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S2 S4 D S1 D D S2 S3 D S1
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S1 S3 D S2 D D S1 S4 D S2

图 7（c）

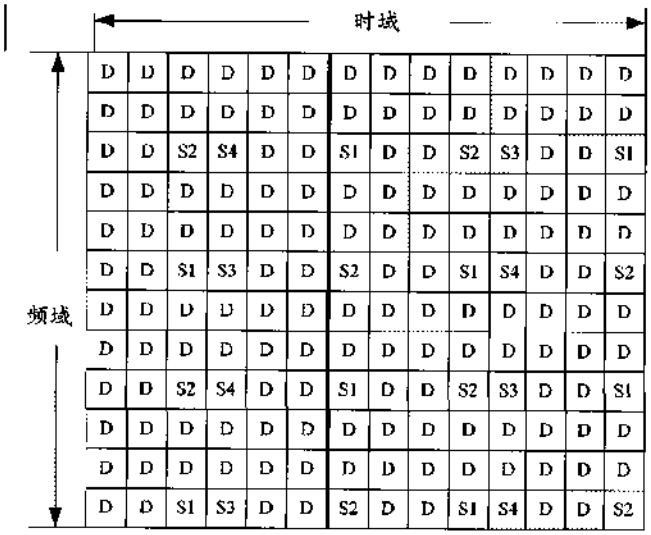

时域
频域
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S2 S4 D D S1 D D S2 S3 D D S1
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S1 S3 D D S2 D D S1 S4 D D S2
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S2 S4 D D S1 D D S2 S3 D D S1
D D D D D D D D D D D D D D
D D D D D D D D D D D D D D
D D S1 S3 D D S2 D D S1 S4 D D S2

图 7（d）

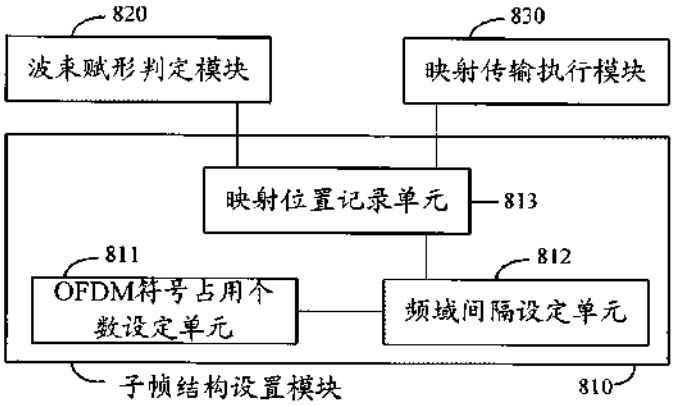

820
波束赋形判定模块
830
映射传输执行模块
映射位置记录单元
813
811
OFDM符号占用个数设定单元
812
频域间隔设定单元
子帧结构设置模块
810

图 8

Espacenet

CN105656607A LAA system communication method and device

Applicant: LONGEO COMMUNICATION TECHNOLOGY CO LTD

Inventors: ZHANG XIAOBO

Classifications:
IPC ***H04L5/00***

Priorities: CN201410635223A 2014-11-12

Applications: CN201410635223A 2014-11-12

Publication: CN105656607A 2016-06-08

Published as: CN105656607A;CN105656607B; CN105872980A

LAA system communication method and device

Abstract

The invention provides a license assisted access (LAA) system communication method and device. The LAA system communication method comprises a step 1 that user equipment (UE) receives a high-level signal to determine the following information: first information including frequency bands of K carriers, second information including physical resource occupied in a sub-frame by each of K reference signal (RS) resource groups, and third information including that an antenna port of a target wireless signal and the K RS resource groups are co-located, wherein the K represents a positive integer larger than 1, the K RS resource groups respectively belong to the K carriers in the frequency domain, and at least one of the K carriers is configured in an unlicensed spectrum; transmission carriers of the target wireless signal is configured in the unlicensed spectrum. According to the LAA system communication method, on the premise of not increasing downlink RS redundancy costs, channel estimation performances are effectively improved, so that LAA LTE after introduction of the LBT technology keeps the maximum forward compatibility.

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(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 5/00(2006.01)

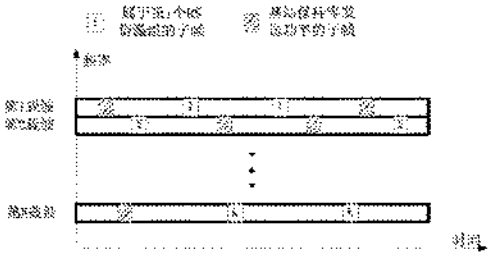
权利要求书2页 说明书7页 附图2页

(54)发明名称

一种LAA系统的通信方法和装置

(57)摘要

本发明提出了一种LAA系统的通信方法和装置。在步骤一中，UE接收高层信令确定以下信息：第一信息.K个载波的频带 第二信息.K个RS资源组中的每个RS资源组在子帧内占用的物理资源 第三信息.目标无线信号的天线端口和所述K个RS资源组是半共址的。其中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。本发明的方法在不增加下行RS冗余开销的前提下有效提高信道估计的性能，使得LBT技术引入后的LAA LTE保持最大的前向兼容性。



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1. 一种UE中的方法，其中，包括如下步骤：

- 步骤A. 接收高层信令确定以下信息：

- 第一信息. K个载波的频带

- 第二信息. K个RS资源组中的每个RS资源组在子帧内占用的物理资源

- 第三信息. 目标无线信号的天线端口和所述K个RS资源组是半共址的。

其中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

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B. 在所述K个RS资源组上的接收下行RS，确定用于传输所述目标无线信号的无线信道的大尺度特性

- 步骤C. 根据所述无线信道的大尺度特性接收所述目标无线信号。

3. 根据权利要求1-2所述的方法，其特征在于，第二信息包括K组子信息，所述K组子信息分别指示所述K个RS资源组在子帧内占用的物理资源，每组子信息包括以下之一：

-. CRS端口数和CRS频率偏移

-. CSI-RS端口数和CSI-RS配置。

4. 根据权利要求1-2所述的方法，其特征在于，所述K个RS资源组共享相同的第二信息，第二信息包括以下之一：

-. CRS端口数和CRS频率偏移

-. CSI-RS端口数和CSI-RS配置。

5. 根据权利要求1-4所述的方法，其特征在于，所述每个RS资源组在时域上实际占用的子帧由所述高层信令和物理层信令共同配置，或者仅由物理层信令配置。

6. 根据权利要求1-5所述的方法，其特征在于，所述目标无线信号在PDSCH上传输，第三信息由PDSCH-Config信息单元指示。

7. 一种基站中的方法，其中，包括如下步骤：

- 步骤A. 发送高层信令指示以下信息：

- 第一信息. K个载波的频带

- 第二信息. K个RS资源组中的每个RS资源组在子帧内占用的物理资源

- 第三信息. 目标无线信号的天线端口和所述K个RS资源组是半共址的。

其中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

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B. 在所述K个RS资源组上的发送下行RS

- 步骤C. 发送所述目标无线信号。

9. 根据权利要求7-8所述的方法，其特征在于，第二信息包括K组子信息，所述K组子信息分别指示所述K个RS资源组在子帧内占用的物理资源，每组子信息包括以下之一：

-. CRS端口数和CRS频率偏移

-. CSI-RS端口数和CSI-RS配置。

10. 根据权利要求 7-8 所述的方法，其特征在于，所述 K 个 RS 资源组共享相同的第二信息，第二信息包括以下之一：

-. CRS 端口数和 CRS 频率偏移

-. CSI-RS 端口数和 CSI-RS 配置。

11. 根据权利要求 7-10 所述的方法，其特征在于，所述每个 RS 资源组在时域上实际占用的子帧由所述高层信令和物理层信令共同配置，或者仅由物理层信令配置。

12. 根据权利要求 7-11 所述的方法，其特征在于，所述目标无线信号在 PDSCH 上传输，第三信息由 PDSCH-Config 信息单元指示。

13. 一种用户设备，其特征在于，该设备包括：

第一模块：用于接收高层信令确定以下信息：

- 第一信息. K 个载波的频带

- 第二信息. K 个 RS 资源组中的每个 RS 资源组在子帧内占用的物理资源

- 第三信息. 目标无线信号的天线端口和所述 K 个 RS 资源组是半共址的。

其中，所述 K 是大于 1 的正整数，所述 K 个 RS 资源组在频域上分别属于所述 K 个载波，所述 K 个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

14. 根据权利要求 13 所述的设备，其特征在于，第一模块还用于在所述 K 个 RS 资源组上的接收下行 RS 以及确定用于传输所述目标无线信号的无线信道的大尺度特性。第一模块还用于根据所述无线信道的大尺度特性接收所述目标无线信号。

15. 一种基站设备，其特征在于，该设备包括：

第一模块：用于发送高层信令指示以下信息：

- 第一信息. K 个载波的频带

- 第二信息. K 个 RS 资源组中的每个 RS 资源组在子帧内占用的物理资源

- 第三信息. 目标无线信号的天线端口和所述 K 个 RS 资源组是半共址的。

其中，所述 K 是大于 1 的正整数，所述 K 个 RS 资源组在频域上分别属于所述 K 个载波，所述 K 个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

16. 根据权利要求 15 所述的设备，其特征在于，第一模块还用于在所述 K 个 RS 资源组上的发送下行 RS。第一模块还用于发送所述目标无线信号。

一种 LAA 系统的通信方法和装置

技术领域

[0001] 本发明涉及无线通信系统中利用非授权频谱通信的方案，特别是涉及基于 LTE(Long Term Evolution，长期演进）的针对非授权频谱 (Unlicensed Spectrum) 的通信方法和装置。

背景技术

[0002] 传统的 3GPP(3rd Generation Partner Project，第三代合作伙伴项目）LTE 系统中，数据传输只能发生在授权频谱上，然而随着业务量的急剧增大，尤其在一些城市地区，授权频谱可能难以满足业务量的需求。3GPP RAN 的 62 次全会讨论了一个新的研究课题，即非授权频谱综合的研究 (RP-132085)，主要目的是研究利用在非授权频谱上的 LTE 的 Non-standalone（非独立）部署，所谓 Non-standalone 是指在非授权频谱上的通信要和授权频谱上的服务小区相关联。一个直观的方法是尽可能重用现有系统中的 CA(Carrier Aggregation，载波聚合）的概念，即部署在授权频谱上的服务小区作为 PCC(Primary Component Carrier，主载波），部署在非授权频谱上的服务小区作为 SCC(Secondary Component Carrier，辅载波）。对于非授权频谱，考虑到其干扰水平的不可控制 / 预测，LBT(Listen Before Talk，先侦听后发送）技术能够有效的避免 LTE 系统和其他系统间的干扰以及 LTE 系统内部不同运营商设备之间的干扰。在 RAN#64 次全会（研讨会）上，非授权频谱上的通信被统一命名为 LAA(License Assisted Access，授权频谱辅助接入）。

[0003] 对于 LTE LAA，一个需要考虑的问题是，（由于 LBT 技术的引入）传统的半静态方式调度的用于信道测量的下行 RS(Reference Signal，参考信号）可能在某些（不可预测的）调度子帧上无法发送。传统的 LTE 中，用于信道测量的下行 RS 还能辅助 UE(User Equipment，用户设备）进行基于 DMRS(Demodulation Reference Signal，解调参考信号）的信道估计，所述用于信道测量的下行 RS 包括 CRS(Cell RS，小区参考信号）和 CSI-RS(Channel Status Indicator RS，信道状态指示参考信号）。LTE LAA 中，所述用于信道测量的下行 RS 在部分子帧上的缺失可能严重影响 PDSCH(Physical Downl ink Shared Channel，物理下行共享信道）的接收性能。此外，如果较长时间在给定载波上无法接收下行 RS，UE(User Equipment，用户设备）可能会失去下行同步进而导致在给定载波上频繁的进行下行预同步操作。

[0004] 针对上述问题，本发明公开了一种 LAA 系统的通信方法和装置。

发明内容

[0005] 本发明公开了一种 UE 中的方法，其中，包括如下步骤：

[0006] - 步骤 A. 接收高层信令确定以下信息：

[0007] - 第一信息 . K 个载波的频带

[0008] - 第二信息 . K 个 RS 资源组中的每个 RS 资源组在子帧内占用的物理资源

[0009] - 第三信息 . 目标无线信号的天线端口和所述 K 个 RS 资源组是半共址的

(Co-located)。

[0010] 其中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0011] 作为一个实施例，所述高层信令是RRC(Radio Resource Control，无线资源控制)信令。作为一个实施例，所述物理资源包括{空域，时域，频域}资源。作为一个实施例，所述物理资源包括{空域，时域，频域，码域(Orthogonal Covering Code，正交覆盖码)}资源。

[0012] 上述空域是指RS天线端口。作为一个实施例，所述RS资源组包括由正整数个RS天线端口，每个RS天线端口占用一定的{时域，频域，码域}资源。两个天线端口是所述半共址的是指其中一个天线端口发送的无线信号所经历的信道的大尺度特性能从另一个天线端口发送的无线信号所经历的信道中推断得出，所述大尺度特性包括{延时扩展，多普勒扩展，多普勒频移，平均增益，平均延时}中的一种或者多种。具体的关于所述“半共址的”的描述参考TS36.211。

[0013] 作为一个实施例，所述目标无线信号在EPDCCH(Enhanced Physical Downlink Control Channel，增强的下行物理控制信道)上传输，第三信息由EPDCCH-Config IE(Information Element，信息单元)指示。作为一个实施例，所述目标无线信号在PDSCH上传输，第三信息由PDSCH-Config IE指示。作为一个实施例，所述K个载波都部署于非授权频谱。作为一个实施例，所述K个载波在频域上是连续的。

[0014] 连续的载波能确保较强的信道相关性，有利于跨载波估计大尺度特性。

[0015] 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：

[0016] -步骤B. 在所述K个RS资源组上的接收下行RS，确定用于传输所述目标无线信号的无线信道的大尺度特性

[0017] -步骤C. 根据所述无线信道的大尺度特性接收所述目标无线信号。

[0018] 作为一个实施例，所述UE在(和所述无线信道具备时间相关性的)给定时间窗内在所述K个RS资源组上接收下行RS，以确定所述无线信道的大尺度特性，所述给定时间窗是所述UE自行确定的。作为一个实施例，所述UE在(和所述无线信道具备频率相关性的)S个RS资源组上接收下行RS，以确定所述无线信道的大尺度特性，所述S个RS资源组是所述UE自行确定的，所述S个RS资源组是所述K个RS资源组的子集。

[0019] 具体的，根据本发明的一个方面，其特征在于，第二信息包括K组子信息，所述K组子信息分别指示所述K个RS资源组在子帧内占用的物理资源，每组子信息包括以下之一：

[0020] -.CRS端口数和CRS频率偏移

[0021] -.CSI-RS端口数和CSI-RS配置。

[0022] 如果第二信息包括CRS端口数和CRS频率信息，则相应的RS资源组在子帧内重用CRS的时频资源；如果第二信息包括CSI-RS端口数和CSI-RS配置，则相应的RS资源组在子帧内重用CSI-RS的时频资源。所述CRS端口数是{1,2,4}中的一个，所述CRS频率偏移是{0,1,2,3,4,5}中的一个。所述CSI-RS端口数是{1,2,4,8}中的一个，所述CSI-RS配置(Configuration)由resourceConfig IE指示，具体参考TS36.211中的表格6.10.5.2-1。

[0023] 作为一个实施例，第二信息还包括生成器索引，所述生成器索引是小于504的非

负整数。作为上述实施例的一个子实施例，所述生成器索引到所述CRS的RS序列生成器的初始值的映射关系重用N_{ID}^{cell}到所述CRS的RS序列生成器的初始值的映射关系（具体描述参考TS36.211的6.10.1.1节）。作为上述实施例的又一个子实施例，所述生成器索引到所述CSI-RS的RS序列生成器的初始值的映射关系重用N_{ID}^{CSI}到所述CSI-RS的RS序列生成器的初始值的映射关系（具体描述参考TS36.211的6.10.5.1节）。

[0024] 具体的，根据本发明的一个方面，其特征在于，所述K个RS资源组共享相同的第二信息，第二信息包括以下之一：

[0025] -.CRS端口数和CRS频率偏移

[0026] -.CSI-RS端口数和CSI-RS配置。

[0027] 上述方面的优点是节省了高层信令的开销，即所述K个RS资源组共享相同的子帧内配置（除了载波带宽可能不同）。此外，如果所述目标无线信号所属的HARQ(Hybrid Automatic Repeat Request，混合自动重传请求）进程(Process)包括在不同载波上PRBP(Physical Resource Block Pair，物理资源块对）时，上述方面有利于所述HARQ进程在不同载波上共享相同的TM(Transmission Mode，传输模式）。

[0028] 具体的，根据本发明的一个方面，其特征在于，所述每个RS资源组在时域上实际占用的子帧由所述高层信令和物理层信令共同配置，或者仅由物理层信令配置。

[0029] 作为一个实施例，对于所述每个RS资源组，实际占用的子帧包括所述高层信令指示的相应子帧集合中的全部或者部分子帧，所述全部或者部分子帧由物理层信令配置或者由UE自行确定。作为一个实施例，对于所述每个RS资源组，实际占用的子帧包括位于所述高层信令指示的相应子帧集合之外的且由物理层信令指示的子帧。作为所述自行确定的一个实施例，UE根据接收功率或者信道统计特征等参数确定。

[0030] 具体的，根据本发明的一个方面，其特征在于，所述目标无线信号在PDSCH上传输，第三信息由PDSCH-Config IE指示。

[0031] 作为一个实施例，对于给定子帧，所述目标无线信号在所述K个载波中的一个载波上传输，对于多个子帧，所述目标无线信号能在所述K个载波中的多个载波上传输。

[0032] 本发明公开了一种基站中的方法，其中，包括如下步骤：

[0033] -步骤A. 发送高层信令指示以下信息：

[0034] -第一信息.K个载波的频带

[0035] -第二信息.K个RS资源组中的每个RS资源组在子帧内占用的物理资源

[0036] -第三信息.目标无线信号的天线端口和所述K个RS资源组是半共址的。

[0037] 其中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0038] 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：

[0039] -步骤B. 在所述K个RS资源组上的发送下行RS

[0040] -步骤C. 发送所述目标无线信号。

[0041] 具体的，根据本发明的一个方面，其特征在于，第二信息包括K组子信息，所述K组子信息分别指示所述K个RS资源组在子帧内占用的物理资源，每组子信息包括以下之一：

[0042] -. CRS 端口数和 CRS 频率偏移

[0043] -. CSI-RS 端口数和 CSI-RS 配置。

[0044] 具体的，根据本发明的一个方面，其特征在于，所述 K 个 RS 资源组共享相同的第二信息，第二信息包括以下之一：

[0045] -. CRS 端口数和 CRS 频率偏移

[0046] -. CSI-RS 端口数和 CSI-RS 配置。

[0047] 具体的，根据本发明的一个方面，其特征在于，所述每个 RS 资源组在时域上实际占用的子帧由所述高层信令和物理层信令共同配置，或者仅由物理层信令配置。

[0048] 具体的，根据本发明的一个方面，其特征在于，所述目标无线信号在 PDSCH 上传输，第三信息由 PDSCH-Config IE 指示。

[0049] 本发明公开了一种用户设备，其特征在于，该设备包括：

[0050] 第一模块：用于接收高层信令确定以下信息：

[0051] - 第一信息. K 个载波的频带

[0052] - 第二信息. K 个 RS 资源组中的每个 RS 资源组在子帧内占用的物理资源

[0053] - 第三信息. 目标无线信号的天线端口和所述 K 个 RS 资源组是半共址的。

[0054] 其中，所述 K 是大于 1 的正整数，所述 K 个 RS 资源组在频域上分别属于所述 K 个载波，所述 K 个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0055] 作为一个实施例，第一模块还用于在所述 K 个 RS 资源组上的接收下行 RS 以及确定用于传输所述目标无线信号的无线信道的大尺度特性。第一模块还用于根据所述无线信道的大尺度特性接收所述目标无线信号。

[0056] 本发明公开了一种基站设备，其特征在于，该设备包括：

[0057] 第一模块：用于发送高层信令指示以下信息：

[0058] - 第一信息. K 个载波的频带

[0059] - 第二信息. K 个 RS 资源组中的每个 RS 资源组在子帧内占用的物理资源

[0060] - 第三信息. 目标无线信号的天线端口和所述 K 个 RS 资源组是半共址的。

[0061] 其中，所述 K 是大于 1 的正整数，所述 K 个 RS 资源组在频域上分别属于所述 K 个载波，所述 K 个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0062] 作为一个实施例，第一模块还用于在所述 K 个 RS 资源组上的发送下行 RS。第一模块还用于发送所述目标无线信号。

[0063] LBT 技术的采用可能会导致 LAA 载波上半静态配置的用于信道测量的下行 RS 在某些子帧无法发送，针对这一问题，本发明的方法使得 UE 利用多个载波上的下行 RS 的“半共址的”这一特性获得针对目标无线信号的传输信道的大尺度特性，利用大尺度特性，再结合所述目标无线信号上的 DMRS 估计小尺度特性，在不增加下行 RS 冗余开销的前提下有效提高信道估计的性能。本发明使得 LBT 技术引入后的 LAA LTE 保持最大的前向兼容性。

附图说明

[0064] 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：

[0065] 图1示出了根据本发明的一个实施例的在LAA载波上进行下行传输的流程图；

[0066] 图2示出了根据本发明的一个实施例的K个RS资源组的子帧分布图；

[0067] 图3示出了根据本发明的一个实施例的UE中的处理装置的结构框图；

[0068] 图4示出了根据本发明的一个实施例的基站中的处理装置的结构框图；

具体实施方式

[0069] 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，本申请的实施例和实施例中的特征可以任意相互组合。

[0070] 实施例1

[0071] 实施例1示例了在LAA载波上进行下行传输的流程图，如附图1所示。附图1中，基站N1维护UE U2的服务小区。

[0072] 对于基站N1，在步骤S11中发送高层信令指示以下信息：

[0073] -第一信息.K个载波的频带

[0074] -第二信息.K个RS资源组中的每个RS资源组在子帧内占用的物理资源

[0075] -第三信息.目标无线信号的天线端口和所述K个RS资源组是半共址的。

[0076] 在步骤S12中在所述K个RS资源组上的发送下行RS。在步骤S13中发送所述目标无线信号。

[0077] 对于UE U2，在步骤S21中接收高层信令确定第一信息，第二信息和第三信息。在步骤S22中在所述K个RS资源组上的接收下行RS，确定用于传输所述目标无线信号的无线信道的大尺度特性。在步骤S23中根据所述无线信道的大尺度特性接收所述目标无线信号。

[0078] 实施例1中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0079] 作为实施例1的子实施例1，第二信息包括K组子信息，所述K组子信息分别指示所述K个RS资源组在子帧内占用的物理资源，每组子信息包括以CSI-RS端口数和CSI-RS配置。

[0080] 作为实施例1的子实施例2，在步骤S22中，UE U2首先对所述K个RS资源组中每一个RS资源组中的正整数个RS端口进行信道估计，确定相应载波的大尺度特性，然后对K个载波上的大尺度特性执行线形平均，获得所述无线信道的大尺度特性。

[0081] 作为实施例1的子实施例3，所述K个RS资源组共享相同的第二信息，第二信息包括以下之一：

[0082] -.CRS端口数和CRS频率偏移

[0083] -.CSI-RS端口数和CSI-RS配置。

[0084] 实施例2

[0085] 实施例2示例了K个RS资源组的子帧分布图，如附图2所示。附图2中，一个小方格表示一个子帧，其中标识数字i的小方格表示第i个RS资源组(i从1到K)的子帧，斜线标识的小方格是基站保持零发送功率的子帧。

[0086] 基站首先发送高层信令指示以下信息：

[0087] -第一信息，K个载波的频带（附图2中的第1载波～第K载波）

[0088] -第二信息，K个RS资源组（第1个RS资源组～第K个RS资源组）中的每个RS资源组在子帧内占用的物理资源

[0089] -第三信息，目标无线信号的天线端口和所述K个RS资源组是半共址的。

[0090] 然后在所述K个RS资源组上（如附图2中标识数字i的小方格所示）的发送下行RS，然后发送所述目标无线信号。

[0091] 实施例2中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0092] 实施例2中，所述高层信令还指示所述K个RS资源组在时域上周期性发送的子帧（每个RS资源组的周期性发送子帧如附图2中相应载波上的小方格所示-包括标识数字的小方格和斜线标识的小方格）。所述基站执行LBT操作确定所述周期性发送子帧中的部分子帧用于实际发送，而在其他子帧上保持零发送功率（即不发送下行RS）。所述基站发送物理层信令指示所述部分子帧。

[0093] 作为实施例2的子实施例1，所述目标无线信号在PDSCH上传输，第三信息由PDSCH-Config信息单元指示。

[0094] 作为实施例2的子实施例2，所述K个载波在频域上是连续的。

[0095] 作为实施例2的子实施例3，所述基站在给定载波的给定子帧（属于RS周期性发送子帧）上保持零发送功率时，UE能够利用其他载波上的在所述给定子帧或者所述给定子帧附近发送的下行RS补偿所述目标无线信号所经历的无线信道的大尺度特性，避免信道估计性能的显著下降。

[0096] 实施例3

[0097] 实施例3示例了UE中的处理装置的结构框图，如附图3所示。附图3中，UE处理装置200由接收模块201组成。

[0098] 接收模块201用于接收高层信令确定以下信息：

[0099] -第一信息，K个载波的频带

[0100] 第二信息，K个RS资源组中的每个RS资源组在子帧内占用的物理资源

[0101] -第三信息，目标无线信号的天线端口和所述K个RS资源组是半共址的。

[0102] 实施例3中，所述K是大于1的正整数，所述K个RS资源组在频域上分别属于所述K个载波，所述K个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0103] 作为实施例3的子实施例1，接收模块201还用于在所述K个RS资源组上的接收下行RS，确定用于传输所述目标无线信号的无线信道的大尺度特性；以及用于根据所述无线信道的大尺度特性接收所述目标无线信号。

[0104] 作为实施例3的子实施例2，所述目标无线信号在PDSCH上传输或者在EPDCCH上传输。

[0105] 作为实施例3的子实施例3，所述目标无线信号在所述K个载波中的任意一个载波上传输。

[0106] 实施例 4

[0107] 实施例 4 示例了基站中的处理装置的结构框图，如附图 4 所示。附图 4 中，基站处理装置 400 由发送模块 401 组成。

[0108] 发送模块 401 用于发送高层信令指示以下信息：

[0109] - 第一信息，K 个载波的频带

[0110] - 第二信息，K 个 RS 资源组中的每个 RS 资源组在子帧内占用的物理资源

[0111] - 第三信息，目标无线信号的天线端口和所述 K 个 RS 资源组是半共址的。

[0112] 实施例 4 中，所述 K 是大于 1 的正整数，所述 K 个 RS 资源组在频域上分别属于所述 K 个载波，所述 K 个载波中至少有一个载波部署于非授权频谱。所述目标无线信号的传输载波部署于非授权频谱。

[0113] 作为实施例 4 的子实施例 1，发送模块 401 还用于在所述 K 个 RS 资源组上的发送下行 RS，以及用于发送所述目标无线信号。

[0114] 作为实施例 4 的子实施例 2，所述 K 个载波都部署于非授权频谱，所述目标无线信号在所述 K 个载波中的任意一个载波上传输。

[0115] 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。

[0116] 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。

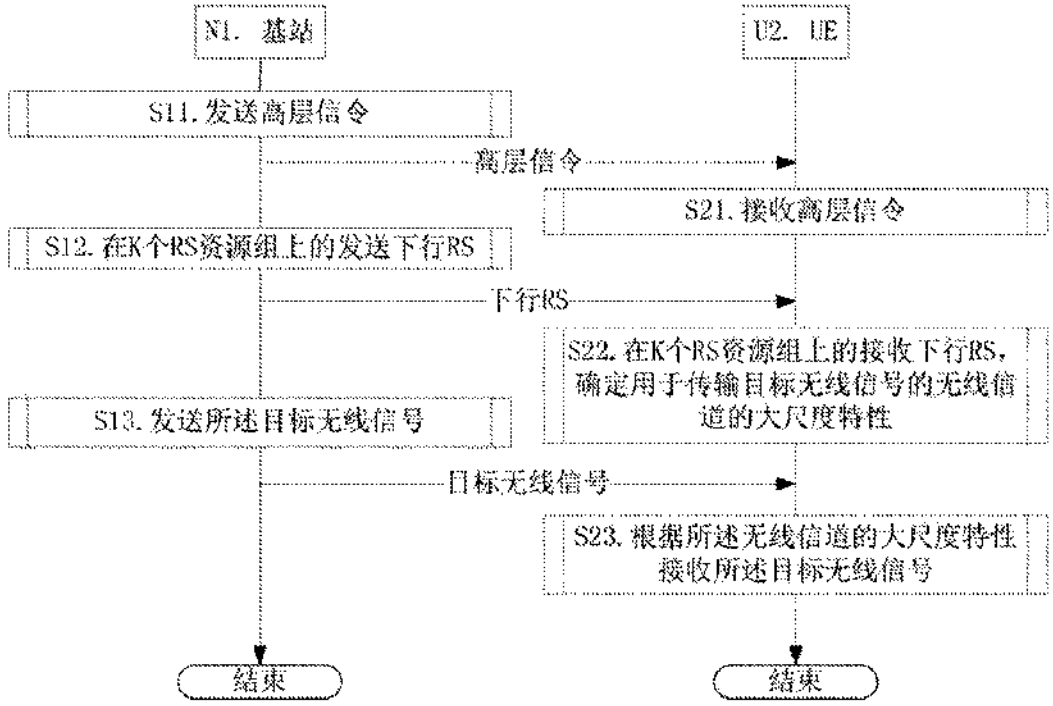

N1. 基站
U2. UE
S11. 发送高层信令
高层信令
S21. 接收高层信令
S12. 在K个RS资源组上的发送下行RS
下行RS
S22. 在K个RS资源组上的接收下行RS，确定用于传输目标无线信号的无线信道的大尺度特性
S13. 发送所述目标无线信号
目标无线信号
S23. 根据所述无线信道的大尺度特性接收所述目标无线信号
结束
结束

图 1

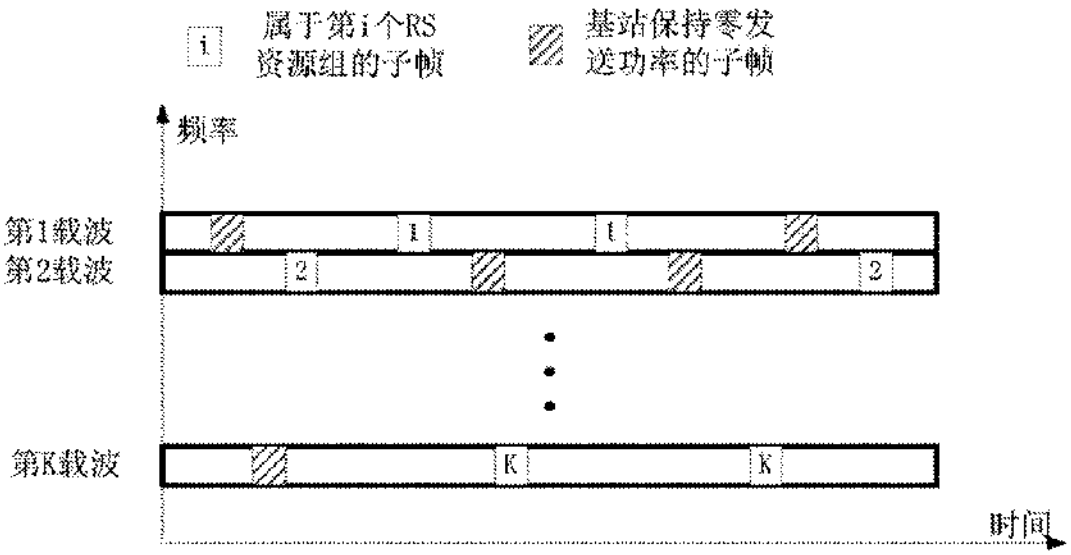

i
属于第i个RS资源组的子帧
基站保持零发送功率的子帧
频率
第1载波
第2载波
第K载波
1
1
2
2
K
K
时间

图 2

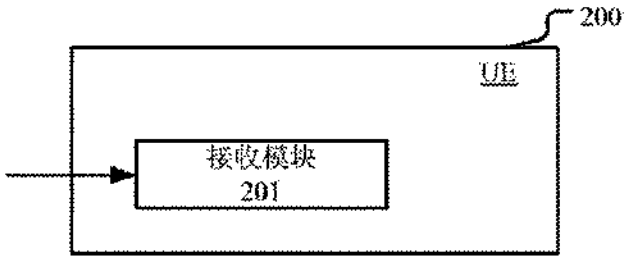


图 3

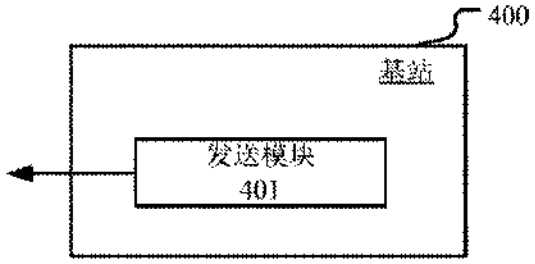


图 4

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(71) Applicant: **INTERDIGITAL PATENT HOLDINGS, INC.** [US/US]; 200 Bellevue Parkway, Suite 300, Wilmington, DE 19809 (US).

(72) Inventors: **LEE, Moon-il**; 104 Rivendell Court, Melville, NY 11747 (US). **HAGHIGHAT, Afshin**; 407 Heron-Vert, Ile-Bizard, QC H9C 3A7 (CA). **JIANG, Mellong**; 11 Pond View Drive, Plainsboro, NJ 08536 (US). **STERN-BERKOWITZ, Janet, A.**; 41-20 Glenwood Street, Little Neck, NY 11363 (US).

(74) Agents: **ROCCIA, Vincent, J.** et al.; Condo Roccia Koptiw LLP, 1800 JFK Blvd., Suite 1700, Philadelphia, PA 19103 (US).

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(54) **Title**: ANTENNA VIRTUALIZATION IN TWO-DIMENSIONAL ANTENNA ARRAY

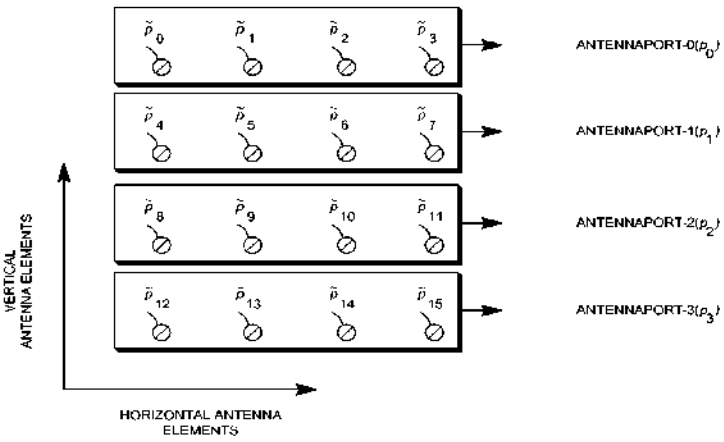


FIG. 15

(57) **Abstract**: Systems, methods, and instrumentalities are disclosed for antenna virtualization, e.g., in at least a two-dimensional antenna array. N_E physical antenna elements may be virtualized to Np logical antenna ports. A virtualization may be WTRU-specific, which may optimize MIMO performance. A simplified MIMO scheme may be used with reduction in feedback, reference signal, and/or control signaling overhead. Antenna virtualization schemes may utilize channel characteristics. Antenna virtualization may be defined, for example, based on antenna port to antenna element mapping, based on a measurement reference signal, based on a codebook or a codebook subset or based on an antenna virtualization matrix. One or more antenna virtualization schemes may be configured in a cell. Antenna virtualization schemes may be configured in a WTRU-specific manner, perhaps for example based on a WTRU channel characteristic(s). A WTRU may report one or more useful (e.g., optimized) antenna virtualization schemes, e.g., based on one or more measurements.

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ANTENNA VIRTUALIZATION IN TWO-DIMENSIONAL ANTENNA ARRAY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/080,008, filed on November 14, 2014, the entire contents of which are hereby incorporated by reference as if fully set-forth herein, for all purposes.

BACKGROUND

[0002] Antenna virtualization may permit resource allocation and/or configuration. However, some antenna virtualization techniques may lead to suboptimal performance.

SUMMARY

[0003] Systems, methods, and instrumentalities are disclosed for antenna virtualization in at least a two-dimensional antenna array. N_E physical antenna elements may be virtualized to N_P logical antenna ports. A virtualization may be wireless transmit/receive unit (WTRU) specific (a WTRU may in some embodiments be referred to as a User Equipment (UE), e.g., UE-specific), which may optimize MIMO performance. A (e.g., simplified) MIMO scheme may be used with reduction in feedback, reference signal, and/or control signaling overhead. Antenna virtualization schemes may utilize one or more channel characteristics. Antenna virtualization may be defined, for example, based on antenna port to antenna element mapping, based on a measurement reference signal, based on a codebook or a codebook subset, and/or based on an antenna virtualization matrix. One or more, or multiple, antenna virtualization schemes may be configured in a cell. Antenna virtualization schemes may be configured in a WTRU-specific manner, perhaps for example based on one or more WTRU channel characteristics. A WTRU may report a useful (e.g., relatively best optimized) antenna virtualization scheme, e.g., based on a measurement.

[0004] One or more techniques may be performed by a wireless transmit/receive unit (WTRU). Techniques may include receiving, via a receiver, at least one downlink (DL) reference signal. Techniques may include determining, via a processor, perhaps for example

based on the DL reference signal, at least one antenna virtualization matrix of a plurality of antenna virtualization matrices. Techniques may include determining, via the processor, a codebook, perhaps for example based on the at least one antenna virtualization matrix. Techniques may include transforming a first two-dimensional (2D), or more, antenna array into a second 2D, or more, antenna array using the at least one antenna virtualization matrix. The second 2D, or more, array being smaller than the first 2D, or more, array. Techniques may include transmitting, via a transmitter, feedback to an evolved-node B (eNB), perhaps for example using at least a part of the codebook.

[0005] One or more wireless transmit/receive units (WTRU) may be configured to perform one or more techniques. A WTRU may comprise a receiver. The receiver may be configured to receive at least one downlink (DL) reference signal. The WTRU may comprise a processor. The processor may be configured at least to determine, perhaps for example based on the DL reference signal, at least one antenna virtualization matrix of a plurality of antenna virtualization matrices. The processor may be configured to determine a codebook, perhaps for example based on the at least one antenna virtualization matrix. The processor may be configured to transform a first at least two-dimensional (2D) antenna array into a second at least 2D antenna array, perhaps for example using the at least one antenna virtualization matrix. The second at least 2D array may be smaller than the first at least 2D array. The WTRU may comprise a transmitter. The transmitter may be configured at least to send feedback to an evolved-node B (eNB), perhaps for example using at least a part of the codebook.

[0006] One or more evolved-Node Bs (eNBs) may be configured to perform one or more techniques. An eNB may comprise a transmitter. The transmitter may be configured to at least send at least one downlink (DL) reference signal to a wireless transmit/receive unit (WTRU). The transmitter may be configured to send a plurality of antenna virtualization matrices to the WTRU. The eNB may comprise a receiver. The receiver may be configured to at least receive an indication of at least one antenna virtualization matrix of the plurality of antenna virtualization matrices. The receiver may be configured to receive feedback from the WTRU. The feedback may be sent using at least a part of the codebook corresponding to the at least one antenna virtualization matrix. The eNB may comprise a processor. The processor may be configured at least to determine to send to the WTRU a confirmation of the at least one antenna virtualization matrix, and/or an indication of another antenna virtualization matrix of the plurality of virtualization matrices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] A more detailed understanding may be had from the following description, given by way of example in conjunction with the accompanying drawings.

[0008] FIG. 1A is a system diagram of an example communications system in which one or more disclosed embodiments may be implemented.

[0009] FIG. 1B is a system diagram of an example wireless transmit/receive unit (WTRU) that may be used within the communications system illustrated in FIG. 1A.

[0010] FIG. 1C is a system diagram of an example radio access network and an example core network that may be used within the communications system illustrated in FIG. 1A.

[0011] FIG. 1D is a system diagram an example radio access network and another example core network that may be used within the communications system illustrated in FIG. 1A.

[0012] FIG. 1E is a system diagram an example radio access network and another example core network that may be used within the communications system illustrated in FIG. 1A.

[0013] FIG. 2 is an example of a 2D antenna array with co-polarized antenna elements.

[0014] FIG. 3 is an example of a 2D antenna array with cross-polarized antenna elements.

[0015] FIG. 4 is an example of elevation beamforming.

[0016] FIG. 5 is an example of vertical sectorization.

[0017] FIG. 6 is an example of antenna elements in a 2D antenna array.

[0018] FIG. 7 is an example of WTRU-specific precoded demodulation reference signal.

[0019] FIG. 8 is an example of a non-precoded cell-specific reference signal.

[0020] FIG. 9 is an example of a WTRU-specific demodulation reference signal for normal cyclic prefix.

[0021] FIG. 10 is an example of a cell-specific reference signal structure according to one or more antenna ports.

[0022] FIG. 11 is an example of a demodulation reference signal pattern supporting up to eight layers.

[0023] FIG. 12 is an example of channel state information reference signal pattern reuse according to one or more ports.

[0024] FIG. 13 is an example of codebook-based precoding with feedback information.

[0025] FIG. 14 is an example of periodic reporting.

[0026] FIG. 15 is an example of antenna port to antenna element mapping.

[0027] FIG. 16 is an example of an antenna virtualization matrix.

[0028] FIG. 17 is an example of multiple types of antenna virtualization.

DETAILED DESCRIPTION

[0029] A detailed description of illustrative embodiments will now be described with reference to the various Figures. Although this description provides a detailed example of possible implementations, it should be noted that the details are intended to be examples and in no way limit the scope of the application. As used herein, the articles "a" and "an", absent further qualification or characterization, may be understood to mean "one or more" or "at least one", for example.

[0030] FIG. 1A is a diagram of an example communications system 100 in which one or more disclosed embodiments may be implemented. The communications system 100 may be a multiple access system that provides content, such as voice, data, video, messaging, broadcast, etc., to multiple wireless users. The communications system 100 may enable multiple wireless users to access such content through the sharing of system resources, including wireless bandwidth. For example, the communications system 100 may employ one or more channel access methods, such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), single-carrier FDMA (SC-FDMA), and the like.

[0031] As shown in FIG. 1A, the communications system 100 may include wireless transmit/receive units (WTRUs), e.g., UEs, 102a, 102b, 102c, and/or 102d (which generally or collectively may be referred to as WTRU 102), a radio access network (RAN) 103/104/105, a core network 106/107/109, a public switched telephone network (PSTN) 108, the Internet 110, and other networks 112, though it will be appreciated that the disclosed embodiments contemplate any number of WTRUs, base stations, networks, and/or network elements. Each of the WTRUs 102a, 102b, 102c, 102d may be any type of device configured to operate and/or communicate in a wireless environment. By way of example, the WTRUs 102a, 102b, 102c, 102d may be configured to transmit and/or receive wireless signals and may include user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a smartphone, a laptop, a netbook, a personal computer, a wireless sensor, consumer electronics, and the like.

[0032] The communications system 100 may also include a base station 114a and a base station 114b. Each of the base stations 114a, 114b may be any type of device configured to wirelessly interface with at least one of the WTRUs 102a, 102b, 102c, 102d to facilitate access to one or more communication networks, such as the core network 106/107/109, the Internet 110,

and/or the networks 112. By way of example, the base stations 114a, 114b may be a base transceiver station (BTS), a Node-B, an eNode B, a Home Node B, a Home eNode B, a site controller, an access point (AP), a wireless router, and the like. While the base stations 114a, 114b are each depicted as a single element, it will be appreciated that the base stations 114a, 114b may include any number of interconnected base stations and/or network elements.

[0033] The base station 114a may be part of the RAN 103/104/105, which may also include other base stations and/or network elements (not shown), such as a base station controller (BSC), a radio network controller (RNC), relay nodes, etc. The base station 114a and/or the base station 114b may be configured to transmit and/or receive wireless signals within a particular geographic region, which may be referred to as a cell (not shown). The cell may further be divided into cell sectors. For example, the cell associated with the base station 114a may be divided into three sectors. Thus, in some embodiments, the base station 114a may include three transceivers, e.g., one for each sector of the cell. In another embodiment, the base station 114a may employ multiple-input multiple output (MIMO) technology and, therefore, may utilize multiple transceivers for each sector of the cell.

[0034] The base stations 114a, 114b may communicate with one or more of the WTRUs 102a, 102b, 102c, 102d over an air interface 115/116/117, which may be any suitable wireless communication link (e.g., radio frequency (RF), microwave, infrared (IR), ultraviolet (UV), visible light, etc.). The air interface 115/116/117 may be established using any suitable radio access technology (RAT).

[0035] More specifically, as noted above, the communications system 100 may be a multiple access system and may employ one or more channel access schemes, such as CDMA, TDMA, FDMA, OFDMA, SC-FDMA, and the like. For example, the base station 114a in the RAN 103/104/105 and the WTRUs 102a, 102b, 102c may implement a radio technology such as Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (UTRA), which may establish the air interface 115/116/117 using wideband CDMA (WCDMA). WCDMA may include communication protocols such as High-Speed Packet Access (HSPA) and/or Evolved HSPA (HSPA+). HSPA may include High-Speed Downlink Packet Access (HSDPA) and/or High-Speed Uplink Packet Access (HSUPA).

[0036] In another embodiment, the base station 114a and the WTRUs 102a, 102b, 102c may implement a radio technology such as Evolved UMTS Terrestrial Radio Access (E-UTRA), which may establish the air interface 115/116/117 using Long Term Evolution (LTE) and/or LTE-Advanced (LTE-A).

[0037] In other embodiments, the base station 114a and the WTRUs 102a, 102b, 102c may implement radio technologies such as IEEE 802.16 (e.g., Worldwide Interoperability for Microwave Access (WiMAX)), CDMA2000, CDMA2000 1X, CDMA2000 EV-DO, Interim Standard 2000 (IS-2000), Interim Standard 95 (IS-95), Interim Standard 856 (IS-856), Global System for Mobile communications (GSM), Enhanced Data rates for GSM Evolution (EDGE), GSM EDGE (GERAN), and the like.

[0038] The base station 114b in FIG. 1A may be a wireless router, Home Node B, Home eNode B, or access point, for example, and may utilize any suitable RAT for facilitating wireless connectivity in a localized area, such as a place of business, a home, a vehicle, a campus, and the like. In some embodiments, the base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.11 to establish a wireless local area network (WLAN). In another embodiment, the base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.15 to establish a wireless personal area network (WPAN). In yet another embodiment, the base station 114b and the WTRUs 102c, 102d may utilize a cellular-based RAT (e.g., WCDMA, CDMA2000, GSM, LTE, LTE-A, etc.) to establish a picocell or femtocell. As shown in FIG. 1A, the base station 114b may have a direct connection to the Internet 110. Thus, the base station 114b may not be required to access the Internet 110 via the core network 106/107/109.

[0039] The RAN 103/104/105 may be in communication with the core network 106/107/109, which may be any type of network configured to provide voice, data, applications, and/or voice over internet protocol (VoIP) services to one or more of the WTRUs 102a, 102b, 102c, 102d. For example, the core network 106/107/109 may provide call control, billing services, mobile location-based services, pre-paid calling, Internet connectivity, video distribution, etc., and/or perform high-level security functions, such as user authentication. Although not shown in FIG. 1A, it will be appreciated that the RAN 103/104/105 and/or the core network 106/107/109 may be in direct or indirect communication with other RANs that employ the same RAT as the RAN 103/104/105 or a different RAT. For example, in addition to being connected to the RAN 103/104/105, which may be utilizing an E-UTRA radio technology, the core network 106/107/109 may also be in communication with another RAN (not shown) employing a GSM radio technology.

[0040] The core network 106/107/109 may also serve as a gateway for the WTRUs 102a, 102b, 102c, 102d to access the PSTN 108, the Internet 110, and/or other networks 112. The PSTN 108 may include circuit-switched telephone networks that provide plain old telephone service (POTS). The Internet 110 may include a global system of interconnected computer

networks and devices that use common communication protocols, such as the transmission control protocol (TCP), user datagram protocol (UDP) and the internet protocol (IP) in the TCP/IP internet protocol suite. The networks 112 may include wired or wireless communications networks owned and/or operated by other service providers. For example, the networks 112 may include another core network connected to one or more RANs, which may employ the same RAT as the RAN 103/104/105 or a different RAT.

[0041] Some or all of the WTRUs 102a, 102b, 102c, 102d in the communications system 100 may include multi-mode capabilities, e.g., the WTRUs 102a, 102b, 102c, 102d may include multiple transceivers for communicating with different wireless networks over different wireless links. For example, the WTRU 102c shown in FIG. 1A may be configured to communicate with the base station 114a, which may employ a cellular-based radio technology, and with the base station 114b, which may employ an IEEE 802 radio technology.

[0042] FIG. 1B is a system diagram of an example WTRU 102. As shown in FIG. 1B, the WTRU 102 may include a processor 118, a transceiver 120, a transmit/receive element 122, a speaker/microphone 124, a keypad 126, a display/touchpad 128, non-removable memory 130, removable memory 132, a power source 134, a global positioning system (GPS) chipset 136, and other peripherals 138. It will be appreciated that the WTRU 102 may include any sub-combination of the foregoing elements while remaining consistent with an embodiment. Also, embodiments contemplate that the base stations 114a and 114b, and/or the nodes that base stations 114a and 114b may represent, such as but not limited to transceiver station (BTS), a Node-B, a site controller, an access point (AP), a home node-B, an evolved home node-B (eNodeB), a home evolved node-B (HeNB or HeNodeB), a home evolved node-B gateway, and proxy nodes, among others, may include some or all of the elements depicted in FIG. 1B and described herein.

[0043] The processor 118 may be a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Array (FPGAs) circuits, any other type of integrated circuit (IC), a state machine, and the like. The processor 118 may perform signal coding, data processing, power control, input/output processing, and/or any other functionality that enables the WTRU 102 to operate in a wireless environment. The processor 118 may be coupled to the transceiver 120, which may be coupled to the transmit/receive element 122. While FIG. 1B depicts the processor 118 and the transceiver 120

as separate components, it will be appreciated that the processor 118 and the transceiver 120 may be integrated together in an electronic package or chip.

[0044] The transmit/receive element 122 may be configured to transmit signals to, or receive signals from, a base station (e.g., the base station 114a) over the air interface 115/116/117. For example, in some embodiments, the transmit/receive element 122 may be an antenna configured to transmit and/or receive RF signals. In another embodiment, the transmit/receive element 122 may be an emitter/detector configured to transmit and/or receive IR, UV, or visible light signals, for example. In yet another embodiment, the transmit/receive element 122 may be configured to transmit and receive both RF and light signals. It will be appreciated that the transmit/receive element 122 may be configured to transmit and/or receive any combination of wireless signals.

[0045] In addition, although the transmit/receive element 122 is depicted in FIG. 1B as a single element, the WTRU 102 may include any number of transmit/receive elements 122. More specifically, the WTRU 102 may employ MIMO technology. Thus, in some embodiments, the WTRU 102 may include two or more transmit/receive elements 122 (e.g., multiple antennas) for transmitting and receiving wireless signals over the air interface 115/116/117.

[0046] The transceiver 120 may be configured to modulate the signals that are to be transmitted by the transmit/receive element 122 and to demodulate the signals that are received by the transmit/receive element 122. As noted above, the WTRU 102 may have multi-mode capabilities. Thus, the transceiver 120 may include multiple transceivers for enabling the WTRU 102 to communicate via multiple RATs, such as UTRA and IEEE 802.11, for example.

[0047] The processor 118 of the WTRU 102 may be coupled to, and may receive user input data from, the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128 (e.g., a liquid crystal display (LCD) display unit or organic light-emitting diode (OLED) display unit). The processor 118 may also output user data to the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128. In addition, the processor 118 may access information from, and store data in, any type of suitable memory, such as the non-removable memory 130 and/or the removable memory 132. The non-removable memory 130 may include random-access memory (RAM), read-only memory (ROM), a hard disk, or any other type of memory storage device. The removable memory 132 may include a subscriber identity module (SIM) card, a memory stick, a secure digital (SD) memory card, and the like. In other embodiments, the processor 118 may access information from, and store data in, memory that is not physically located on the WTRU 102, such as on a server or a home computer (not shown).

[0048] The processor 118 may receive power from the power source 134, and may be configured to distribute and/or control the power to the other components in the WTRU 102. The

power source 134 may be any suitable device for powering the WTRU 102. For example, the power source 134 may include one or more dry cell batteries (e.g., nickel-cadmium (NiCd), nickel-zinc (NiZn), nickel metal hydride (NiMH), lithium-ion (Li-ion), etc.), solar cells, fuel cells, and the like.

[0049] The processor 118 may also be coupled to the GPS chipset 136, which may be configured to provide location information (e.g., longitude and latitude) regarding the current location of the WTRU 102. In addition to, or in lieu of, the information from the GPS chipset 136, the WTRU 102 may receive location information over the air interface 115/116/117 from a base station (e.g., base stations 114a, 114b) and/or determine its location based on the timing of the signals being received from two or more nearby base stations. It will be appreciated that the WTRU 102 may acquire location information by way of any suitable location-determination implementation while remaining consistent with an embodiment.

[0050] The processor 118 may further be coupled to other peripherals 138, which may include one or more software and/or hardware modules that provide additional features, functionality and/or wired or wireless connectivity. For example, the peripherals 138 may include an accelerometer, an e-compass, a satellite transceiver, a digital camera (for photographs or video), a universal serial bus (USB) port, a vibration device, a television transceiver, a hands free headset, a Bluetooth® module, a frequency modulated (FM) radio unit, a digital music player, a media player, a video game player module, an Internet browser, and the like.

[0051] FIG. 1C is a system diagram of the RAN 103 and the core network 106 according to an embodiment. As noted above, the RAN 103 may employ a UTRA radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 115. The RAN 103 may also be in communication with the core network 106. As shown in FIG. 1C, the RAN 103 may include Node-Bs 140a, 140b, 140c, which may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 115. The Node-Bs 140a, 140b, 140c may each be associated with a particular cell (not shown) within the RAN 103. The RAN 103 may also include RNCs 142a, 142b. It will be appreciated that the RAN 103 may include any number of Node-Bs and RNCs while remaining consistent with an embodiment.

[0052] As shown in FIG. 1C, the Node-Bs 140a, 140b may be in communication with the RNC 142a. Additionally, the Node-B 140c may be in communication with the RNC 142b. The Node-Bs 140a, 140b, 140c may communicate with the respective RNCs 142a, 142b via an Iub interface. The RNCs 142a, 142b may be in communication with one another via an Iur interface. Each of the RNCs 142a, 142b may be configured to control the respective Node-Bs 140a, 140b, 140c to which it is connected. In addition, each of the RNCs 142a, 142b may be configured to

carry out or support other functionality, such as outer loop power control, load control, admission control, packet scheduling, handover control, macrodiversity, security functions, data encryption, and the like.

[0053] The core network 106 shown in FIG. 1C may include a media gateway (MGW) 144, a mobile switching center (MSC) 146, a serving GPRS support node (SGSN) 148, and/or a gateway GPRS support node (GGSN) 150. While each of the foregoing elements are depicted as part of the core network 106, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0054] The RNC 142a in the RAN 103 may be connected to the MSC 146 in the core network 106 via an IuCS interface. The MSC 146 may be connected to the MGW 144. The MSC 146 and the MGW 144 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and traditional land-line communications devices.

[0055] The RNC 142a in the RAN 103 may also be connected to the SGSN 148 in the core network 106 via an IuPS interface. The SGSN 148 may be connected to the GGSN 150. The SGSN 148 and the GGSN 150 may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between and the WTRUs 102a, 102b, 102c and IP-enabled devices.

[0056] As noted above, the core network 106 may also be connected to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0057] FIG. 1D is a system diagram of the RAN 104 and the core network 107 according to an embodiment. As noted above, the RAN 104 may employ an E-UTRA radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 116. The RAN 104 may also be in communication with the core network 107.

[0058] The RAN 104 may include eNode-Bs 160a, 160b, 160c, though it will be appreciated that the RAN 104 may include any number of eNode-Bs while remaining consistent with an embodiment. The eNode-Bs 160a, 160b, 160c may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 116. In some embodiments, the eNode-Bs 160a, 160b, 160c may implement MIMO technology. Thus, the eNode-B 160a, for example, may use multiple antennas to transmit wireless signals to, and receive wireless signals from, the WTRU 102a.

[0059] Each of the eNode-Bs 160a, 160b, 160c may be associated with a particular cell (not shown) and may be configured to handle radio resource management decisions, handover

decisions, scheduling of users in the uplink (UL) and/or downlink (DL), and the like. As shown in FIG. 1D, the eNode-Bs 160a, 160b, 160c may communicate with one another over an X2 interface.

[0060] The core network 107 shown in FIG. 1D may include a mobility management gateway (MME) 162, a serving gateway 164, and a packet data network (PDN) gateway 166. While each of the foregoing elements are depicted as part of the core network 107, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0061] The MME 162 may be connected to each of the eNode-Bs 160a, 160b, 160c in the RAN 104 via an S1 interface and may serve as a control node. For example, the MME 162 may be responsible for authenticating users of the WTRUs 102a, 102b, 102c, bearer activation/deactivation, selecting a particular serving gateway during an initial attach of the WTRUs 102a, 102b, 102c, and the like. The MME 162 may also provide a control plane function for switching between the RAN 104 and other RANs (not shown) that employ other radio technologies, such as GSM or WCDMA.

[0062] The serving gateway 164 may be connected to each of the eNode-Bs 160a, 160b, 160c in the RAN 104 via the S1 interface. The serving gateway 164 may generally route and forward user data packets to/from the WTRUs 102a, 102b, 102c. The serving gateway 164 may also perform other functions, such as anchoring user planes during inter-eNode B handovers, triggering paging when downlink data is available for the WTRUs 102a, 102b, 102c, managing and storing contexts of the WTRUs 102a, 102b, 102c, and the like.

[0063] The serving gateway 164 may also be connected to the PDN gateway 166, which may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices.

[0064] The core network 107 may facilitate communications with other networks. For example, the core network 107 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and traditional land-line communications devices. For example, the core network 107 may include, or may communicate with, an IP gateway (e.g., an IP multimedia subsystem (IMS) server) that serves as an interface between the core network 107 and the PSTN 108. In addition, the core network 107 may provide the WTRUs 102a, 102b, 102c with access to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0065] FIG. 1E is a system diagram of the RAN 105 and the core network 109 according to an embodiment. The RAN 105 may be an access service network (ASN) that employs IEEE 802.16 radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 117. As will be further discussed below, the communication links between the different functional entities of the WTRUs 102a, 102b, 102c, the RAN 105, and the core network 109 may be defined as reference points.

[0066] As shown in FIG. 1E, the RAN 105 may include base stations 180a, 180b, 180c, and an ASN gateway 182, though it will be appreciated that the RAN 105 may include any number of base stations and ASN gateways while remaining consistent with an embodiment. The base stations 180a, 180b, 180c may each be associated with a particular cell (not shown) in the RAN 105 and may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 117. In some embodiments, the base stations 180a, 180b, 180c may implement MIMO technology. Thus, the base station 180a, for example, may use multiple antennas to transmit wireless signals to, and receive wireless signals from, the WTRU 102a. The base stations 180a, 180b, 180c may also provide mobility management functions, such as handoff triggering, tunnel establishment, radio resource management, traffic classification, quality of service (QoS) policy enforcement, and the like. The ASN gateway 182 may serve as a traffic aggregation point and may be responsible for paging, caching of subscriber profiles, routing to the core network 109, and the like.

[0067] The air interface 117 between the WTRUs 102a, 102b, 102c and the RAN 105 may be defined as an R1 reference point that implements the IEEE 802.16 specification. In addition, each of the WTRUs 102a, 102b, 102c may establish a logical interface (not shown) with the core network 109. The logical interface between the WTRUs 102a, 102b, 102c and the core network 109 may be defined as an R2 reference point, which may be used for authentication, authorization, IP host configuration management, and/or mobility management.

[0068] The communication link between each of the base stations 180a, 180b, 180c may be defined as an R8 reference point that includes protocols for facilitating WTRU handovers and the transfer of data between base stations. The communication link between the base stations 180a, 180b, 180c and the ASN gateway 182 may be defined as an R6 reference point. The R6 reference point may include protocols for facilitating mobility management based on mobility events associated with each of the WTRUs 102a, 102b, 102c.

[0069] As shown in FIG. 1E, the RAN 105 may be connected to the core network 109. The communication link between the RAN 105 and the core network 109 may defined as an R3 reference point that includes protocols for facilitating data transfer and mobility management

capabilities, for example. The core network 109 may include a mobile IP home agent (MIP-HA) 184, an authentication, authorization, accounting (AAA) server 186, and a gateway 188. While each of the foregoing elements are depicted as part of the core network 109, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0070] The MIP-HA may be responsible for IP address management, and may enable the WTRUs 102a, 102b, 102c to roam between different ASNs and/or different core networks. The MIP-HA 184 may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices. The AAA server 186 may be responsible for user authentication and for supporting user services. The gateway 188 may facilitate interworking with other networks. For example, the gateway 188 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and traditional land-line communications devices. In addition, the gateway 188 may provide the WTRUs 102a, 102b, 102c with access to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0071] Although not shown in FIG. 1E, it will be appreciated that the RAN 105 may be connected to other ASNs and the core network 109 may be connected to other core networks. The communication link between the RAN 105 the other ASNs may be defined as an R4 reference point, which may include protocols for coordinating the mobility of the WTRUs 102a, 102b, 102c between the RAN 105 and the other ASNs. The communication link between the core network 109 and the other core networks may be defined as an R5 reference, which may include protocols for facilitating interworking between home core networks and visited core networks.

[0072] Systems, methods, and instrumentalities are disclosed for antenna virtualization, for example, in a least a two-dimensional antenna array. N_E physical antenna elements may be virtualized to N_P logical antenna ports. A virtualization may be WTRU-specific, which may optimize MIMO performance. A simplified MIMO scheme may be used with reduction in feedback, reference signal, and/or control signaling overhead. One or more antenna virtualization schemes may utilize one or more channel characteristics. Antenna virtualization may be defined, for example, based on antenna port to antenna element mapping, based on a measurement reference signal, based on a codebook or a codebook subset, and/or based on an antenna virtualization matrix. One or more, or multiple, antenna virtualization schemes may be

configured in a cell. One or more antenna virtualization schemes may be configured in a WTRU-specific manner based on a WTRU channel characteristic. A WTRU may report a useful (e.g., relatively best optimized) antenna virtualization scheme, e.g., based on a measurement.

[0073] MIMO techniques for one dimensional (1D) antenna configurations may, for example, define antenna ports in a horizontal domain. The number of antenna ports may be limited, for example, due to the limited space of the transmitter site and/or due to a certain level of antenna spacing to provide MIMO gain. MIMO schemes may be implemented in two dimensional (2D) antenna arrays, which may allow a larger number of antenna elements at a transmitter and/or additional control of antennas in the vertical domain. A higher system performance may be achieved by exploiting a higher degree of freedom of the spatial channel.

[0074] FIG. 2 is an example of a 2D antenna array with co-polarized antenna elements. FIG. 3 is an example of a 2D antenna array with cross-polarized antenna elements. One or more, or each, antenna configuration may be defined, for example, by parameters (N, M, K), where N, M, and/or K represent the number of antenna columns, number of antenna rows, and/or polarization, respectively.

[0075] FIG. 4 is an example of elevation beamforming, e.g., via adaptive downtilt. FIG. 5 is an example of vertical sectorization. Elevation beamforming and/or vertical sectorization techniques may be considered in MIMO techniques to exploit vertical antenna ports. Elevation beamforming, which may also be referred to as adaptive downtilt, may form a beam in the vertical dimension to increase beamforming gain. Elevation beamforming may minimize inter-cell interference, for example, by reducing signal power to neighbor cell. As a result of less interference, system throughput may be increased. Vertical sectorization may exploit spatial reuse gain, for example, by forming one or more, or multiple, vertical beams in a cell. One or more, or each, vertical beam may correspond to a sector.

[0076] Antenna virtualization may be implemented in a 2D antenna array. A 2D antenna array may be defined as (N, M, K), where N, M and K represent the number of antenna columns, number of antenna rows, and/or polarization, respectively. As shown in FIGS. 2 and 3, N x M x K antenna elements may be used. In a given 2D antenna configuration, the number of antenna ports may depend on the number of RF chains and/or transmit and receive units (TXRUs) used. An antenna element may be regarded as a physical antenna implemented in a 2D antenna array. An antenna port may be regarded as a logical antenna seen by a wireless transmit/receive unit (WTRU). A WTRU may also be referred to as User Equipment (UE).

[0077] FIG. 6 is an example of antenna elements in a 2D antenna array. As shown in FIG. 6, for example, 16 antenna elements may be used in a 2D antenna array. For example of

virtualization, four antenna ports may be configured with the 16 antenna elements. A WTRU may recognize and/or see four antenna ports even though an eNB has 16 antenna elements.

[0078] For example, an antenna port may be configured with at least four antenna elements with a specific antenna virtualization vector. p_0 may be defined with four antenna elements $\tilde{p}_0, \tilde{p}_4, \tilde{p}_8, \tilde{p}_{12}$. p_1 may be defined with 4 antenna elements $\tilde{p}_1, \tilde{p}_5, \tilde{p}_9, \tilde{p}_{13}$. p_2 may be defined with four antenna elements $\tilde{p}_2, \tilde{p}_6, \tilde{p}_{10}, \tilde{p}_{14}$. p_3 may be defined with 4 antenna elements $\tilde{p}_3, \tilde{p}_7, \tilde{p}_{11}, \tilde{p}_{15}$. An antenna port may be seen as a reference signal in LTE/LTE-A, such as a cell-specific reference signal and/or a channel-state-information reference signal.

[0079] A reference signal in LTE/LTE-A may be classified as a WTRU-specific reference signal (WTRU-RS) and/or as a cell-specific reference signal (CRS). A WTRU-RS may be used for a specific WTRU, such that a WTRU-RS type RS is transmitted for resources allocated to the specific WTRU. A CRS may be shared by one or more, or all, WTRUs in a cell, such that a CRS type RS is transmitted in a wideband manner. Reference signal usage may be further distinguished and/or differentiated as a demodulation reference signal (DM-RS) and/or a channel-state-information reference signal (CSI-RS).

[0080] A DM-RS may be used for a specific WTRU. A DM-RS type RS may be precoded to exploit beamforming gain. A DM-RS type RS may be transmitted in time/frequency resources allocated to a WTRU given that a WTRU-specific DM-RS might not be shared with other WTRUs in the cell. A DM-RS may be used for demodulation purposes.

[0081] FIG. 7 is an example of WTRU-specific precoded demodulation reference signal (DM-RS). FIG. 7 shows that an RS may be precoded with the same precoding used for data symbols, for example, perhaps when precoded DM-RS is employed. The same number of RS sequences corresponding to the number of layers K may be transmitted. K may be equal to, or smaller, than antenna ports N_t.

[0082] K streams may be allocated for a WTRU and/or shared with one or more, or multiple, WTRUs. Co-scheduled WTRUs may share the same time/frequency resources at the same time, for example, perhaps when one or more, or multiple, WTRUs share K streams. A measurement reference signal, such as CSI-RS, may be used together with precoded DM-RS for a WTRU to measure channel state information.

[0083] A CRS may be defined for one or more, or all, WTRUs in a cell. A CRS may be used for demodulation and measurement purposes. A non-precoded RS may be employed, e.g., to keep cell coverage uniform, given that a CRS may be shared by WTRUs. A precoded RS may have different cell coverage according to directions, for example, due to the beamforming effect.

[0084] FIG. 8 is an example of a non-precoded cell-specific reference signal. FIG. 8 shows an example of a Multiple Input Multiple Output (MIMO) transmitter for non-precoded Cell-Specific Reference Signal (CRS) transmission. A WTRU transparent antenna virtualization may be used, for example, perhaps when the number of physical antenna elements and/or logical antenna port is different. RS sequences may be transmitted on antenna ports, e.g., one or more, or all, antenna ports, perhaps irrespective of the number of streams.

[0085] Reference Signal (RS) structure in 3GPP LTE may vary. FIG. 9 is an example of a WTRU-specific demodulation reference signal for normal cyclic prefix. FIG. 9 shows a DM-RS for antenna port-5, which may be defined in LTE to support non-codebook based transmission at an eNB. Antenna port-5 may support one layer transmission. RS overhead may significantly increase, for example, if antenna port-5 is transmitted with CRS (e.g., one or more, or every time).

[0086] FIG. 10 is an example of a cell-specific reference signal structure according to one or more, antenna ports. FIG. 10 shows a CRS pattern for one, two, and four antenna ports for normal CP. CRS patterns for one or more, or each, antenna port may be mutually orthogonal in time/frequency domain. R0 and R1 indicate CRS for antenna port 0 and antenna port 1, respectively. Data resource elements (REs) located at an RE where CRS antenna ports are transmitted may be muted, for example, to avoid interference between CRS antenna ports, among other scenarios.

[0087] A predefined RS sequence (e.g. Pseudo-random (PN)) may be transmitted in an RE location for CRS ports, for example, perhaps to minimize inter-cell interference. This may improve channel estimation accuracy from a CRS. A PN sequence may be applied, for example, at an Orthogonal Frequency Division Multiplexing (OFDM) symbol level in a subframe. The PN sequence may be defined, for example, according to cell-ID, subframe number, and/or position of OFDM symbol.

[0088] For example, the number of CRS antenna ports may be two in an OFDM symbol containing a CRS per Physical Resource block (PRB). The number of PRBs in LTE may vary from 6 to 110. A total number of CRS for an antenna port in an OFDM symbol containing RS may be two times the number of resource blocks (RBs), i.e., 2xNRB. The sequence length may be $2xN_{RB}^{DL}$. NRB may be the number of RBs corresponding to a bandwidth. The sequence may be binary or complex. A complex sequence, r(m), may be given by Eq. 1.

$$r(m) = \frac{1}{\sqrt{2}}\left(1 - 2 \cdot c(2m)\right) + j\frac{1}{\sqrt{2}}\left(1 - 2 \cdot c(2m+1)\right), m = 0,1,\ldots,2N_{RB}^{DL} - 1 \qquad Eq.\ 1$$

[0089] In Eq. 1, N_{RB}^{DL} denotes one or more RBs corresponding to the maximum bandwidth in an LTE system. N_{RB}^{DL} may, for example, be 110, as described herein. C denotes a PN sequence with length equal to 31. C may be defined with Gold-sequence.

[0090] Complex sequence, r(m), may be given by Eq. 2, perhaps for example when a DM-RS may be configured, among other scenarios.

$$r(m) = \frac{1}{\sqrt{2}}(1 - 2 \cdot c(2m)) + j\frac{1}{\sqrt{2}}(1 - 2 \cdot c(2m+1)), m = 0,1,\ldots,12N_{RB}^{PDSCH} - 1 \qquad \textit{Eq. 2}$$

[0091] In Eq. 2, N_{RB}^{PDSCH} denotes one or more of RBs allocated for a specific WTRU. A sequence length may vary, perhaps for example according to the number RBs allocated for a WTRU.

[0092] A reference signal (RS) structure in 3GPP LTE-A may vary from an RS structure in LTE. A DM-RS based downlink transmission in LTE-A may reduce RS overhead. CRS-based downlink transmission may transmit RS sequences for physical antenna ports. DM-RS based downlink transmission may reduce the RS overhead, for example, considering that the same number of RS as the number of layers may be used for DM-RS, among other reasons. The number of layers may be equal to, or smaller, than the number of physical antenna ports.

[0093] FIG. 11 is an example of a demodulation reference signal pattern supporting up to eight layers. FIG. 11 shows the DM-RS patterns in a PRB for a subframe with normal CP. For example, two Code Division Multiplexing (CDM) groups may be used for multiplexing up to four layers in one or more, or each, CDM group. Up to eight layers may be multiplexed in this pattern. A 4x4 Walsh spreading may be used, for example, for CDM multiplexing for one or more, or each, CDM group.

[0094] FIG. 12 is an example of channel state information reference signal pattern (CSI-RS) reuse according to a number ports. In FIG. 12, the same pattern indicates a set of REs for a particular CSI-RS configuration. A DM-RS may be used for demodulation performance. A time/frequency sparse CSI-RS may be introduced for measurement purposes. CSI-RS may be transmitted with a duty cycle {5, 10, 20, 40, 80} ms in PDSCH region. CSI-RS pattern reuse, e.g., up to 20, may be available in a subframe, as shown in FIG. 12.

[0095] FIG. 13 is an example of codebook-based precoding with feedback information. Feedback information may be, for example, a precoding matrix index in codebook as shown in FIG. 13. Feedback information may be, for example, channel state information. Feedback information may be other information.

[0096] A codebook may include a set of precoding vectors/matrices for one or more, or each, rank and/or the number of antennas. One or more, or each, of the precoding vectors/matrices may have its own index. A receiver may inform a transmitter about a useful (e.g., relatively best optimized) precoding vector/matrix index. A transmitter may inform a receiver about which precoding vector/matrix index is applied for a transmission.

[0097] Codebook based precoding may have performance degradation, for example, due to a finite number of precoding vectors/matrices, which may contrast with non-codebook based precoding. Codebook-based precoding may be useful as it may lower control signaling/feedback overhead.

[0098] Table 1 and Table 2 show example codebooks for 2Tx and 4Tx employed in 3GPP.

Table 1 – 2Tx downlink codebook

Codebook index	Number of rank	
	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	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	-

Table 2 – Example 4Tx downlink codebook

Codebook index	u_n	Number of layers υ			
		1	2	3	4
0	$u_0 = [1 \quad -1 \quad -1 \quad -1]^T$	$W_0^{\{1\}}$	$W_0^{\{14\}}/\sqrt{2}$	$W_0^{\{124\}}/\sqrt{3}$	$W_0^{\{1234\}}/2$
1	$u_1 = [1 \quad -j \quad 1 \quad j]^T$	$W_1^{\{1\}}$	$W_1^{\{12\}}/\sqrt{2}$	$W_1^{\{123\}}/\sqrt{3}$	$W_1^{\{1234\}}/2$
2	$u_2 = [1 \quad 1 \quad -1 \quad 1]^T$	$W_2^{\{1\}}$	$W_2^{\{12\}}/\sqrt{2}$	$W_2^{\{123\}}/\sqrt{3}$	$W_2^{\{3214\}}/2$
3	$u_3 = [1 \quad j \quad 1 \quad -j]^T$	$W_3^{\{1\}}$	$W_3^{\{12\}}/\sqrt{2}$	$W_3^{\{123\}}/\sqrt{3}$	$W_3^{\{3214\}}/2$
4	$u_4 = [1 \quad (-1-j)/\sqrt{2} \quad -j \quad (1-j)/\sqrt{2}]^T$	$W_4^{\{1\}}$	$W_4^{\{14\}}/\sqrt{2}$	$W_4^{\{124\}}/\sqrt{3}$	$W_4^{\{1234\}}/2$
5	$u_5 = [1 \quad (1-j)/\sqrt{2} \quad j \quad (-1-j)/\sqrt{2}]^T$	$W_5^{\{1\}}$	$W_5^{\{14\}}/\sqrt{2}$	$W_5^{\{124\}}/\sqrt{3}$	$W_5^{\{1234\}}/2$
6	$u_6 = [1 \quad (1+j)/\sqrt{2} \quad -j \quad (-1+j)/\sqrt{2}]^T$	$W_6^{\{1\}}$	$W_6^{\{13\}}/\sqrt{2}$	$W_6^{\{134\}}/\sqrt{3}$	$W_6^{\{1324\}}/2$
7	$u_7 = [1 \quad (-1+j)/\sqrt{2} \quad j \quad (1+j)/\sqrt{2}]^T$	$W_7^{\{1\}}$	$W_7^{\{13\}}/\sqrt{2}$	$W_7^{\{134\}}/\sqrt{3}$	$W_7^{\{1324\}}/2$
8	$u_8 = [1 \quad -1 \quad 1 \quad 1]^T$	$W_8^{\{1\}}$	$W_8^{\{12\}}/\sqrt{2}$	$W_8^{\{124\}}/\sqrt{3}$	$W_8^{\{1234\}}/2$
9	$u_9 = [1 \quad -j \quad -1 \quad -j]^T$	$W_9^{\{1\}}$	$W_9^{\{14\}}/\sqrt{2}$	$W_9^{\{134\}}/\sqrt{3}$	$W_9^{\{1234\}}/2$
10	$u_{10} = [1 \quad 1 \quad 1 \quad -1]^T$	$W_{10}^{\{1\}}$	$W_{10}^{\{13\}}/\sqrt{2}$	$W_{10}^{\{123\}}/\sqrt{3}$	$W_{10}^{\{1324\}}/2$
11	$u_{11} = [1 \quad j \quad -1 \quad j]^T$	$W_{11}^{\{1\}}$	$W_{11}^{\{13\}}/\sqrt{2}$	$W_{11}^{\{134\}}/\sqrt{3}$	$W_{11}^{\{1324\}}/2$
12	$u_{12} = [1 \quad -1 \quad -1 \quad 1]^T$	$W_{12}^{\{1\}}$	$W_{12}^{\{12\}}/\sqrt{2}$	$W_{12}^{\{123\}}/\sqrt{3}$	$W_{12}^{\{1234\}}/2$
13	$u_{13} = [1 \quad -1 \quad 1 \quad -1]^T$	$W_{13}^{\{1\}}$	$W_{13}^{\{13\}}/\sqrt{2}$	$W_{13}^{\{123\}}/\sqrt{3}$	$W_{13}^{\{1324\}}/2$
14	$u_{14} = [1 \quad 1 \quad -1 \quad -1]^T$	$W_{14}^{\{1\}}$	$W_{14}^{\{13\}}/\sqrt{2}$	$W_{14}^{\{123\}}/\sqrt{3}$	$W_{14}^{\{3214\}}/2$
15	$u_{15} = [1 \quad 1 \quad 1 \quad 1]^T$	$W_{15}^{\{1\}}$	$W_{15}^{\{12\}}/\sqrt{2}$	$W_{15}^{\{123\}}/\sqrt{3}$	$W_{15}^{\{1234\}}/2$

[0099] In Table 2, $W_n^{\{s\}}$ is given by $W_n = I - 2u_n u_n^H / u_n^H u_n$ in the set $\{s\}$. I denotes four-by-four identity matrix. The 2Tx codebook has seven precoding vectors/matrices. The identity matrix may be used for open-loop transmission. Six precoding vectors/matrices may be utilized for closed-

loop transmission. The 4Tx codebook has 64 precoding matrix indexes, 16 of which may be used for one or more, or each, transmission rank.

[0100] Codebooks shown above may have common properties. For example, a common property may be a constant modulus (CM) property where one or more, or each, element in one or more, or each, precoding vector/matrix may have a unit power. A common property may be a nested property where a lower rank precoding vector/matrix may be a column subset of higher rank precoding vector/matrix. A common property may be a constrained alphabet where a precoding alphabet is constrained, for example, by $\left\{\pm 1,\pm j,\pm\frac{(1+j)}{\sqrt{2}},\pm\frac{(-1+j)}{\sqrt{2}}\right\}$.

[0101] CSI feedback may be provided. At least two types of reporting channels may be used, such as Physical Uplink Control Channel (PUCCH) and Physical Uplink Shared Channel (PUSCH). A PUCCH reporting channel may provide CSI feedback, perhaps for example while allowing limited feedback overhead. A PUSCH reporting channel may allow a relatively large amount of feedback overhead, perhaps with less reliability. A PUCCH reporting channel may be used for periodic CSI feedback for coarse link adaptation, perhaps while a PUSCH reporting channel may be triggered aperiodically for finer link adaptation, for example. Table 3 illustrates an example of reporting modes.

Table 3 – Reporting modes

Scheduling Mode	Periodic CSI reporting channels	Aperiodic CSI reporting channel
Frequency non-selective	PUCCH	
Frequency selective	PUCCH	PUSCH

[0102] CSI feedback may be reported in the format of rank (RI), precoder/precoding matrix index (PMI), and/or a channel quality indicator/indication (CQI). RI and/or PMI may be calculated at a WTRU receiver, for example, by selecting rank and/or precoding matrix in a predefined codebook. This may maximize WTRU throughput. PMI and/or CQI may be further classified into wideband, subband, and/or WTRU-selected subband. RI may be reported in wideband manner. Table 4 shows an example of CSI feedback according to transmission mode.

Table 4 – Example of CSI feedback according to Reporting Modes

<table>
<tr><th>Transmission Mode</th><th>Aperiodic Feedback</th><th>Periodic Feedback</th></tr>
<tr><td>1</td><td rowspan="4">Mode 2-0: WTRU selected sub band CQI: WB CQI + CQI over M best subbands.

Mode 3-0: high layer(HL) configured subband CQI: WB CQI + subband CQI.

Notes:
CQI for first CW, No PMI</td><td rowspan="4">Mode 1-0: WB CQI

Mode 2-0: WTRU Selected sub band CQI: WB CQI + WTRU reports CQI in useful subband in one or more, or each, BW part, one BW part in one or more, or each, reporting opportunity.

Notes:
CQI for first CW, No PMI</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="3">Mode 1-2: WB CQI / Multiple PMI: CQI for one or more, or each, CW; PMI for one or more, or each, subband.

Mode 2-2: WTRU selected sub band CQI / Multiple PMI: CQI per CW and PMI, both over full BW and M best subbands.

Mode 3-1: HL configured sub band CQI / Single PMI: WB CQI + subband CQI, both per CW.</td><td rowspan="3">Mode 1-1: WB CQI / Single PMI

Mode 2-1: WTRU selected subband CQI / Single PMI (if $N_{RB}^{DL} > 7$): WB CQI/PMI + WTRU reports CQI in useful subband in one or more, or each, BW part</td></tr>
<tr><td>4</td></tr>
<tr><td>6</td></tr>
<tr><td>8</td><td rowspan="2">Mode 3-1: HL configured sub band CQI / Single PMI (see above)</td></tr>
<tr><td>5</td></tr>
</table>

[0103] Periodic feedback may be transmitted on a PUCCH channel. Periodic feedback may be transmitted on a PUSCH channel, for example, perhaps when that channel exists. Aperiodic feedback may be requested by DCI Format 0 and/or DCI format 4, for example, perhaps when the Channel Quality Indications (CQI) Request bit is set. Aperiodic feedback may be transmitted on Physical Uplink shared Channel (PUSCH).

[0104] FIG. 14 is an example of periodic reporting. Periodic reporting may use a sequence of different types of reports. Report types may be defined. For example, Type 1 may be Subband CQI, Type 2 may be Wideband CQI/PMI, Type 3 may be RI, and/or Type 4 may be Wideband CQI. FIG. 14 shows an example of a reporting sequence, where the number in one or more, or each, rectangle corresponds to a report type.

[0105] Types of periodic Physical Uplink Control Channel (PUCCH) feedback may be extended for up to eight Tx antenna ports. For example, Type 1 report may support CQI feedback for WTRU selected sub-bands. Type 1a report may support subband CQI and/or second PMI feedback. Type 2, Type 2b, and/or Type 2c report may support wideband CQI and/or PMI feedback. Type 2a report may support wideband PMI feedback. Type 3 report may support Rank Indicator (RI) feedback. Type 4 report may support wideband CQI. Type 5 report may support RI and/or wideband PMI feedback. Type 6 report may support RI and/or PTI feedback. In a Type 6 report, precoding type indicator (PTI) may be used for eight transmit antenna ports, for example, given that an 8Tx precoder may be defined with a dual codebook.

[0106] Antenna virtualization may be used in a cell-specific manner, perhaps for example transparent to a receiver and/or irrespective of receiver location and/or channel characteristics. In some circumstances, MIMO performance might not be fully optimized. Suboptimal performance may be more pronounced for example, perhaps when a transmitter is equipped with a large number of antenna elements.

[0107] An antenna virtualization scheme may be determined and/or optimized according to one or more WTRU channel characteristics. A WTRU-specific antenna virtualization may (e.g., relatively fully) exploit the MIMO gain. WTRU-specific antenna virtualization may be applied in at least a two-dimensional antenna array. Antenna virtualization may be defined, for example, based on antenna port to antenna element mapping, based on a measurement reference signal, based on a codebook or a codebook subset, and/or based on an antenna virtualization matrix. WTRU-specific antenna virtualization may enable one or more, or multiple, antenna virtualization schemes to be configured in a cell. Antenna virtualization schemes may be configured in a WTRU-specific manner, perhaps for example based on one or more WTRU channel characteristics. A

WTRU may report a useful (e.g., relatively best optimized) antenna virtualization scheme based on a measurement.

[0108] MIMO performance may be optimized with a relatively larger number of antenna elements (for example, which may be considered physical antennas). One or more antenna virtualization schemes may be useful, for example, to (e.g., fully) exploit the degree of freedom of one or more MIMO channels. One or more antenna virtualization schemes may allow formation of antenna ports (for example, which can be considered logical antennas). N_E antenna elements may be virtualized to N_P antenna ports. MIMO schemes (e.g. as simplified) may be used with a reduced feedback, reference signal, and/or control signaling overhead.

[0109] In one or more techniques, antenna virtualization, antenna virtualization scheme, antenna virtualization method, antenna virtualization configuration, logical antenna configuration, and/or virtual antenna configuration may be used interchangeably.

[0110] Antenna virtualization may be defined as one or more antenna port to antenna element mapping rules. For example, N_E antenna elements may be mapped to N_P antenna ports, for example, when N_E antenna elements may be used at the transmitter. One or more mapping rules between N_E antenna elements and N_P antenna ports may be considered as antenna port to antenna element mapping rules.

[0111] FIG. 15 is an example of antenna port to antenna element mapping. More specifically, FIG. 15 shows an example of antenna port to antenna element mapping, perhaps for example when 16 antenna elements (N_E=16) are used at a transmitter and 4 antenna ports (N_P=4) are defined. Antenna elements in a row may be mapped to an antenna port.

[0112] One or more antenna port to antenna element mapping rules may be defined, perhaps for example as a set of indices. Referring to FIG. 15, for example where 16 antenna elements are used at the transmitter and four antenna ports are defined. One or more, or each, of the four antenna ports may have a set of antenna element indices. For example, where P_0 = {0, 1, 2, 3}, P_1 = {4, 5, 6, 7}, P_2 = {8, 9, 10, 11} and P_3 = {12, 13, 14, 15}, antenna port 0 may be formed with antenna elements 0, 1, 2, and 3; antenna port 1 may be formed with the antenna elements 4, 5, 6, and 7; antenna port 2 may be formed with the antenna elements 8, 9, 10, and 11; and/or antenna port 3 may be formed with the antenna elements 12, 13, 14, and 15.

[0113] For example, such as in the previous example, an antenna element may be mapped onto at least one antenna port. For example, an antenna element may be mapped onto at least two, or more, antenna ports. For example, an antenna element may be mapped onto at least two, or more, antenna ports, such as P_0 = {0, 1, 2, 3, 4, 5, 6, 7}, P_1 = {4, 5, 6, 7, 8, 9,10, 11}, P_2 = {8, 9, 10, 11, 12, 13, 14, 15}, and/or P_0 = {12, 13, 14, 15, 0, 1, 2, 3}, and/or the like.

[0114] One or more antenna ports may be the same and/or similar as the number of antenna elements. Antenna port to antenna element mapping may be one-to-one correspondence, perhaps for example where N_E may be the same as N_P (e.g., N_E=N_P), among other scenarios.

[0115] Antenna virtualization may be defined as one or more cells. For example, an N_C cell may be configured using antenna virtualization given N_E antenna elements used for a transmitter.

[0116] A cell-ID to antenna element mapping may be used and/or one or more sets of antenna elements may be determined, perhaps for example based on a cell-ID (e.g., a physical cell-ID and/or a virtual cell-ID). One or more, or each, cell may have the same or similar number of assigned antenna ports. For example, perhaps where four cells are defined with 16 antenna elements (e.g., N_C=4 and N_E=16), one or more, or each, cell may be mapped onto 4 antenna elements. This arrangement may be represented as Cell-1 = {0, 1, 2, 3}, Cell-2 = {4, 5, 6, 7}, Cell-3 = {8, 9, 10, 11} and Cell-4 = {12, 13, 14, 15}.

[0117] An antenna element may be mapped onto cell-IDs. For example, an antenna element may be mapped onto one or more, or all, cell-IDs, which may be represented as Cell-1 = {0,1,.., 15}, Cell-2 = {0,1,.., 15}, Cell-3 = {0,1,.., 15} and Cell-4 = {0,1,.., 15}.

[0118] A different complex weight may be used for one or more, or each, cell. A complex weight for one or more, or each, cell may be defined as an N_P x N_E matrix. N_P may be the number of antenna ports for a cell. For example, N_P may be different according to the cell. For example, N_P may be the same for one or more, or all, cells.

[0119] N_C cells may be considered as one or more vertical sectors. One or more N_C cells may have the same physical cell ID and/or different physical cell IDs. A common CRS may be used for one or more N_C cells. A different CSI-RS configuration may be used for one or more, or each, N_C cell. A CSI for a vertical sector may be configured as a CSI process. A virtual cell-ID may be assigned for one or more, or each, CSI-RS configuration. A WTRU may be requested to report CSI for one or more configured N_C cells. One or more N_C cells may be defined as independent cells. A different physical cell ID may be assigned for one or more N_C cells.

[0120] Antenna virtualization may be defined, by way of explanation, as an antenna virtualization matrix, among other definitions. For example, an N_P x N_E antenna virtualization matrix may be defined as an antenna virtualization scheme.

[0121] FIG. 16 is an example of defining antenna virtualization as an antenna virtualization matrix. FIG. 16 shows an example definition of antenna virtualization as an antenna virtualization matrix where N_E=16 and N_P=4. One or more different antenna virtualization schemes may have one or more different antenna virtualization matrices.

[0122] An antenna port may be formed, for example, by associating a row vector with a complex weight vector. An antenna element may be formed, for example, by associating a column vector with a complex weight vector.

[0123] In one or more techniques, N_P may be the same as N_E, which may be referred to as unity. An antenna virtualization matrix for unity may be an identity matrix where the antenna element and antenna port are the same, perhaps for example such that physical antennas are the same as logical antennas. An antenna virtualization matrix for unity may be a permutation matrix, perhaps for example where antenna port to antenna element mapping may be one to one correspondence, perhaps for example while indexes may be permutated. An antenna virtualization matrix for unity may be a DFT matrix, perhaps for example where N_P number of beams may be formed with N_E antenna elements, perhaps for example such that one or more, or each, antenna port may correspond to a beam. An antenna virtualization matrix for unity may be a phase shift matrix.

[0124] An antenna virtualization matrix may have complex weights w_k^n, e.g., as shown in FIG. 16, where w_k^n is a complex weight for k-th antenna element to map onto n-th antenna port. A complex weight may be determined as a function of an antenna virtualization scheme (e.g., matrix or matrices).

[0125] Antenna virtualization may be defined as a measurement reference signal configuration. For example, a measurement reference signal may be configured with two components, such as for example vertical antennas and horizontal antennas. One or more antenna ports for vertical antennas and/or horizontal antennas may be dependent on the antenna virtualization scheme. One or more antenna ports for vertical antennas and/or horizontal antennas may be the same or different according to an antenna virtualization scheme. For example, the antenna virtualization scheme/matrix may include configuration information for at least one of an antenna port for a vertical antenna and/or at least one of an antenna port for a horizontal antenna.

[0126] At least one measurement reference signal may be CSI-RS. CSI-RS may have at least two components, such as for example vertical CSI-RS (v-CSI-RS) and/or horizontal CSI-RS (h-CSI-RS). One or more antenna ports for v-CSI-RS and h-CSI-RS may be defined commonly and/or independently. One or more antenna ports for v-CSI-RS may be determined as a function of the number of antenna port for h-CSI-RS. N_V x N_H may be N_V antenna ports for v-CSI-RS and/or N_H antenna ports for h-CSI-RS, for example.

[0127] One or more antenna virtualization schemes may be defined as one or more codebooks, which may contain one or more precoding vectors/matrices. For example, a codebook may be used for CSI feedback and/or indication of a transmitted precoding matrix index (or indices).

[0128] A codebook may contain precoding vectors/matrices according to rank, perhaps for example where rank may one or more layers that may be simultaneously transmitted.

[0129] A codebook may be defined according to a CSI-RS configuration(s). A codebook may be defined/configured as a function one or more antenna ports for CSI-RS. A codebook may be defined/configured as a function of one or more antenna ports for combination of v-CSI-RS and/or h-CSI-RS.

[0130] A different or similar codebook may be used according to an antenna virtualization scheme(s). For example, a codebook for an antenna virtualization scheme 1 (e.g., the numerical references used for illustration/explanation and not for limitation) may be different from, or similar to, a codebook for antenna virtualization scheme 2. For example, the number of antenna ports used for antenna virtualization scheme 1 and antenna virtualization scheme 2 may be the same or different.

[0131] One or more antenna virtualization schemes may be defined as a codebook subset. For example, for one or more antenna ports for a measurement reference signal (e.g. CSI-RS), at least one codebook may be defined and/or at least one subset of the codebook may be used for an antenna virtualization scheme.

[0132] A codebook subset(s) may be defined as a bitmap(s). N_{CB} bits may be used to define the codebook subset(s), for example, perhaps when N_{CB} precoders may be defined in a codebook(s). For example, perhaps where NCB may be eight, a codebook subset for a first antenna virtualization scheme may be defined as {11110000} and/or a codebook subset for a second antenna virtualization scheme may be defined as {00001111}. The first four codewords in a codebook may be defined as a codebook subset for the first antenna virtualization and/or the last four codewords in a codebook may be defined as a codebook subset for the second antenna virtualization. A codebook subset for a first antenna virtualization scheme and/or a codebook subset for a second antenna virtualization scheme may be mutually exclusive or overlapped, e.g., partially overlapped.

[0133] A codebook subset may be determined as a function of one or more antenna ports for vertical antennas (e.g. v-CSI-RS) and/or one or more antenna ports for horizontal antennas (e.g. h-CSI-RS). A WTRU configured with a codebook subset may determine a useful (e.g., relatively best optimized) precoding vector/matrix index within the codebook subset, for example, perhaps when the WTRU reports CSI.

[0134] One or more antenna virtualization schemes and/or one or more antenna virtualization types may be used interchangeably.

[0135] One or more WTRU-specific antenna virtualization schemes may be configured. For example, one or more, or multiple, antenna virtualization schemes may be defined/configured in a cell(s). One or more antenna virtualization schemes N_{AV} may be configured in a cell(s). N_{AV} may be similar or different for one or more, or each, cell. N_{AV} may be defined as a function of physical cell-ID. N_{AV} may be signaled via higher layer signaling.

[0136] One or more antenna ports may be the same for one or more, or all, antenna virtualization schemes. Different mapping rules, codebook, codebook subset, reference signal configuration, and/or antenna virtualization matrix may be used.

[0137] One or more, or multiple antenna virtualization types may be defined/configured. An antenna virtualization type (e.g. type-A – which is a label used for explanation/illustration and not limitation) may use horizontal antenna elements to form an antenna port. An antenna virtualization type (e.g. type-B) may use vertical antenna elements to form an antenna port. An antenna virtualization type (e.g. type-C) may use horizontal and/or vertical antenna elements to form an antenna port.

[0138] FIG. 17 is an example of one or more, or multiple, types of antenna virtualization. In the example shown in FIG. 17, $N_{AV}=3$. For one or more, or each, of three virtualization schemes, $N_K=16$ and/or $N_P=4$. FIG. 17 shows one or more antenna port to antenna element mapping rules may be defined/configured in a cell(s). Similar or different mapping rules may apply for one or more, or each, antenna virtualization scheme.

[0139] One or more, or multiple, measurement reference signals may be configured as antenna virtualization schemes. A measurement reference signal may be, for example, a CSI-RS. One or more, or multiple, configured measurement reference signals may have the same or different number of antenna ports.

[0140] For example, of the same number of antenna ports, a total number of antenna ports may be the same for one or more, or all, configured measurement reference signals, perhaps for example while the number of antenna ports for vertical and/or horizontal antennas may be different. A first configured measurement reference signal may have 4 x 2 (N_V x N_H) antenna configurations, perhaps for example while a second configured measurement reference signal may have 2 x 4 antenna configurations. A CSI-RS pattern may be determined as a function of the total number of antenna ports. A CSI-RS pattern may be determined as a function of the number of vertical and/or horizontal antennas.

[0141] One or more, or multiple, CSI-RS may be configured where one or more, or each, CSI-RS may be associated with a certain codebook. For example, a first CSI-RS may be associated

with the first codebook and/or a second CSI-RS may be associated with a second codebook. The first codebook and the second codebook may be the same or different.

[0142] For example, CSI-RS-1 may be associated with codebook-1 and/or CSI-RS-2 may be associated with codebook-2. Codebook-1 and/or codebook-2 may be defined together or independently. Codebook-1 and codebook-2 may be, or might not be, mutually exclusive. Codebook-1 and codebook-2 may be a subset of a codebook. CSI-RS and/or an associated codebook may be configured, for example, via higher layer signaling. The same or a different codebook may be configured for two or more CSI-RS configurations.

[0143] A WTRU may use an associated measurement reference signal to report CSI, for example, perhaps when a WTRU may be configured with a codebook and/or codebook subset. A codebook and/or a codebook subset may be tied with a measurement reference signal for antenna virtualization.

[0144] A WTRU may use an associated measurement reference signal to report CSI, for example, perhaps when a WTRU may be configured with a transmission mode. For example, two CSI-RSs may be configured. A WTRU may use CSI-RS-1 for CSI measurement, for example, perhaps when a WTRU may be configured with a first transmission mode (e.g. TM-1). A WTRU may use CSI-RS-2 for CSI measurement, for example, perhaps when the WTRU may be configured with a second transmission mode (e.g. TM-2). A transmission mode may be tied with a measurement reference signal for antenna virtualization.

[0145] One or more, or multiple, configured measurement reference signals may have a similar or different number of antenna ports. One or more, or multiple, CSI-RS may be configured with a similar or different number of antenna ports. For example, one or more CSI-RS on par with one or more antenna virtualization schemes N_{AV} may be configured. A first CSI-RS may have two antenna ports, a second CSI-RS may have four antenna ports, and so on, for example. For example, CSI-RS used for measurement may be determined by one or more of a configured transmission mode, a configured codebook, and/or a measured WTRU location. One or more, or each, measurement reference signal may be associated with a codebook.

[0146] One or more, or multiple, antenna virtualization matrices may be defined/configured. One or more antenna virtualization matrices may be configured as an antenna virtualization codebook(s). For example, N_{AV} antenna virtualization matrices may be defined in a codebook. An index may be used to indicate which antenna virtualization matrix is used (e.g., an antenna virtualization matrix index).

[0147] An antenna virtualization codebook may contain two or more antenna virtualization matrices, which may, for example, be defined as an N_P x N_E complex matrix. Codewords, for

example, antenna virtualization matrices, in the antenna virtualization codebook may have the same N_E. For example, codewords may have the same or different N_P. An antenna virtualization codebook may be predefined. A subset of antenna virtualization codebook may be configured, for example, via higher layer signaling.

[0148] An antenna virtualization scheme may be configured in a WTRU-specific manner. A WTRU may be configured, for example, via higher layer signaling, to assume a certain antenna virtualization.

[0149] An antenna virtualization may be configured for a WTRU in a semi-static manner. WTRU-specific RRC signaling may be used to indicate an antenna virtualization scheme used for a WTRU.

[0150] For example, a CSI reporting mode may be determined as a function of an antenna virtualization scheme. Aperiodic CSI reporting may be used in a first antenna virtualization scheme. Periodic CSI reporting may be used in a second antenna virtualization scheme. For example, a codebook and/or a codebook subset may be determined as a function of an antenna virtualization scheme. Two or more codebooks may be defined. One codebook may be used according to an antenna virtualization configuration. Two or more codebook subsets may be defined. One codebook subset may be used according to an antenna virtualization configuration.

[0151] A transmission mode may be defined as a function of an antenna virtualization scheme. For example, an open-loop transmission mode may be used for a first antenna virtualization scheme. A closed-loop transmission mode may be used for a second antenna virtualization scheme. An open-loop transmission mode may be a transmission mode without PMI reporting, perhaps for example where CQI and/or RI may be reported. A closed-loop transmission mode may be a transmission mode with PMI reporting, perhaps for example where PMI may be reported with CQI and/or RI. A WTRU may measure a different number of CSI-RS ports in accordance with a configured antenna virtualization scheme, for example, perhaps when a different antenna virtualization may have a different number of antenna ports.

[0152] A default antenna virtualization scheme may be broadcasted in an SIB. A WTRU may use a default antenna virtualization scheme, for example, perhaps, even if, or unless, configured with another antenna virtualization scheme. A default antenna virtualization scheme may be a cell specific antenna virtualization. A default antenna virtualization scheme may be a cell-specific reference signal (CRS).

[0153] A codebook subset restriction field may be used to indicate an antenna virtualization scheme.

[0154] An eNB may configure a different antenna virtualization scheme according to a WTRU location. For example, an eNB may configure a first antenna virtualization scheme when a WTRU is located at a low elevation (e.g., ground level in a building). An eNB may configure a second antenna virtualization scheme, perhaps for example when a WTRU is located at a high elevation (e.g. a high floor level of a building).

[0155] A first and second antenna virtualization scheme may have similar or different antenna configurations. For example, 2 x 4 antenna configurations may be used for a first antenna virtualization scheme. For example, 4 x 2 antenna configurations may be used for a second antenna virtualization scheme. First and second antenna virtualization schemes may have a different number of antenna ports.

[0156] An eNB may configure one or more (e.g., different) antenna virtualization schemes, perhaps for example, according to one or more WTRU channel characteristics. For example, an eNB may configure an antenna virtualization scheme according to angle of arrival in azimuth and/or elevation of an uplink signal from a WTRU. For example, an eNB may configure an antenna virtualization scheme according to an angular spread of azimuth and/or elevation of an uplink signal from a WTRU. An uplink signal may be one or more of PUSCH, DM-RS, PUCCH, and/or Sounding Reference Signal (SRS).

[0157] In one or more techniques, the plurality of antenna virtualization scheme (e.g., matrices) may be preconfigured on the WTRU. In one or more techniques, the WTRU may receive the plurality of antenna virtualization schemes (e.g., matrices) from a network node, such as for example an eNB.

[0158] In one or more techniques, a WTRU may determine an antenna virtualization matrix index that may correspond to at least one antenna virtualization matrix. The at least one antenna virtualization matrix may be one that the WTRU has determined to be optimal, for example. At least one of the codebook or a subset of the codebook may correspond to the antenna virtualization matrix index. The WTRU may send the antenna virtualization matrix index to a network node, such as an eNB. The WTRU may receive from the eNB a confirmation of the at least one antenna virtualization matrix, and/or an indication of another antenna virtualization matrix of the plurality of virtualization matrices (e.g., an index corresponding to another antenna virtualization matrix). The WTRU may change from an antenna virtualization matrix that the WTRU determined to another antenna virtualization matrix (e.g., that the eNB may have indicated), perhaps for example upon receipt of an indication of another antenna virtualization matrix (e.g., an index of another antenna virtualization matrix sent by an eNB).

[0159] An antenna virtualization scheme may be used for WTRU transmit antennas. For example, a WTRU may use one or more antenna elements N_E at a transmitter. An eNB may configure an antenna virtualization scheme to the N_E antenna elements to form N_P antenna ports.

[0160] N_E antenna elements used at a WTRU transmitter may be a 2D antenna array. N_P may be equal to, or smaller than, one or more antenna ports that may be used for uplink transmission. A MIMO scheme may support N_P antenna ports in the system.

[0161] One or more, or multiple, types of SRS may be defined. A first type of SRS may be transmitted in antenna elements. A second type of SRS may be transmitted with antenna virtualization. A first type of SRS may be defined as N_E ports. A second type of SRS may be defined as N_P ports.

[0162] An antenna virtualization scheme may be defined as one or more of an antenna port to element mapping rule and/or an antenna virtualization matrix.

[0163] An uplink MIMO scheme may be dependent on one or more antenna virtualization schemes that may be configured for WTRU transmit antennas, for example. An uplink MIMO scheme may be used, for example, perhaps when N_E may be larger than a certain number predefined (N_{MAX}). An antenna port mode may be used (for example a single antenna port), for example, perhaps when N_E may be larger than N_{MAX} and/or an antenna virtualization scheme might not be configured. An antenna port mode may be considered (for example a single antenna port) as a default MIMO scheme. A MIMO scheme associated with N_P antenna ports may be used, for example, perhaps when N_E may be larger than N_{MAX} and/or an antenna virtualization scheme may be configured. For example, N_{MAX} may be four. A MIMO scheme associated with N_E antenna ports may be used, for example, perhaps when N_E may be equal to or smaller than N_{MAX} and/or an antenna virtualization scheme might not be configured. A WTRU may use a MIMO scheme associated with N_P antenna ports, for example, perhaps when a WTRU may be configured with an antenna virtualization scheme for the WTRU transmit antennas.

[0164] A dynamic indication may be used to adapt an antenna virtualization scheme, for example, perhaps for example when at least one of a set of configured antenna virtualization schemes may be indicated and/or other virtualization schemes may be available to adapt.

[0165] A Downlink control Information (DCI) used for aperiodic reporting may be used to indicate an antenna virtualization scheme for the CSI measurement. A WTRU may be requested and/or triggered to report aperiodic CSI by a DCI. The DCI may include information for antenna virtualization. A WTRU may assume a certain antenna virtualization scheme indicated in the DCI for the CSI measurement. An antenna virtualization scheme may be one or more of a CSI-RS

configuration, antenna virtualization matrix, codebook, and/or antenna port to antenna element mapping.

[0166] An antenna virtualization indication field may be defined in a DCI used for aperiodic reporting triggering. An antenna virtualization indication field may be activated/deactivated by eNB. An antenna virtualization indication field may be activated in a DCI according to a configured transmission mode. A group DCI may be used to indicate an antenna virtualization scheme. For example, a group Radio Network Temporary Identifier (RNTI) may be defined to indicate an antenna virtualization scheme. A WTRU configured with a group RNTI may assume that an antenna virtualization scheme is indicated in the DCI.

[0167] An implicit antenna virtualization adaptation may be used. For example, a WTRU may assume an associated antenna virtualization scheme, for example, perhaps when a WTRU may be configured with a transmission mode.

[0168] An antenna virtualization scheme may be determined as a function of one or more of a subframe number, a system frame number (SFN), and/or an OFDM symbol number in a subframe. For example, a WTRU measurement of a CSI in a subframe may (e.g., implicitly) indicate an antenna virtualization scheme, for example, based on a subframe number and/or an SFN number. An associated codebook for an antenna virtualization scheme may be used for CSI reporting.

[0169] An antenna virtualization scheme may be determined as a function of a virtual cell-ID. An antenna virtualization scheme may be derived from the virtual cell-ID configured for a CSI-RS, for example, perhaps when a CSI-RS may be configured with a virtual cell-ID. For example, a modulo operation may be used to derive an antenna virtualization scheme for a virtual cell-ID.

[0170] A WTRU may report a configured (e.g. useful, such as a relatively best optimized) antenna virtualization scheme among a set of antenna virtualization schemes.

[0171] A WTRU may report a useful (e.g., such as a relatively best optimized) antenna virtualization scheme from among a set of defined and/or configured antenna virtualization schemes. A WTRU reporting of a useful (e.g., such as a relatively best optimized) antenna virtualization scheme may be periodic and/or aperiodic. An eNB may be triggered to report a useful (e.g., such as a relatively best optimized) antenna virtualization scheme. A bit field may be defined for useful (e.g., such as a relatively best optimized) antenna virtualization scheme reporting in a DCI used for aperiodic reporting triggering. A useful antenna virtualization scheme reporting may be event-triggered. A WTRU may measure an antenna virtualization scheme and/or report to an eNB for a useful (e.g., such as a relatively best optimized) antenna virtualization scheme. For example, the WTRU may measure an antenna virtualization scheme and/or report to an eNB for a useful (e.g., such as a relatively best optimized) antenna virtualization scheme,

perhaps when a CQI for a certain antenna virtualization scheme may be lower than a predefined threshold.

[0172] An antenna virtualization scheme may be defined as one or more of a CSI-RS configuration, codebook, and/or feedback mode. One or more, or multiple, antenna virtualization schemes may be configured. An antenna virtualization scheme may be a CSI-RS. Associated codebooks for one or more, or each, CSI-RS may be defined independently. A WTRU may determine a useful (e.g., such as a relatively best optimized) antenna virtualization scheme. A WTRU may measure CSI for a CSI-RS configured with its associated codebook. A WTRU may select an antenna virtualization scheme, for example, that may provide the highest throughput performance based on the measured CSI.

[0173] Systems, methods, and instrumentalities are contemplated for antenna virtualization in at least a two-dimensional antenna array. N_E physical antenna elements may be virtualized to N_P logical antenna ports. A virtualization may be WTRU-specific, which may optimize MIMO performance. A simplified MIMO scheme may be used with reduction in feedback, reference signal, and/or control signaling overhead. One or more antenna virtualization schemes may utilize channel characteristics. Antenna virtualization may be defined, for example, based on antenna port to antenna element mapping, based on a measurement reference signal, based on a codebook and/or a codebook subset, and/or based on an antenna virtualization matrix. One or more, or multiple, antenna virtualization schemes may be configured in a cell. Antenna virtualization schemes may be configured in a WTRU-specific manner, perhaps for example based on one or more WTRU channel characteristics. A WTRU may report a useful (e.g., such as a relatively best optimized) antenna virtualization scheme, e.g., based on a measurement.

[0174] A WTRU may refer to an identity of the physical device, or to the user's identity such as subscription related identities, e.g., MSISDN, SIP URI, etc. WTRU may refer to application-based identities, e.g., user names that may be used per application.

[0175] The processes and instrumentalities described herein may apply in any combination, may apply to other wireless technologies, and for other services. Although features and elements are described herein in example combinations, one of ordinary skill in the art will appreciate that one or more, or each, feature or element can be used alone or in any combination with any of the other features and elements. The processes described above may be implemented in a computer program, software, and/or firmware incorporated in a computer-readable medium for execution by a computer and/or processor. Examples of computer-readable media include, but are not limited to, electronic signals (transmitted over wired and/or wireless connections) and/or computer-readable storage media. Examples of computer-readable storage media include, but are

not limited to, a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as, but not limited to, internal hard disks and removable disks, magneto-optical media, and/or optical media such as CD-ROM disks, and/or digital versatile disks (DVDs). A processor in association with software may be used to implement a radio frequency transceiver for use in a WTRU (UE), terminal, base station, RNC, and/or any host computer.

CLAIMS

What is Claimed is:

1. A method performed by a wireless transmit/receive unit (WTRU), the method comprising:

receiving, via a receiver, at least one downlink (DL) reference signal;

determining, via a processor, based on the DL reference signal, at least one antenna virtualization matrix of a plurality of antenna virtualization matrices;

determining, via the processor, a codebook based on the at least one antenna virtualization matrix;

transforming a first at least two-dimensional (2D) antenna array into a second at least 2D antenna array using the at least one antenna virtualization matrix, the second at least 2D array being smaller than the first at least 2D array; and

transmitting, via a transmitter, feedback to an evolved-node B (eNB) using at least a part of the codebook.

2. The method of claim 1, wherein the plurality of antenna virtualization matrices are specific to the WTRU.

3. The method of claim 1, wherein the feedback includes at least one of: a precoder matrix index (PMI), a rank indication (RI), or a channel quality indication (CQI).

4. The method of claim 1, wherein the at least one antenna virtualization matrix is an optimized antenna virtualization matrix of the plurality of antenna virtualization matrices.

5. The method of claim 1, wherein the at least one antenna virtualization matrix is determined based on one or more characteristics of at least one WTRU channel.

6. The method of claim 1, wherein the at least one antenna virtualization matrix includes configuration information for at least one of: an antenna port for a vertical antenna or an antenna port for a horizontal antenna.

7. The method of claim 1, wherein the DL reference signal is at least one of: a precoded signal, or a non-precoded signal.

8. The method of claim 1, wherein the feedback is transmitted to the eNB using a subset of the codebook.

9. The method of claim 1, where the at least one antenna virtualization matrix is defined as a physical antenna element to logical antenna port mapping.

10. The method of claim 1, wherein the plurality of antenna virtualization matrices are preconfigured on the WTRU.

11. The method of claim 1, further comprising:

receiving, via the receiver, the plurality of antenna virtualization matrices from the eNB.

12. The method of claim 1, further comprising:

performing at least one measurement on the DL reference signal, wherein the at least one antenna virtualization matrix is determined based on the at least one measurement.

13. The method of claim 1, further comprising:

determining, via the processor, a channel state information reference signal (CSI-RS) configuration corresponding to the at least one antenna virtualization matrix.

14. The method of claim 1, further comprising:

determining an antenna virtualization matrix index corresponding to the at least one antenna virtualization matrix, wherein at least one of: the codebook or a subset of the codebook, further corresponds to the antenna virtualization matrix index.

15. The method of claim 14, further comprising:

transmitting, via the transmitter, the antenna virtualization matrix index to the eNB; and

receiving, via the receiver, from the eNB at least one of: a confirmation of the at least one antenna virtualization matrix, or an indication of another antenna virtualization matrix of the plurality of virtualization matrices.

16. The method of claim 15, further comprising:

changing from the at least one antenna virtualization matrix to the other antenna virtualization matrix upon receipt of the indication of the other antenna virtualization matrix.

17. A wireless transmit/receive unit (WTRU), comprising:

a receiver, the receiver configured at least to receive at least one downlink (DL) reference signal;

a processor, the processor configured at least to:

determine, based on the DL reference signal, at least one antenna virtualization matrix of a plurality of antenna virtualization matrices;

determine a codebook based on the at least one antenna virtualization matrix; and

transform a first at least two-dimensional (2D) antenna array into a second at least 2D antenna array using the at least one antenna virtualization matrix, the second at least 2D array being smaller than the first at least 2D array; and

a transmitter, the transmitter configured at least to send feedback to an evolved-node B (eNB) using at least a part of the codebook.

18. The WTRU of claim 17, wherein the plurality of antenna virtualization matrices are specific to the WTRU.

19. The WTRU of claim 17, wherein the feedback includes at least one of: a precoder matrix index (PMI), a rank indication (RI), or a channel quality indication (CQI).

20. The WTRU of claim 17, wherein the at least one antenna virtualization matrix is an optimized antenna virtualization matrix of the plurality of antenna virtualization matrices.

21. The WTRU of claim 17, wherein the processor is further configured such that the at least one antenna virtualization matrix is determined based on one or more characteristics of at least one WTRU channel.

22. The WTRU of claim 17, wherein the at least one antenna virtualization matrix includes configuration information for at least one of: an antenna port for a vertical antenna or an antenna port for a horizontal antenna.

23. The WTRU of claim 17, wherein the DL reference signal is at least one of: a precoded signal, or a non-precoded signal.

24. The WTRU of claim 17, wherein the feedback is transmitted to the eNB using a subset of the codebook.

25. The WTRU of claim 17, wherein the processor is further configured to determine a channel state information reference signal (CSI-RS) configuration corresponding to the at least one antenna virtualization matrix.

26. An evolved-Node B (eNB), comprising:

a transmitter, the transmitter configured to at least:

send at least one downlink (DL) reference signal to a wireless transmit/receive unit (WTRU); and

send a plurality of antenna virtualization matrices to the WTRU;

a receiver, the receiver configured to at least:

receive an indication of at least one antenna virtualization matrix of the plurality of antenna virtualization matrices; and

receive feedback from the WTRU, the feedback sent using at least a part of the codebook corresponding to the at least one antenna virtualization matrix; and

a processor, the processor configured at least to:

determine to send to the WTRU at least one of: a confirmation of the at least one antenna virtualization matrix, or an indication of another antenna virtualization matrix of the plurality of virtualization matrices.

27. The eNB of claim 26, wherein the plurality of antenna virtualization matrices are specific to the WTRU.

28. The eNB of claim 26, wherein the feedback includes at least one of: a precoder matrix index (PMI), a rank indication (RI), or a channel quality indication (CQI).

29. The eNB of claim 26, wherein the DL reference signal is at least one of: a precoded signal, or a non-precoded signal.

30. The eNB of claim 26, wherein the feedback is sent to the eNB using a subset of the codebook.

31. The eNB of claim 26, wherein the plurality of antenna virtualization matrices include configuration information for at least one of: an antenna port for a vertical antenna or an antenna port for a horizontal antenna.

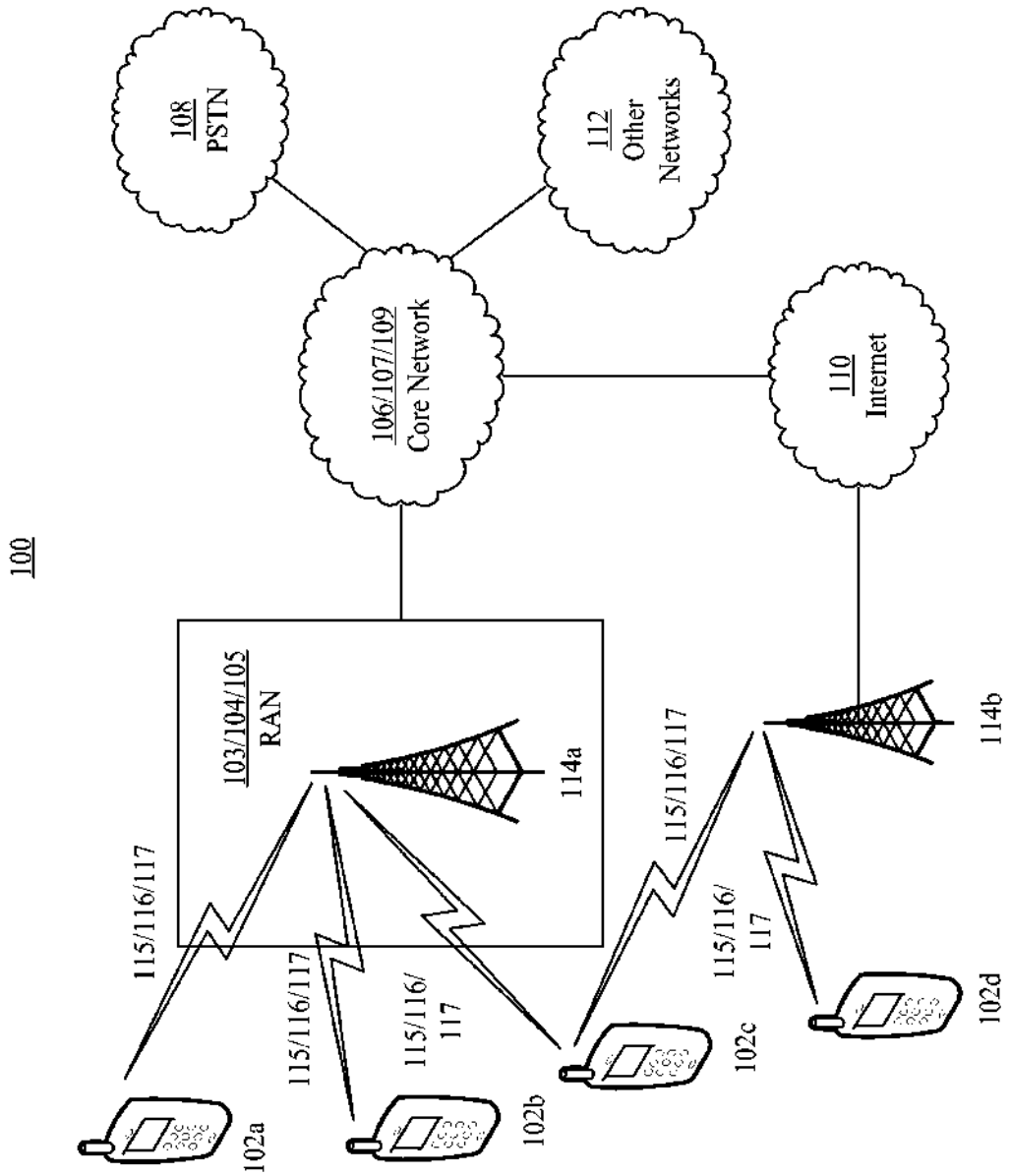

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108
PSTN
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Other
Networks
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Core Network
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Internet
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RAN
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114b
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FIG. 1A

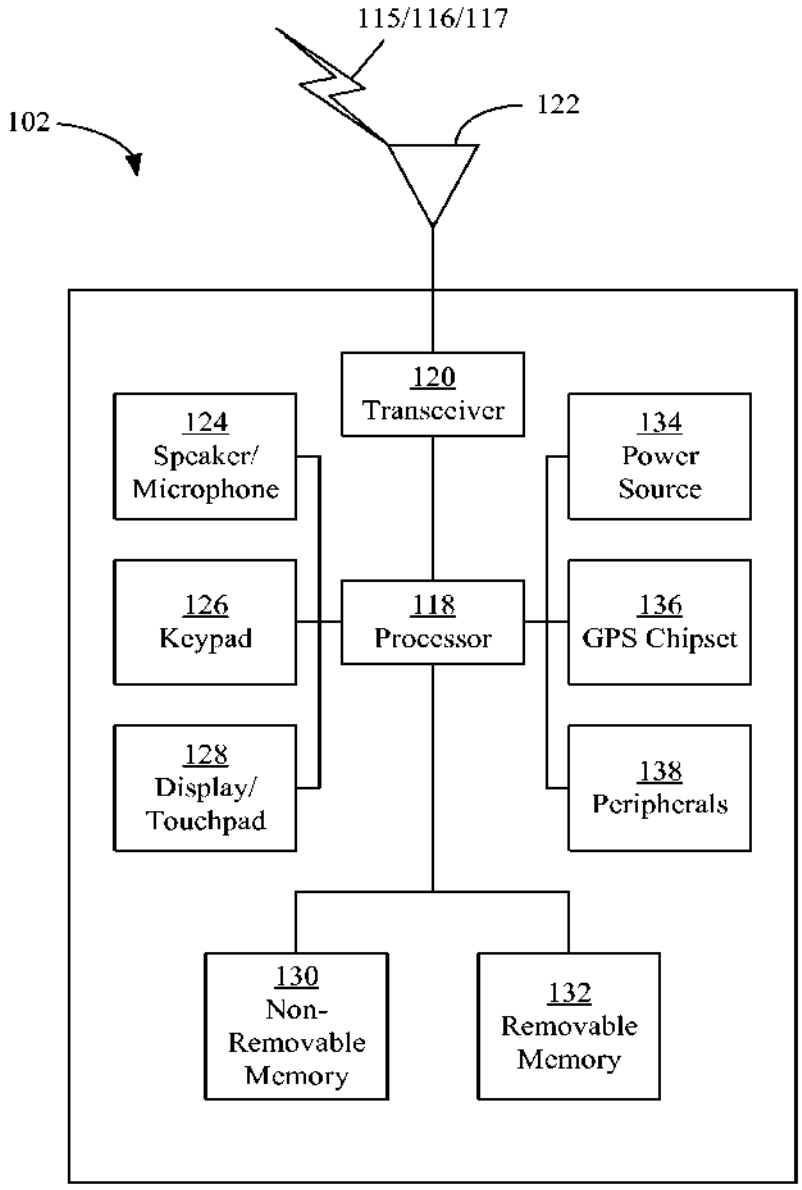

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102
120
Transceiver
124
Speaker/
Microphone
134
Power
Source
126
Keypad
118
Processor
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GPS Chipset
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Display/
Touchpad
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130
Non-
Removable
Memory
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Removable
Memory

FIG. 1B

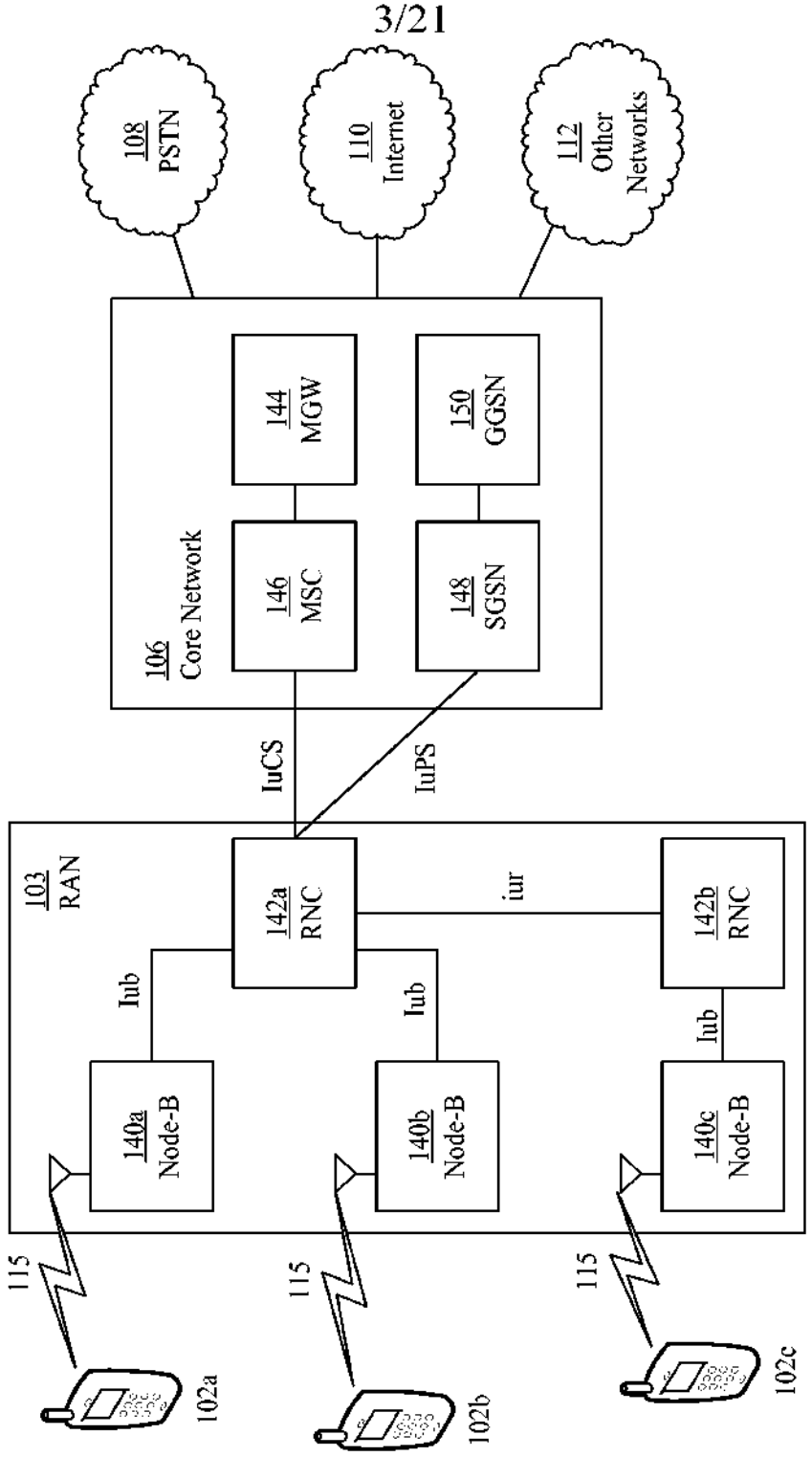

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106 Core Network
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150 GGSN
146 MSC
148 SGSN
IuCS
IuPS
103 RAN
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iur
142b RNC
Iub
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140b Node-B
140c Node-B
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102b
102c

FIG. 1C

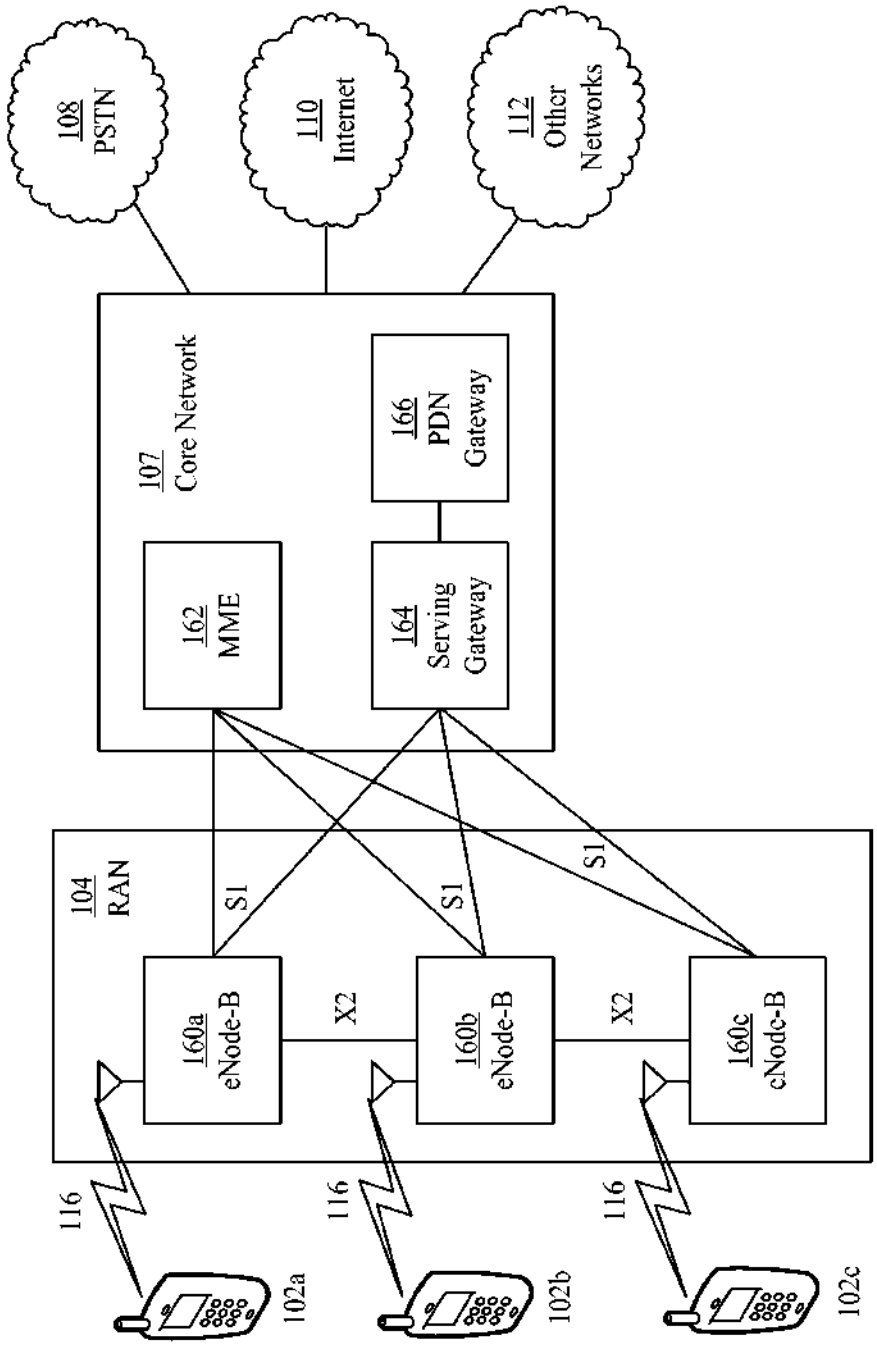

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112 Other Networks
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166 PDN Gateway
162 MME
164 Serving Gateway
104 RAN
S1
S1
S1
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102a
102b
102c

FIG. 1D

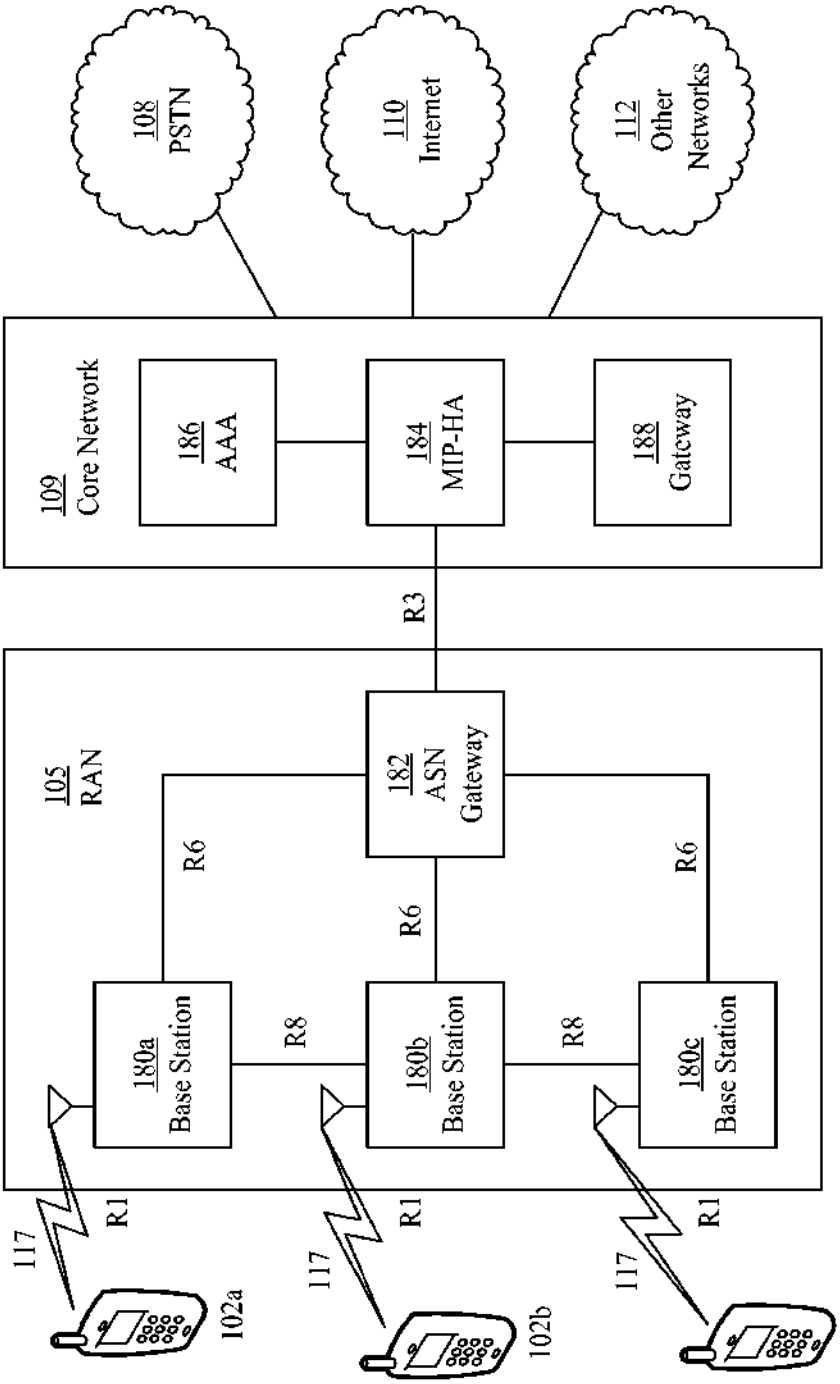
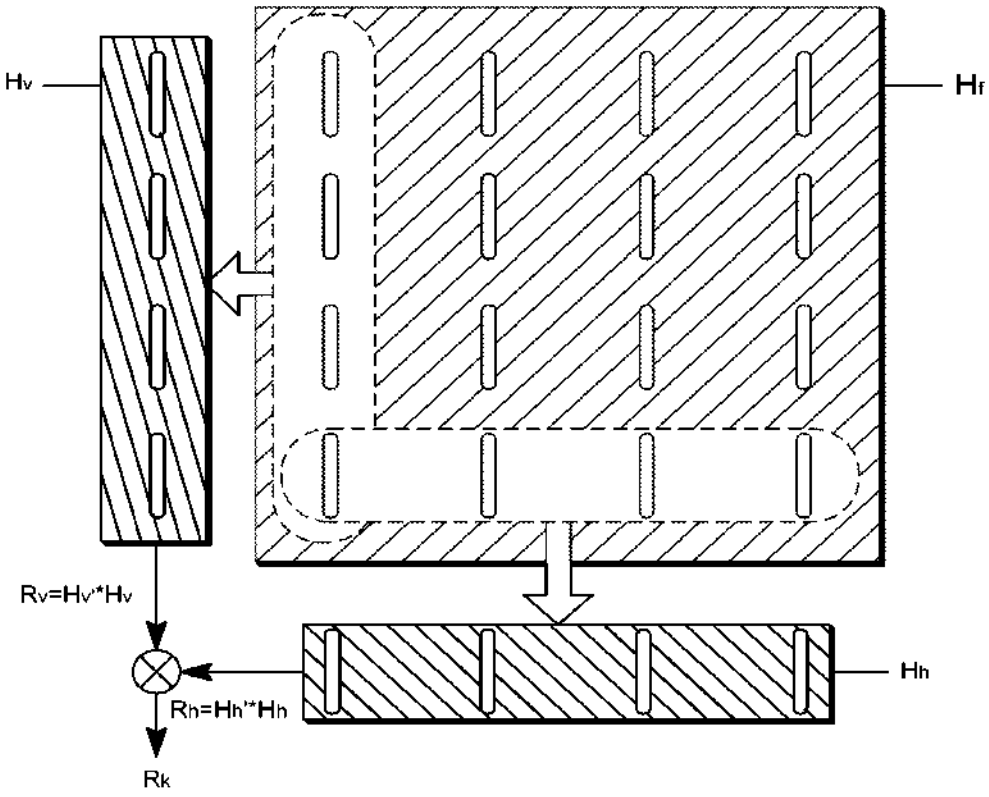
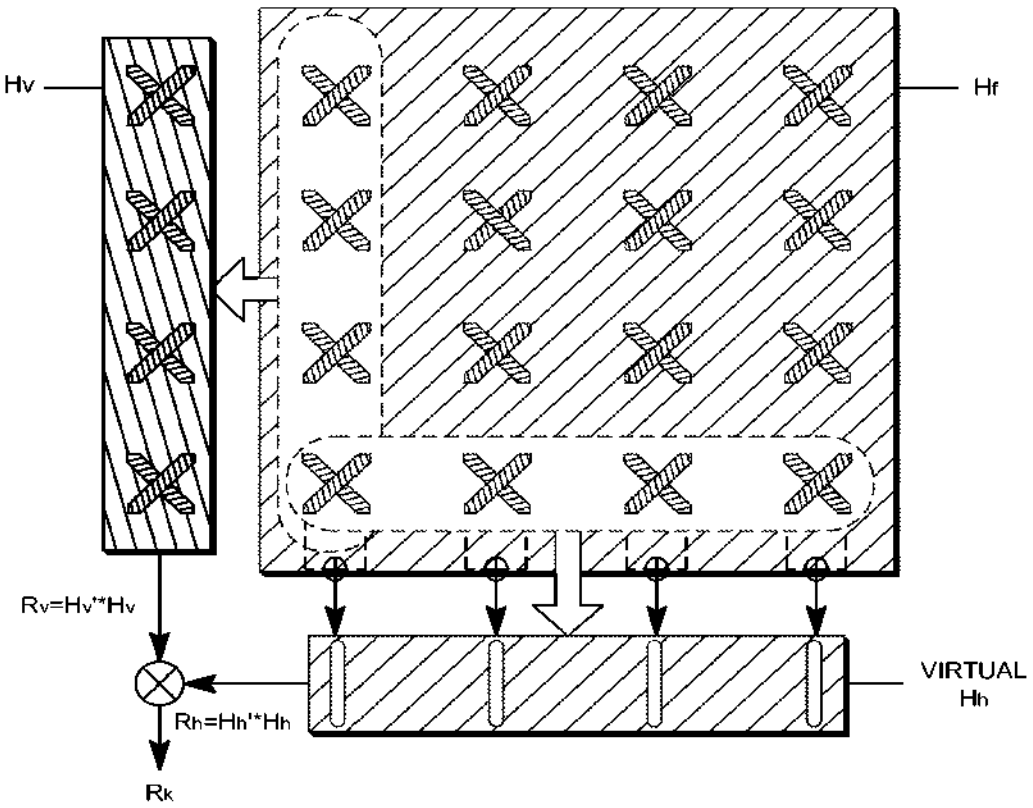

108
PSTN
110
Internet
112
Other
Networks
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Core Network
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AAA
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MIP-HA
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Gatcway
R3
105
RAN
182
ASN
Gateway
R6
R6
R6
180a
Base Station
180b
Base Station
180c
Base Station
R8
R8
R1
R1
R1
117
117
117
102a
102b
102c

FIG. 1E



(a) CO-POLARIZATION (4,4,1)

FIG. 2



(b) CROSS-POLARIZATION (4,4,2)

FIG. 3

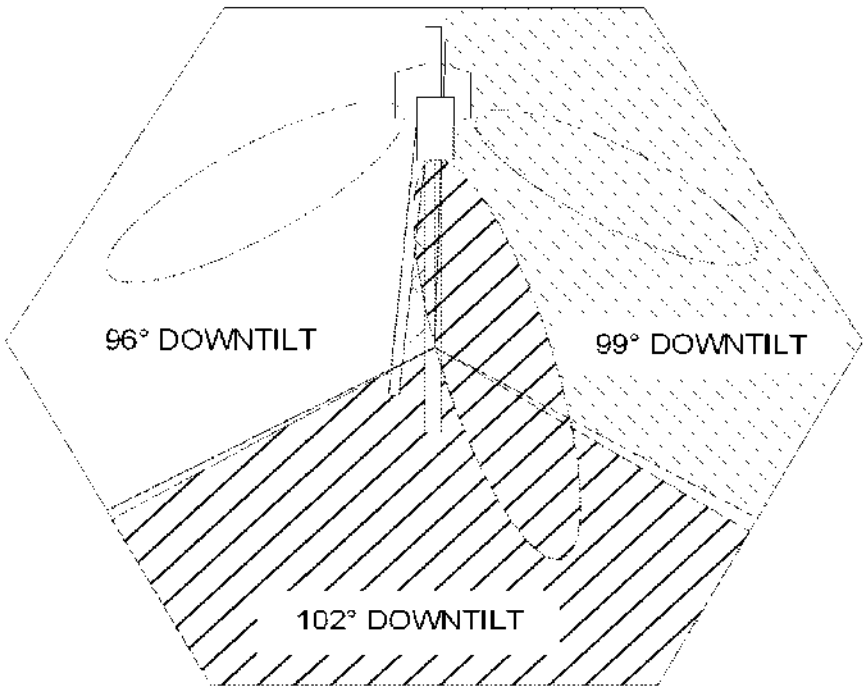


FIG. 4

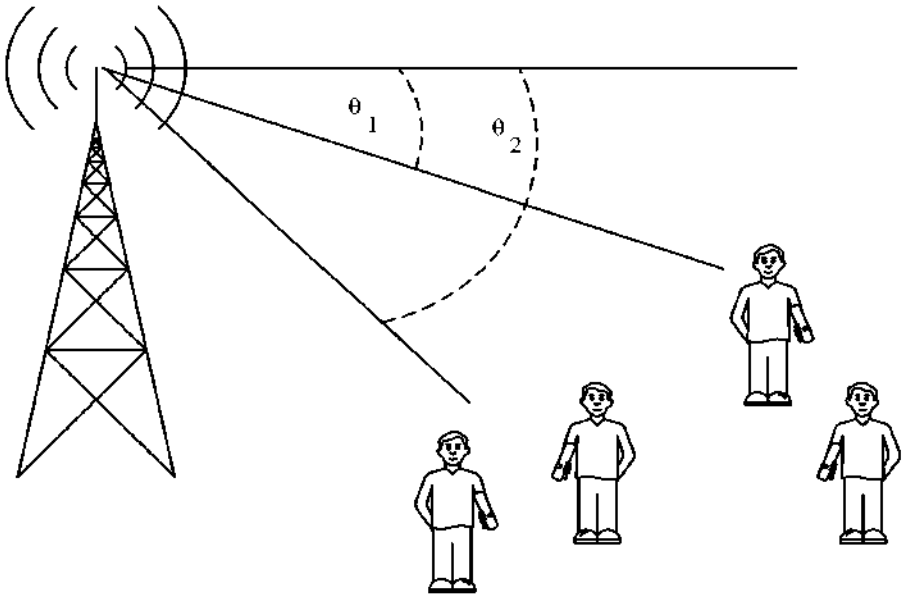


FIG. 5

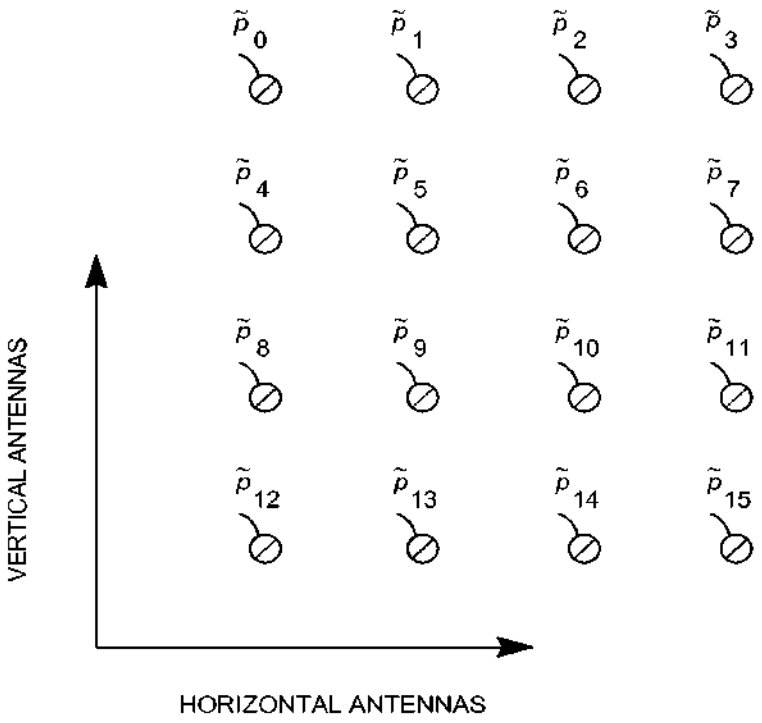

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$\tilde{p}_{15}$
VERTICAL ANTENNAS
HORIZONTAL ANTENNAS

FIG. 6

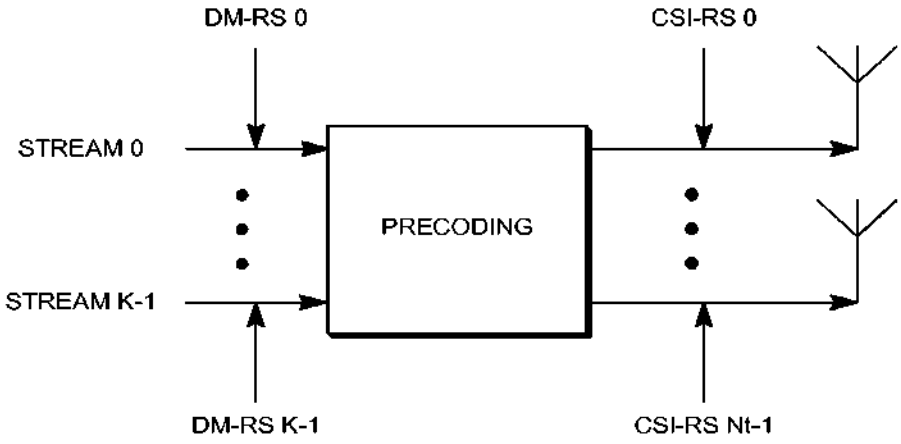


FIG. 7

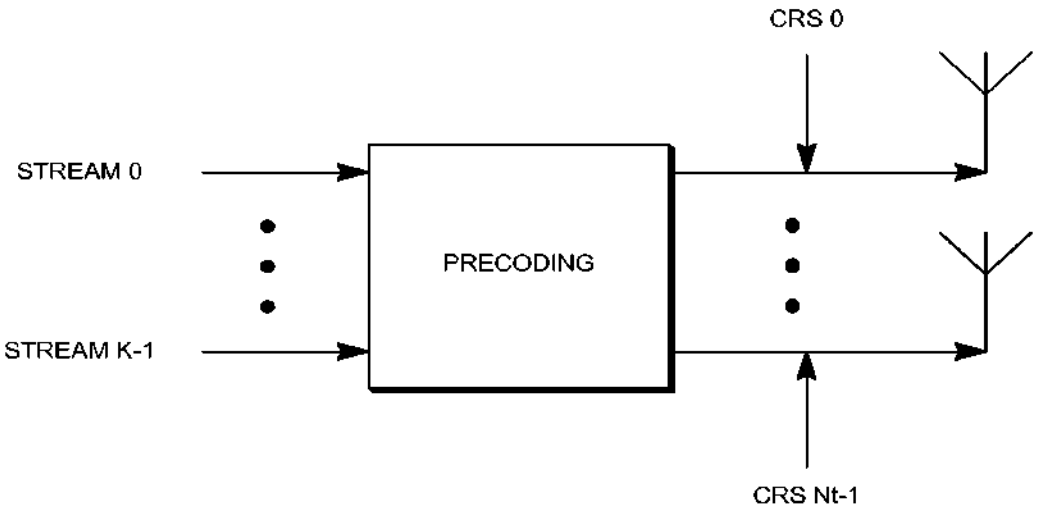


FIG. 8

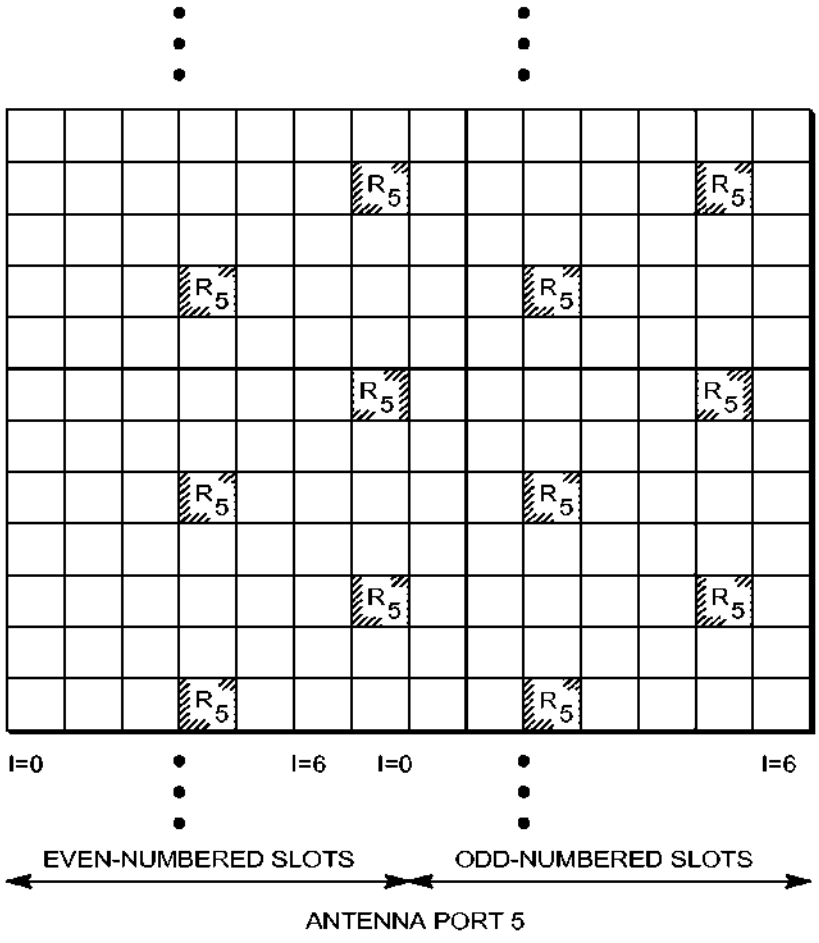

R5
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EVEN-NUMBERED SLOTS
ODD-NUMBERED SLOTS
ANTENNA PORT 5

FIG. 9

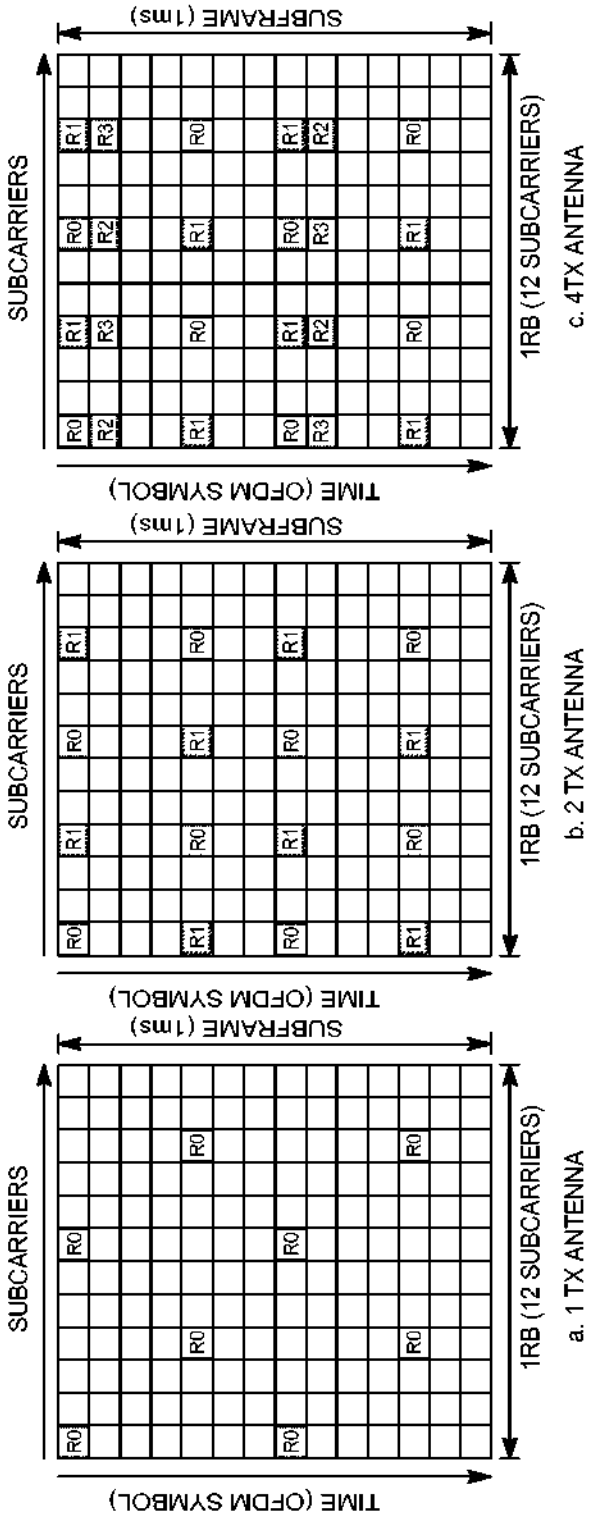

SUBFRAME (1ms)
SUBCARRIERS
TIME (OFDM SYMBOL)
1RB (12 SUBCARRIERS)
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b. 2 TX ANTENNA
c. 4TX ANTENNA
R0
R1
R2
R3

FIG. 10

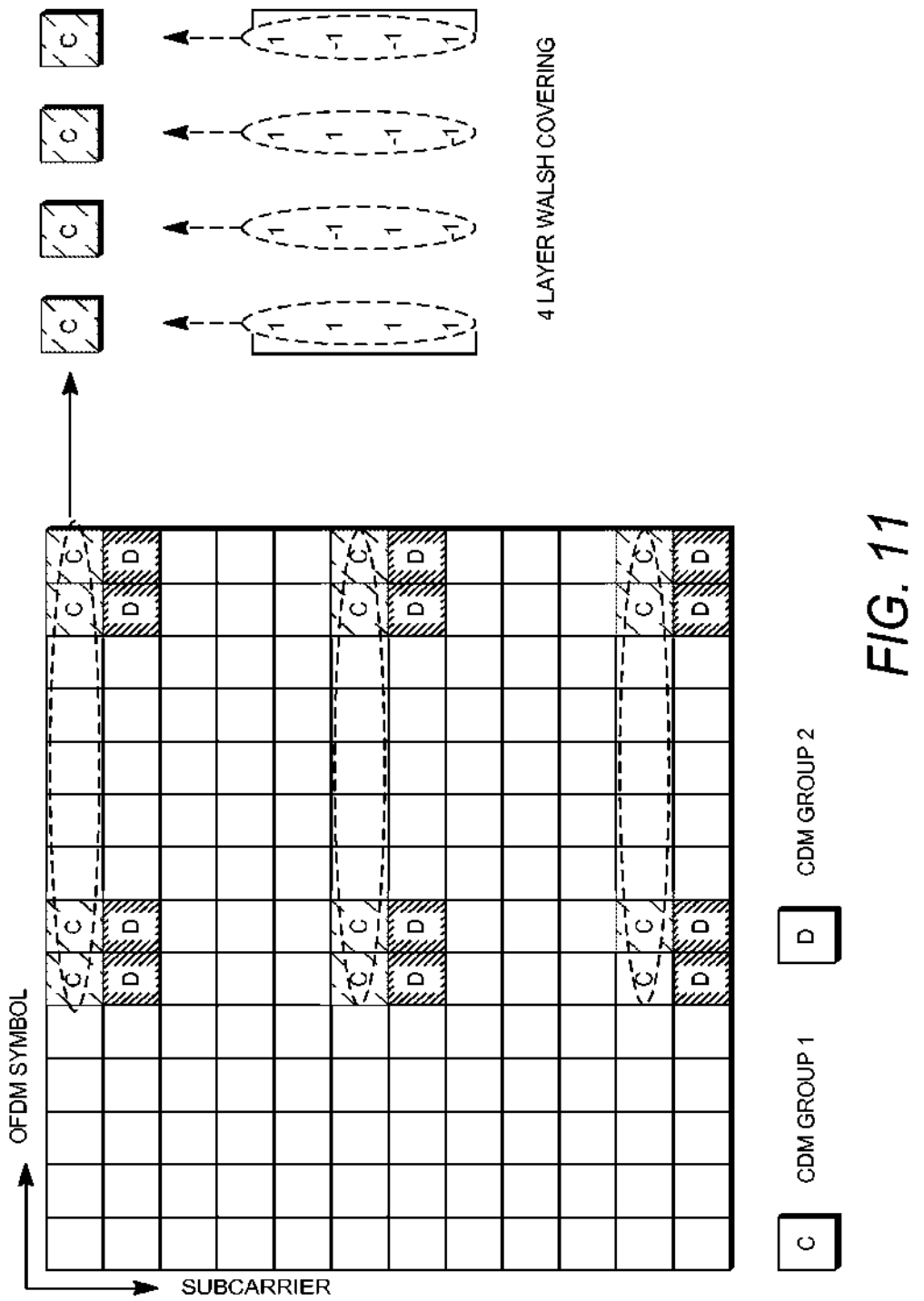

4 LAYER WALSH COVERING
OFDM SYMBOL
SUBCARRIER
CDM GROUP 1
CDM GROUP 2
C
D

FIG. 11

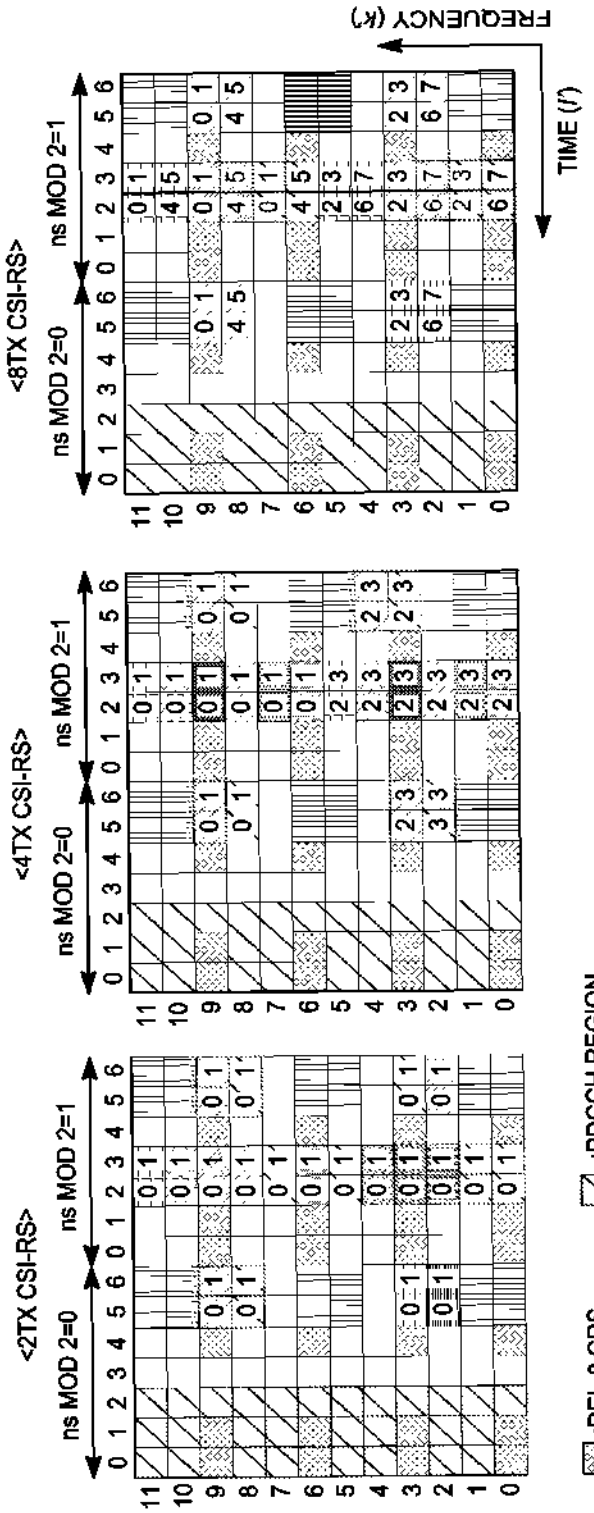

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TIME (l')
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:REL-9/10 DM-RS
:PDSCH

FIG. 12

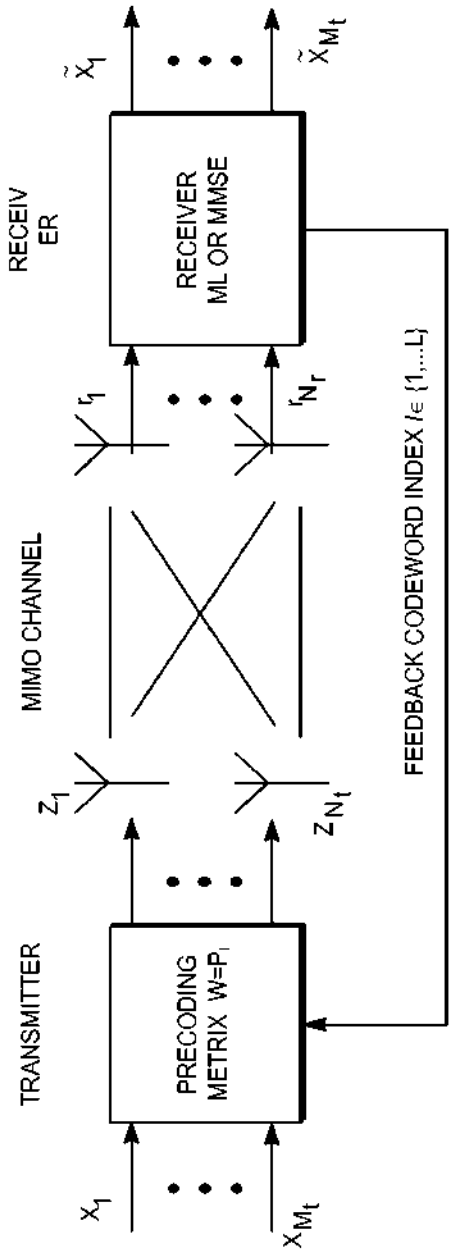

TRANSMITTER
PRECODING METRIX W=P_i
MIMO CHANNEL
RECEIV ER
RECEIVER ML OR MMSE
FEEDBACK CODEWORD INDEX i∈ {1,...L}

FIG. 13

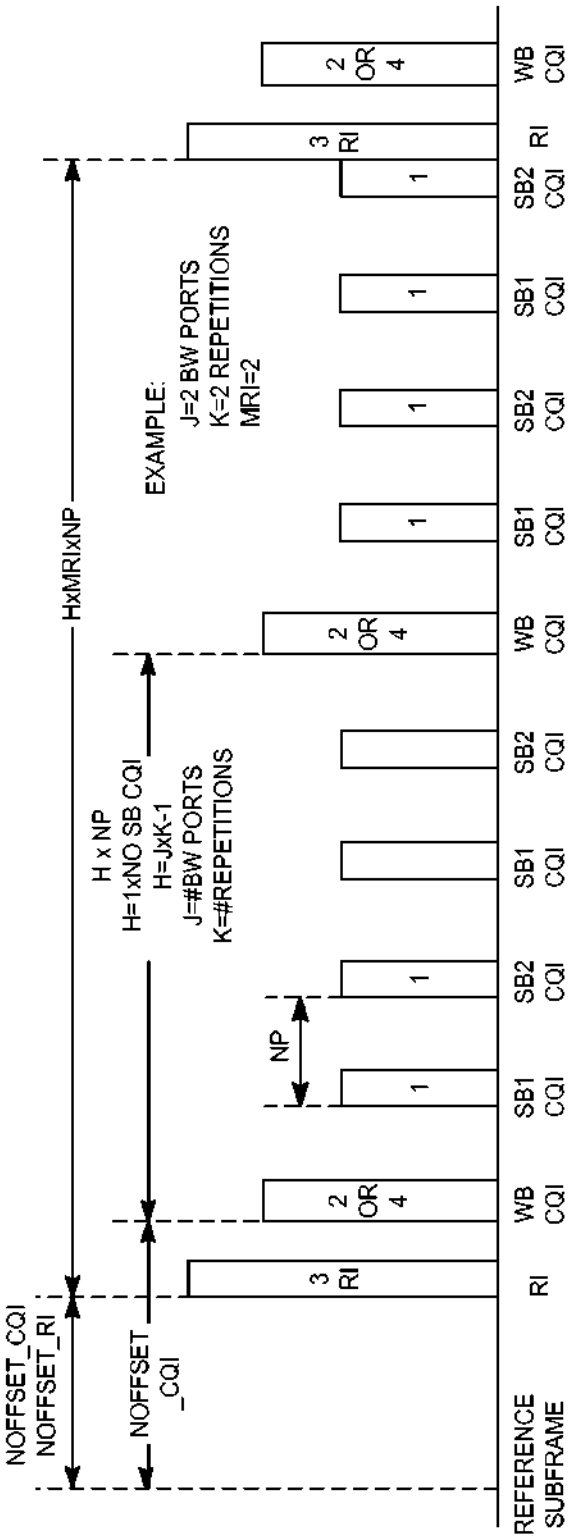

REFERENCE SUBFRAME
NOFFSET_CQI
NOFFSET_RI
NOFFSET_CQI
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H x NP
H=1xNO SB CQI
H=JxK-1
J=#BW PORTS
K=#REPETITIONS
NP
EXAMPLE:
J=2 BW PORTS
K=2 REPETITIONS
MRI=2
RI
WB CQI
SB1 CQI
SB2 CQI
3 RI
2 OR 4
1

FIG. 14

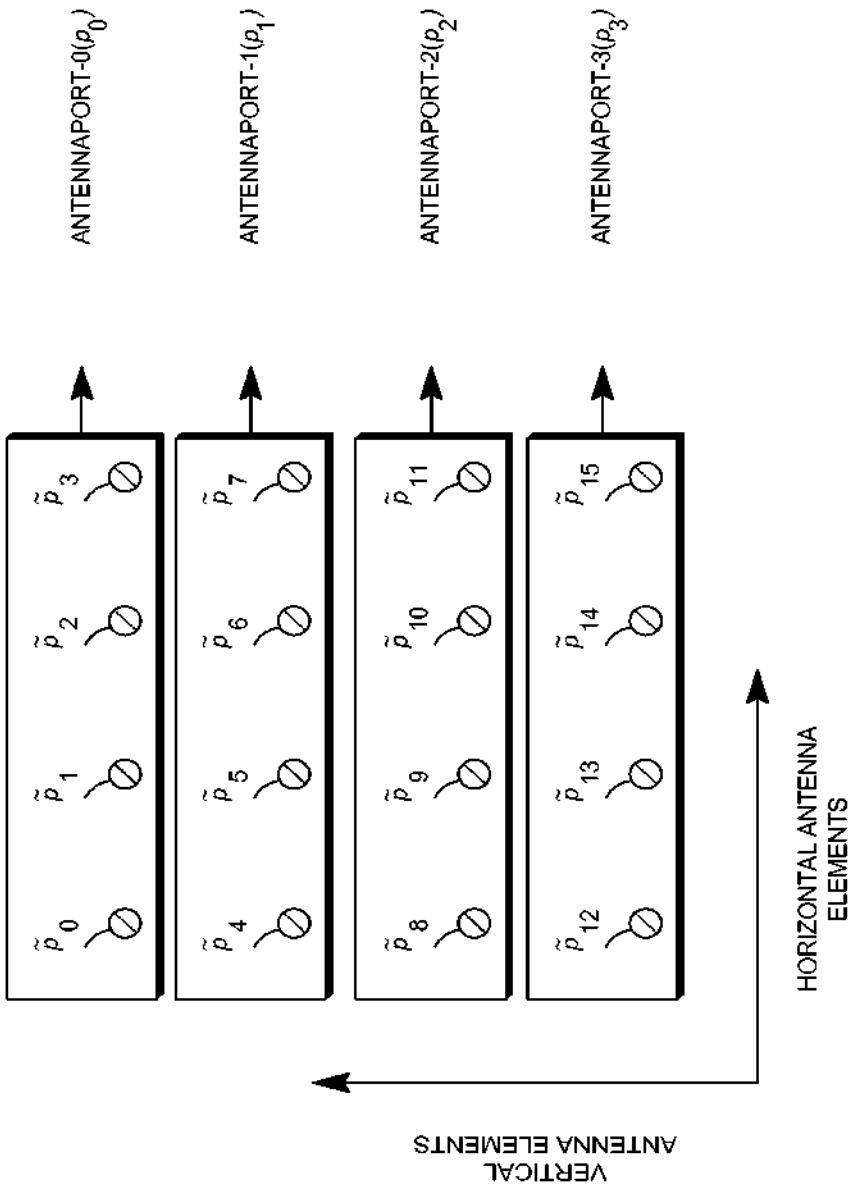

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ANTENNAPORT-1(p_1)
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HORIZONTAL ANTENNA ELEMENTS
VERTICAL ANTENNA ELEMENTS

FIG. 15

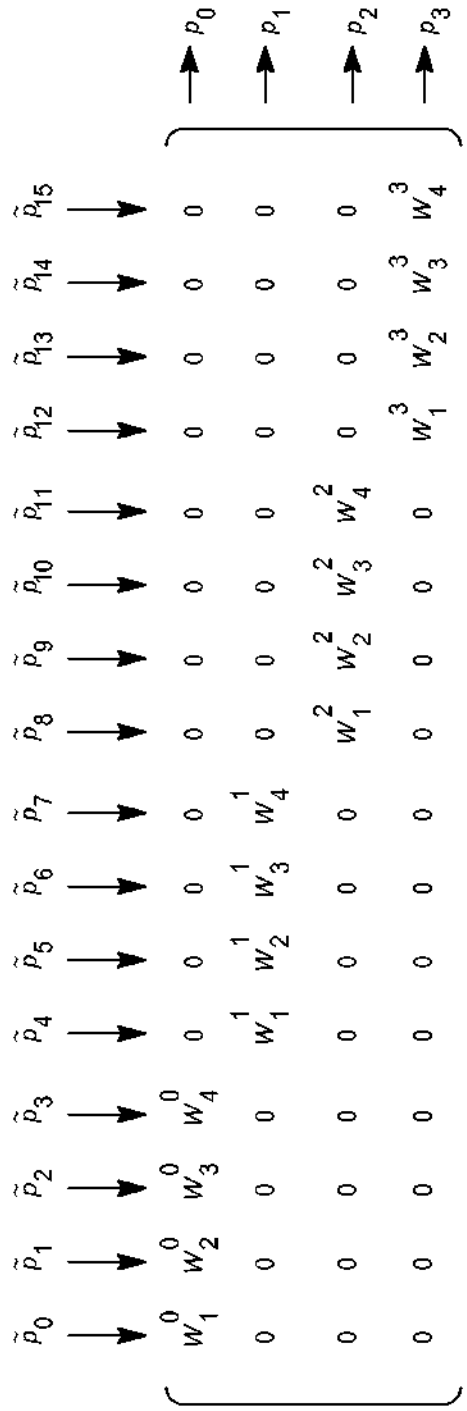

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W_1^0 W_2^0 W_3^0 W_4^0 W_1^1 W_2^1 W_3^1 W_4^1 W_1^2 W_2^2 W_3^2 W_4^2 W_1^3 W_2^3 W_3^3 W_4^3

FIG. 16

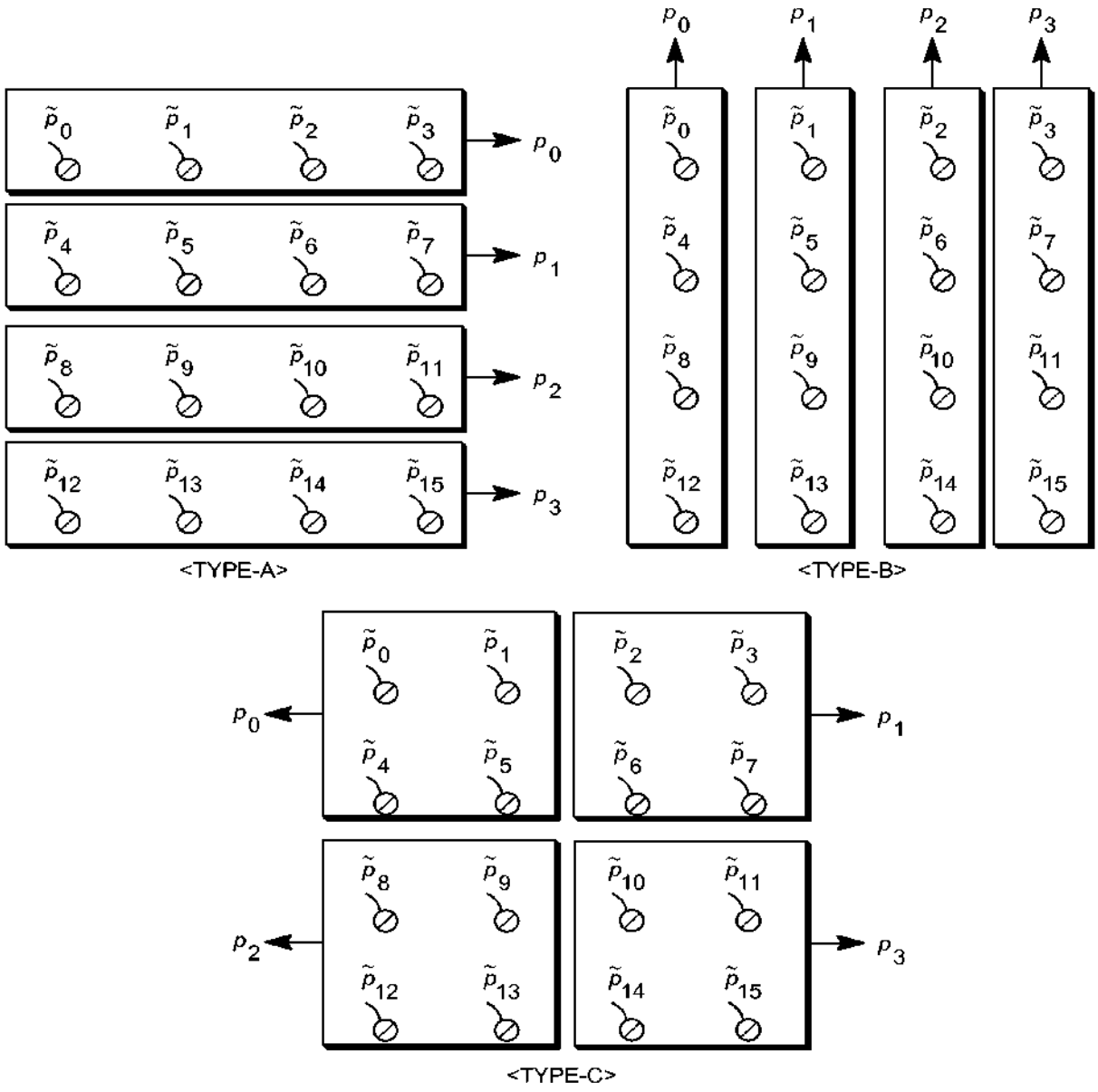

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FIG. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/060381

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B7/04 H04B7/06 H04L5/00
ADD.

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 H01Q

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/098689 A1 (LEE MOON-IL [US] ET AL) 10 April 2014 (2014-04-10) paragraphs [0070], [0073] - [0076], [0112], [0134], [0146] - [0150], [0156], [0172]; figure 17	1-31
A	US 2014/177744 A1 (KRISHNAMURTHY SANDEEP H [US] ET AL) 26 June 2014 (2014-06-26) paragraphs [0031] - [0038], [0048], [0057], [0077], [0091], [0105]	1-31

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"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
18 January 2016	26/01/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Muntean, T

2

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2015/060381

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014098689 A1	10-04-2014	EP 2901571 A1	05-08-2015
		JP 2015536099 A	17-12-2015
		TW 201429182 A	16-07-2014
		US 2014098689 A1	10-04-2014
		WO 2014052806 A1	03-04-2014
US 2014177744 A1	26-06-2014	CN 105210307 A	30-12-2015
		EP 2936703 A1	28-10-2015
		KR 20150098665 A	28-08-2015
		US 2014177744 A1	26-06-2014
		WO 2014099346 A1	26-06-2014

Form PCT/ISA/210 (patent family annex) (April 2005)

Electronic Acknowledgement Receipt

EFS ID:	45099979
Application Number:	17143180
International Application Number:	
Confirmation Number:	3253
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	155075
Filer:	Jialin Zhong/Eddie Rowell
Filer Authorized By:	Jialin Zhong
Attorney Docket Number:	20160089-PCT-US-DA1
Receipt Date:	28-FEB-2022
Filing Date:	07-JAN-2021
Time Stamp:	14:19:19
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	Information Disclosure Statement (IDS) Form (SB08)	ZL0205-0002-PCT-US-CON1_IDS.pdf	1034618 3ce0c7875df95990649c756fd664693faeb7849b	no	4

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Information:					
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2	Foreign Reference	CN105207705A.pdf	5016592 86ad1a40d911a52862876bd7b026c33af78e7c5	no	23
Warnings:					
Information:					
3	Foreign Reference	CN101447815A.pdf	4893717 61f95e715cd1940c53f6117c92a4fef0b3688113	no	26
Warnings:					
Information:					
4	Foreign Reference	CN105656607A.pdf	2876406 976d7a1e2aa0f78c20ae19bd188195c42a5b802	no	13
Warnings:					
Information:					
5	Foreign Reference	WO2016077584A1.pdf	3730376 0a0a708a949c5191048802e94ac79a3446ffcadc	no	63
Warnings:					
Information:					
6	Other reference-Patent/Application/ Search Documents	Search_Report_20201032075 74.pdf	360933 d5e43d440f24808d398779703e53a0634a35a664	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	17912642	

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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

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United States Patent and Trademark Office
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/143,180	01/07/2021	OPAP	1070	20160089-PCT-US-DA1	20	4

CONFIRMATION NO. 3253

REPLACEMENT FILING RECEIPT

155075
Zhong Law, LLC
100 Connell Drive
Suite 2300
Berkeley Heights, NJ 07922

OC000000129826773

Date Mailed: 11/17/2021

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.

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Inventor(s)

Xiaobo ZHANG, Shanghai, CHINA;

Applicant(s)

APEX BEAM TECHNOLOGIES LLC, MARSHALL, TX;

Assignment For Published Patent Application

APEX BEAM TECHNOLOGIES LLC, MARSHALL, TX

Power of Attorney: The patent practitioners associated with Customer Number 155075

Domestic Priority data as claimed by applicant

This application is a CON of 16/429,077 06/03/2019 PAT 10944527
which 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

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Permission to Access Search Results: Yes

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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: 01/21/2021
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/143,180**
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

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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.

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/143,180	01/07/2021	Xiaobo ZHANG	20160089-PCT-US-DA1

CONFIRMATION NO. 3253

155075
Zhong Law, LLC
100 Connell Drive
Suite 2300
Berkeley Heights, NJ 07922

POA ACCEPTANCE LETTER



Date Mailed: 11/17/2021

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**.

/mtcklemichael/

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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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	17/143,180
Filing Date	01-07-2021
First Named Inventor	Xiaobo ZHANG
Title	Method and Device for Multi-Antenna Transmission in UE and Base Station
Art Unit	
Examiner Name	
Attorney Docket Number	ZL0205-0002-PCT-US-CON1

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

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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.**

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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.

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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: APEX BEAM TECHNOLOGIES LLC

Application No./Patent No.: 17/143,180 Filed/Issue Date: 01-07-2021

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 057757, Frame 0344, 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.

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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

[Page 2 of 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.

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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).
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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:	44265830
Application Number:	17143180
International Application Number:	
Confirmation Number:	3253
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:	Jialin Zhong/Eddie Rowell
Filer Authorized By:	Jialin Zhong
Attorney Docket Number:	20160089-PCT-US-DA1
Receipt Date:	12-NOV-2021
Filing Date:	07-JAN-2021
Time Stamp:	10:01:26
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-CON1_Marked_up_ADS.pdf	1667597 a1231b623589b85fa0d1be6a16ad599111a10863d6	no	7

Warnings:

Information:					
This is not an USPTO supplied ADS fillable form					
2	Power of Attorney	ZL0205-0002-PCT-US-CON1_82A.pdf	219915 ce2bb572811ee6fcc8c6fd1e72d825713a8ab2e6c	no	1
Warnings:					
Information:					
3	Power of Attorney	POA82B_Apex_ex.pdf	1100582 d420cacc9e65ed86bfe977d510b06e062166a185	no	2
Warnings:					
Information:					
4	Assignee showing of ownership per 37 CFR 3.73	ZL0205-0002-PCT-US-CON1_3_73c.pdf	121185 85c15e98dc3b200f3c72ac3763719ada4a906526	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	3109279		

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-DA1
	Application Number	17/143,180
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 601, BUILDING 34, NO. 2777 EAST JINXIU ROAD		
Address 2	Pudong District		
City	Shanghai	**State/Province**	OT
Postal Code	201206	**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-DA1	**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

WEB ADS 1.0

PTO/AIA/14 (08-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/429,077	2019-06-03

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16/429,077	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)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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-DA1
	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	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-DA1
	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 601, BUILDING 34, NO. 2777 EAST JINXIU ROAD~~ 104 EAST HOUSTON STREET		
Address 2	~~Pudong District~~ SUITE 180		
City	~~Shanghai~~ MARSHALL	**State/Province**	~~CT~~ TX
Country i	~~CN~~ US	Postal Code	~~201206~~ 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-DA1
	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
17/143,180	01/07/2021	Xiaobo ZHANG	20160089-PCT-US-DA1

CONFIRMATION NO. 3253

157297
Langbo Communication Technology Co. LTD
4132 SNOWBANK CT.
SAN JOSE, CA 95135

PUBLICATION NOTICE

OC000000125253009

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

Publication No.US-2021-0126751-A1
Publication Date:04/29/2021

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

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	17143180
Filing Date	2021-01-07
First Named Inventor	Xiaobo ZHANG
Art Unit	2472
Examiner Name	
Attorney Docket Number	

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	Electronics and Telecommunications Research Insti	
	2	20150010106	A1	2015-01-08	Nokia Solutions and Networks Oy	
	3	20110223876	A1	2011-09-15	Jee Woong Kang	

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	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY	Abstract and drawingsheets of the patentspecification, paragraphs58、67-97 of thespecification,	

EFS Web 2.1.17

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	
	Attorney Docket Number	

	2	103687010	CN	A	2014-03-26	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY		
	3	101567865	CN	A	2009-10-28	TD TECH LTD		
	4	2016018100	WO	A1	2016-02-04	LG ELECTRONICS INC		

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.	T5
	1	Nortel Discussion on RS Designfor Higher-order MIMOin LTE-A,2009.03.27 3GPPTSG-RAN Working Group 1 Meeting#56bis R1-091591	
	2	LG Electronics RS designenhancements forsupporting EB and FD-MIMO,2014.10.10,3GPP TSG RAN WG1 Meeting #78bisR1-144047	
	3	Ericsson Phasee2modeling of 2D AntennaArrays,2014.11.21,3GPP TSG-RAN WG1#79 R1-145169	
	4	Texas InstrumentsRemaining Issues onULMIMO TransmissionMode and DCI FormatDesign,2010.07.02,3GGP TSG RAN WG161bis R1-103705	
	5	ISR received in application No. PCT/CN2017/112033 dated 07 February 2018	☒
	6	First Office Action received from the no. 201611098328.7 dated January 06, 2020.	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	
	Attorney Docket Number	

	7	First Search Report received from the no. 201611098328.7 dated December 26,2019	☒
	8	Notice of Granting Patent Right for Invention received from the no. 201611098328.7 dated April.21,2020	☒

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	17143180
	Filing Date	2021-01-07
	First Named Inventor	Xiaobo ZHANG
	Art Unit	2472
	Examiner Name	
	Attorney Docket Number	

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)	2021-03-29
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.

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	

Form PCT/ISA /210 (patent family annex) (July 2009)

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[0076]、[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。

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"&" 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）
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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
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				CN	103687010	B	2017年 7月 4日
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				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）

[19] 中华人民共和国国家知识产权局

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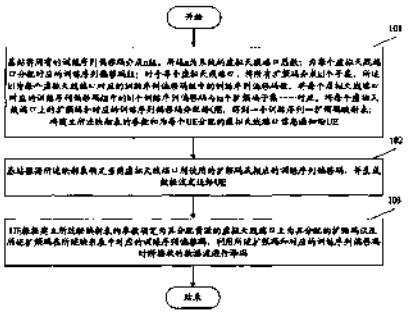
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[21] 申请号 200810104687.8
[71] 申请人 鼎桥通信技术有限公司
地址 100102 北京市朝阳区望京北路 9 号叶青大厦 D 座 15 层
[72] 发明人 拉盖施 范 晨 王大飞
[74] 专利代理机构 北京德琦知识产权代理有限公司
代理人 王 斌 王 琦
权利要求书 2 页 说明书 11 页 附图 2 页

[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。

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。

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

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

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

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

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

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

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

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。

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

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

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。

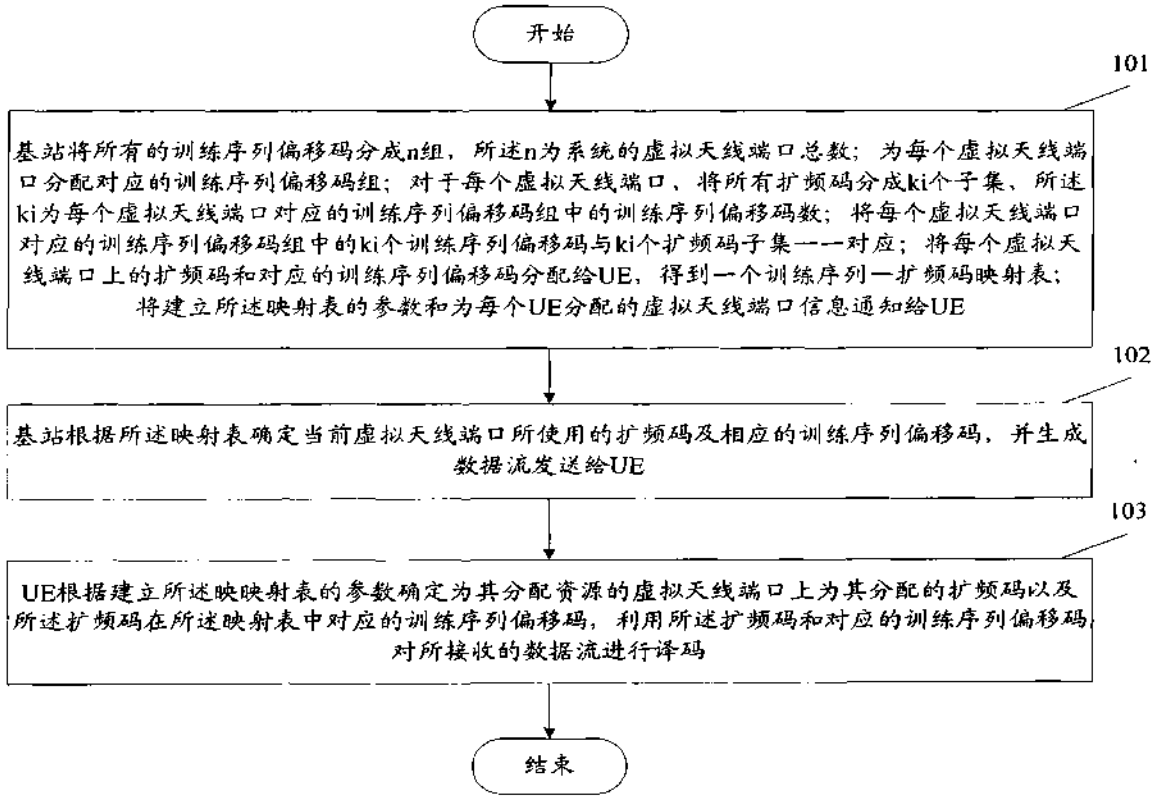

开始
101
基站将所有的训练序列偏移码分成n组，所述n为系统的虚拟天线端口总数；为每个虚拟天线端口分配对应的训练序列偏移码组；对于每个虚拟天线端口，将所有扩频码分成ki个子集，所述ki为每个虚拟天线端口对应的训练序列偏移码组中的训练序列偏移码数；将每个虚拟天线端口对应的训练序列偏移码组中的ki个训练序列偏移码与ki个扩频码子集一一对应；将每个虚拟天线端口上的扩频码和对应的训练序列偏移码分配给UE，得到一个训练序列—扩频码映射表；将建立所述映射表的参数和为每个UE分配的虚拟天线端口信息通知给UE
102
基站根据所述映射表确定当前虚拟天线端口所使用的扩频码及相应的训练序列偏移码，并生成数据流发送给UE
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
结束

图 1

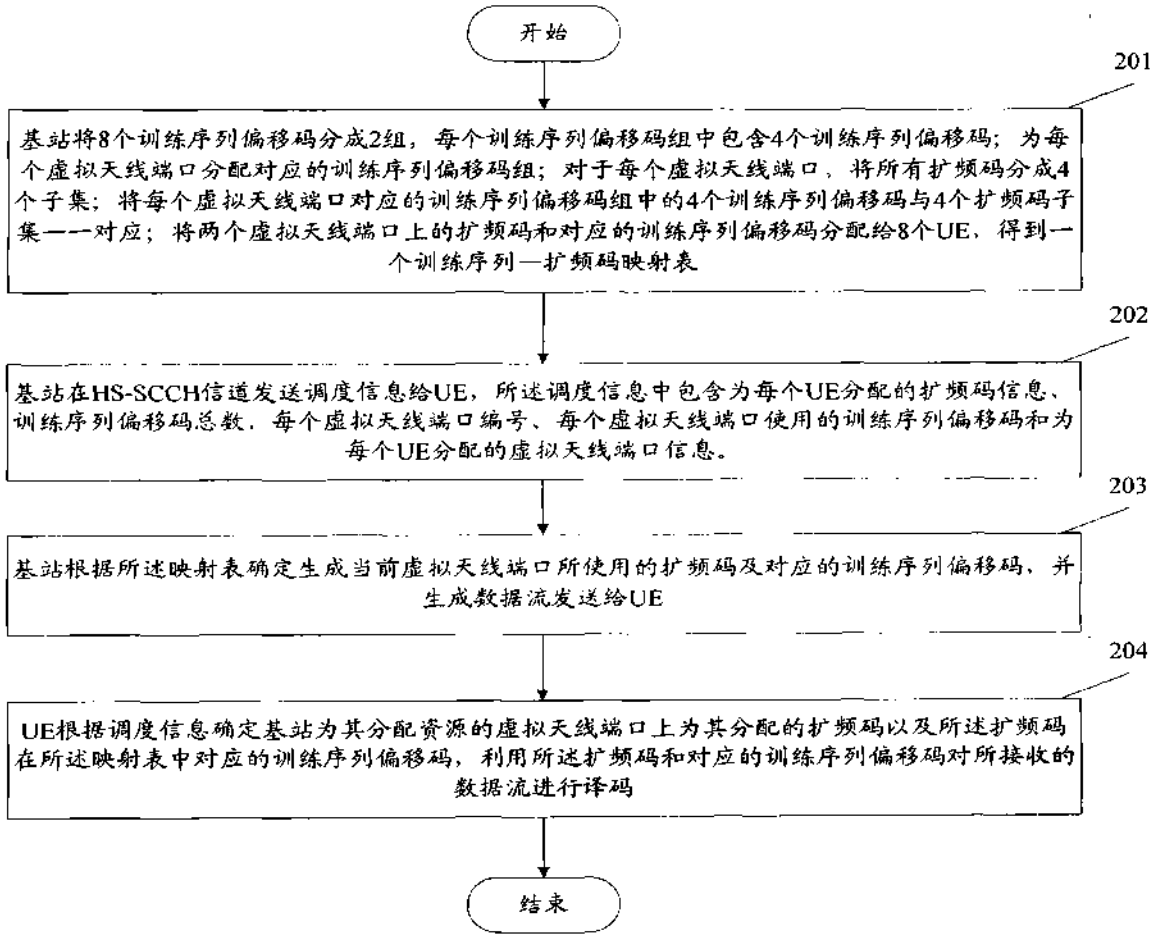

开始
201
基站将8个训练序列偏移码分成2组，每个训练序列偏移码组中包含4个训练序列偏移码；为每个虚拟天线端口分配对应的训练序列偏移码组；对于每个虚拟天线端口，将所有扩频码分成4个子集；将每个虚拟天线端口对应的训练序列偏移码组中的4个训练序列偏移码与4个扩频码子集一一对应；将两个虚拟天线端口上的扩频码和对应的训练序列偏移码分配给8个UE，得到一个训练序列—扩频码映射表
202
基站在HS-SCCH信道发送调度信息给UE，所述调度信息中包含为每个UE分配的扩频码信息、训练序列偏移码总数，每个虚拟天线端口编号、每个虚拟天线端口使用的训练序列偏移码和为每个UE分配的虚拟天线端口信息。
203
基站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
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
结束

图 2

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(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

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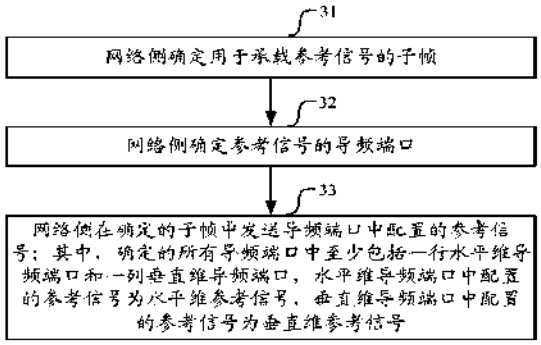
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(54)发明名称

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。



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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

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

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，

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，

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。

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，几具有固定的下倾角(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，在垂直方上没有端口，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

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；

[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；

[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二实例示意图；

[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

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。

[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 又包括以下二种方式：

[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

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。

[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：

[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

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

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：

[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：

[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。

[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

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

之内，则本发明也意图包含这些改动和变型在内。

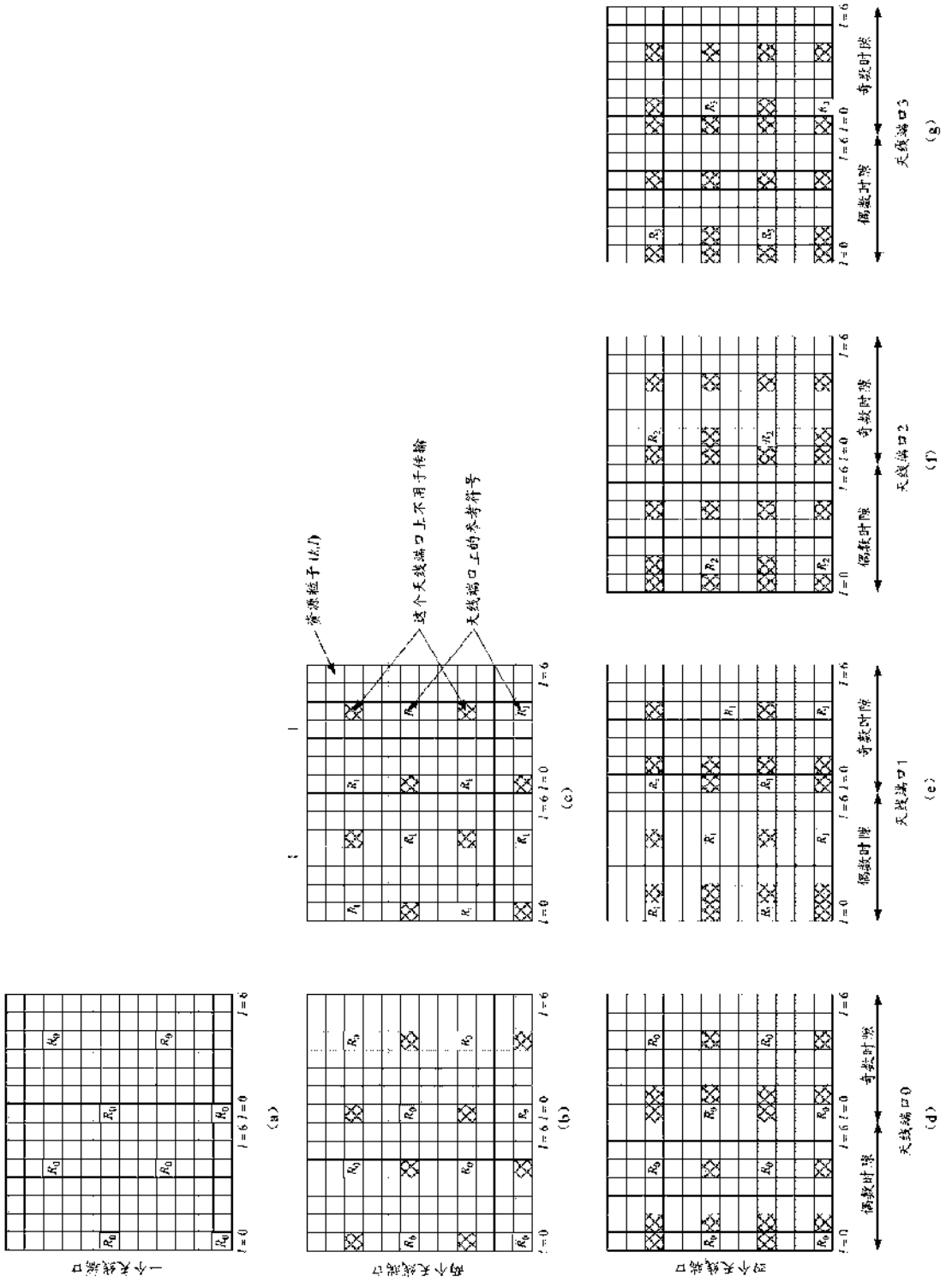

一个天线端口
两个天线端口
四个天线端口
资源粒子 (k,l)
这个天线端口上不用于传输
天线端口上的参考符号
偶数时隙
奇数时隙
天线端口0
天线端口1
天线端口2
天线端口3
(a)
(b)
(c)
(d)
(e)
(f)
(g)

图 1

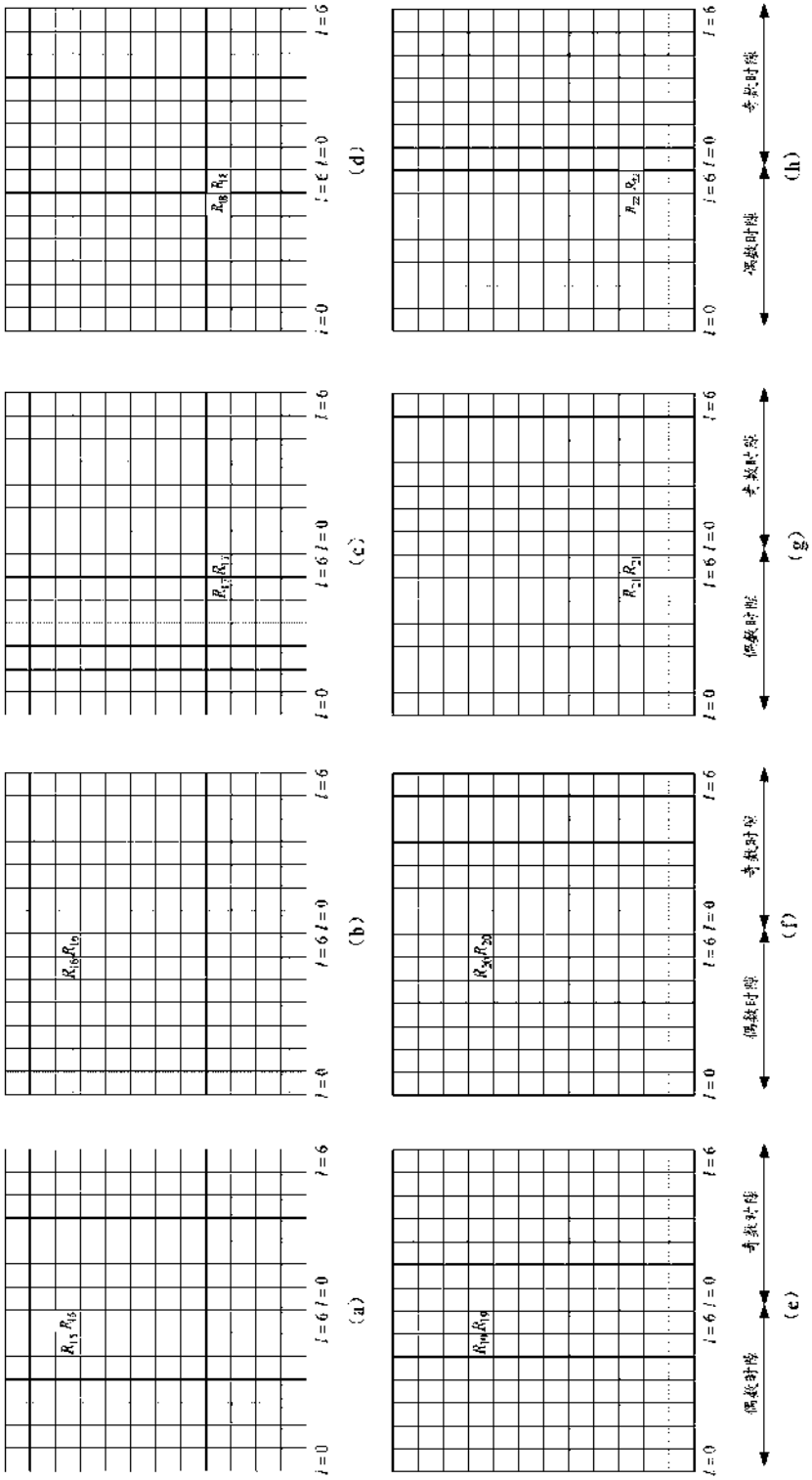


图 2

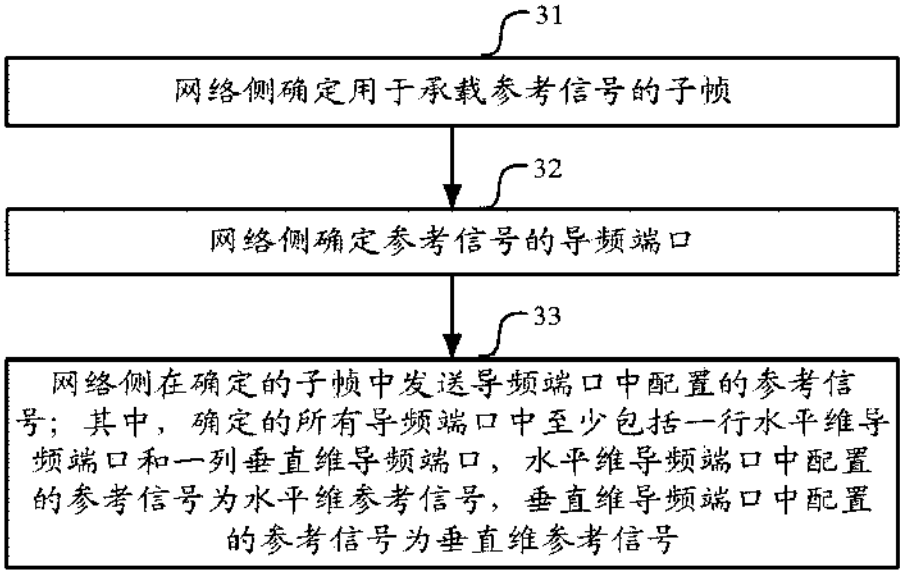

31
网络侧确定用于承载参考信号的子帧
32
网络侧确定参考信号的导频端口
33
网络侧在确定的子帧中发送导频端口中配置的参考信号；其中，确定的所有导频端口中至少包括一行水平维导频端口和一列垂直维导频端口，水平维导频端口中配置的参考信号为水平维参考信号，垂直维导频端口中配置的参考信号为垂直维参考信号

图 3

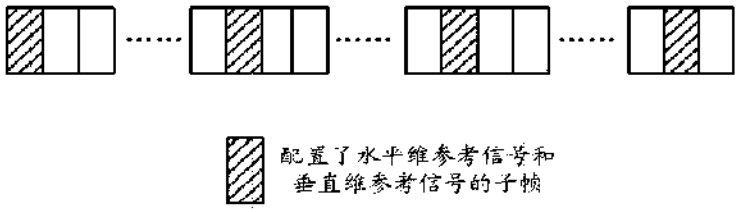

配置了水平维参考信号和
垂直维参考信号的子帧

图 4A

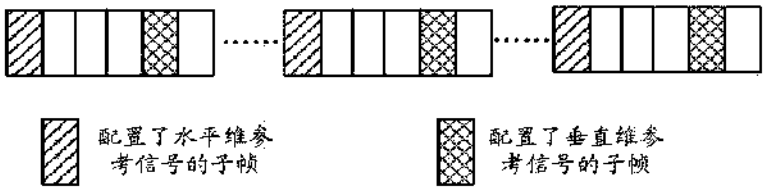

配置了水平维参
考信号的子帧
配置了垂直维参
考信号的子帧

图 4B

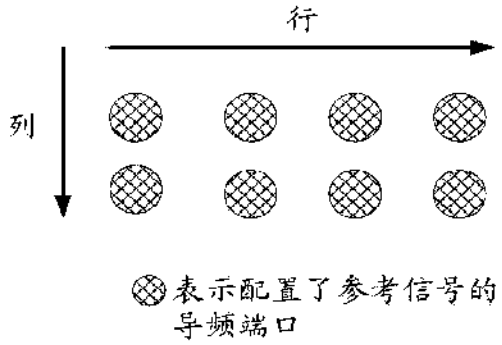


图 5A

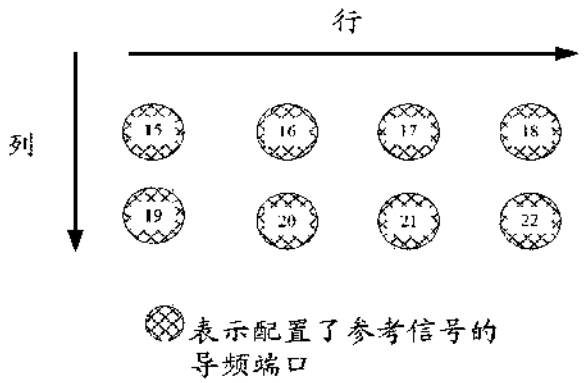


图 5B

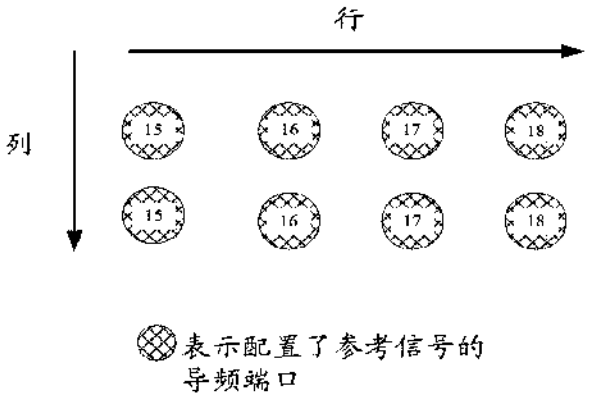


图 5C

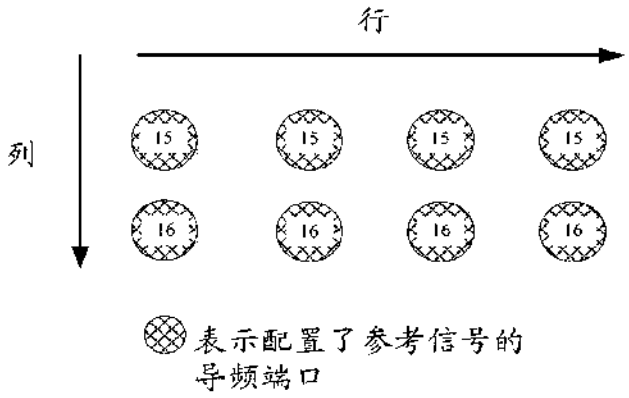
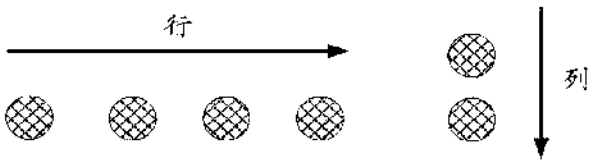
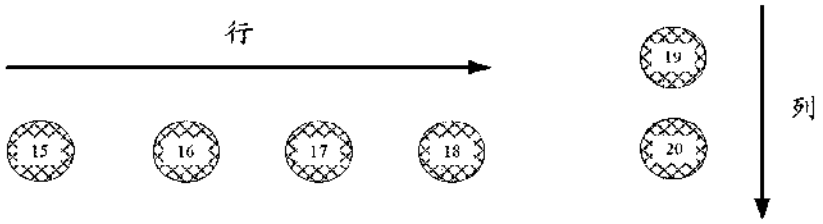


图 5D



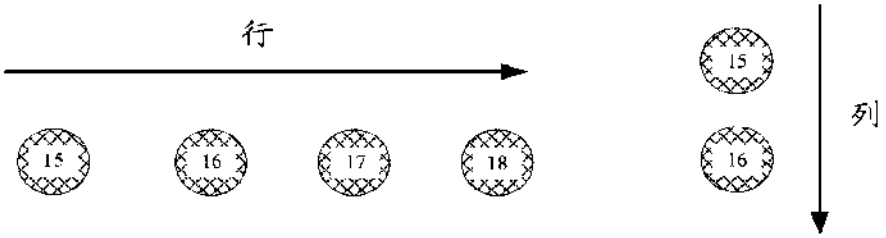
表示配置了参考信号的导频端口

图 6A



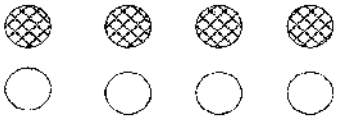
表示配置了参考信号的导频端口

图 6B



表示配置了参考信号的导频端口

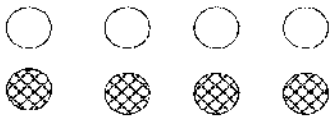
图 6C



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

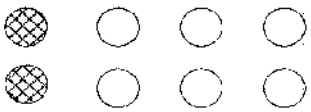
图 7A



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

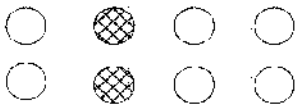
图 7B



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

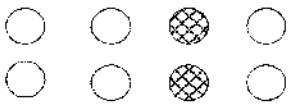
图 8A



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

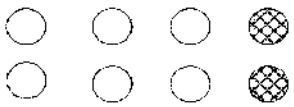
图 8B



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

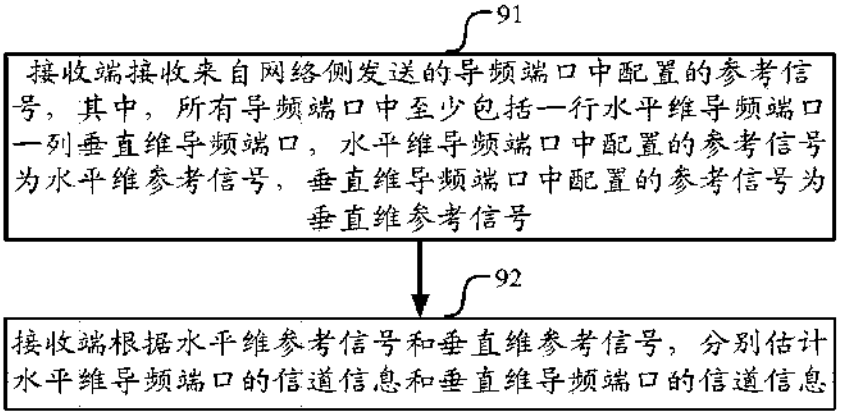


图 9

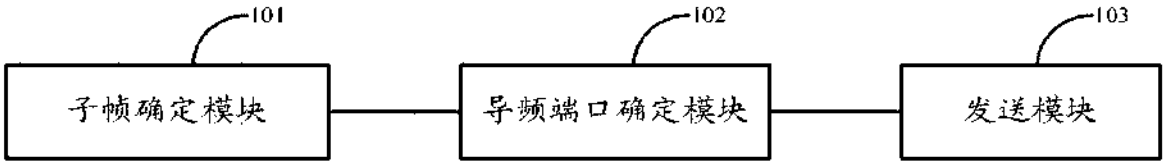


图 10



图 11

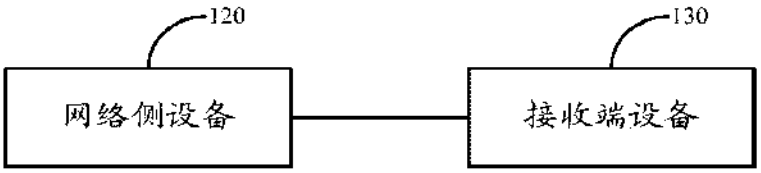


图 12

(19)中华人民共和国国家知识产权局

(12)发明专利申请

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(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

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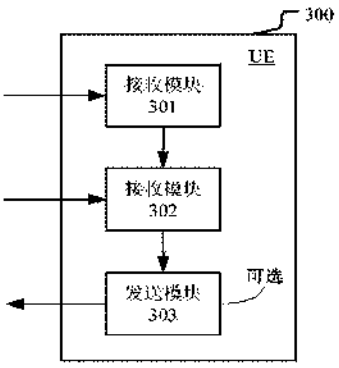
权利要求书2页 说明书8页 附图3页

(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，第一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。

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 H 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 H 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。

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。

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。

[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个子帧。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

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 RSI 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 RSI 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；

[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,

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 H 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

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$W^1_{8\times 1}$和第二PMI索引的矩阵$W^2_{4\times 1}$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

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。

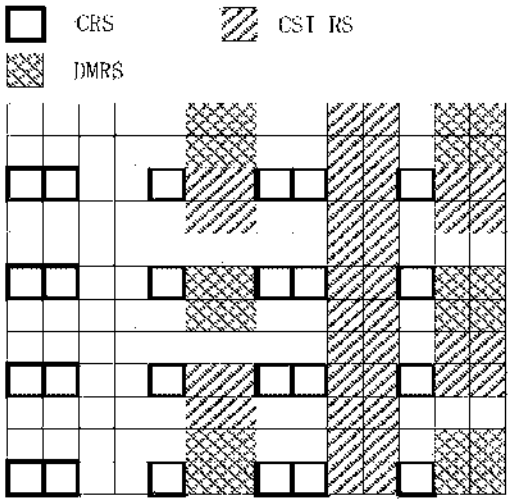

CRS
CSI RS
DMRS

图 1

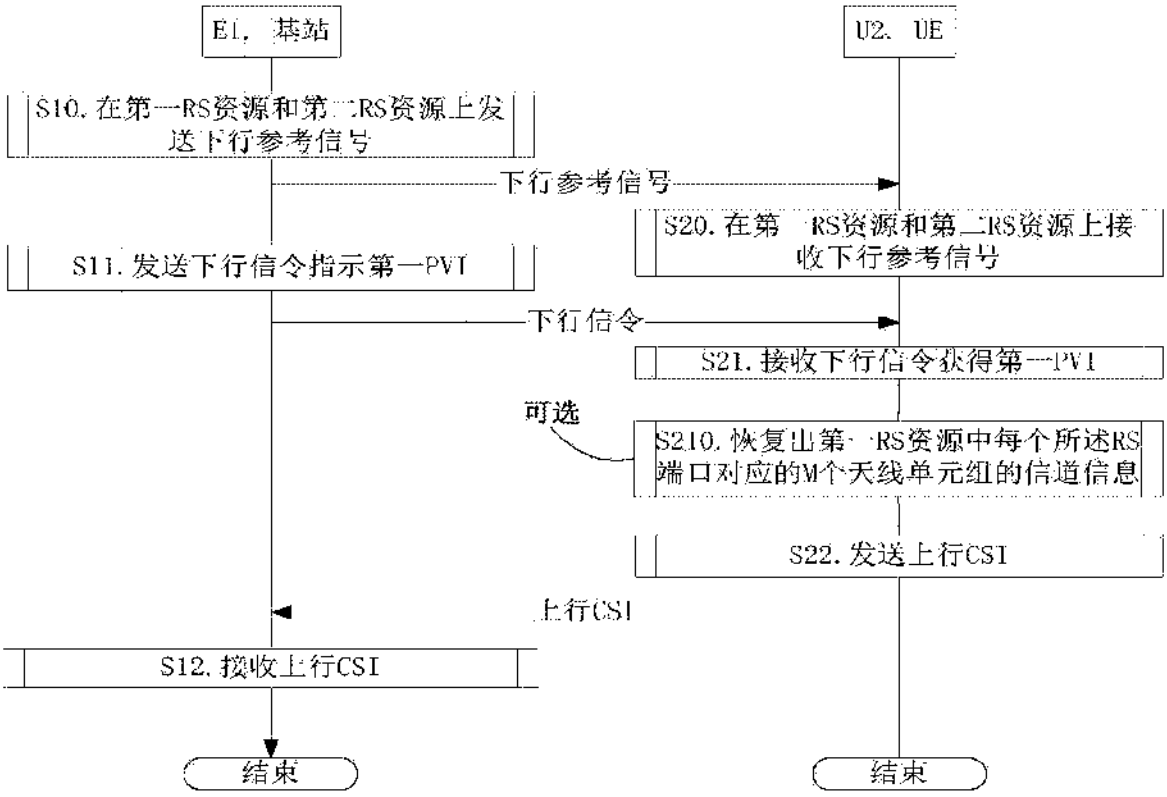

E1. 基站
U2. UE
S10. 在第一RS资源和第二RS资源上发送下行参考信号
下行参考信号
S20. 在第一RS资源和第二RS资源上接收下行参考信号
S11. 发送下行信令指示第一PVI
下行信令
S21. 接收下行信令获得第一PVI
可选
S210. 恢复出第一RS资源中每个所述RS端口对应的M个天线单元组的信道信息
S22. 发送上行CSI
上行CSI
S12. 接收上行CSI
结束
结束

图 2

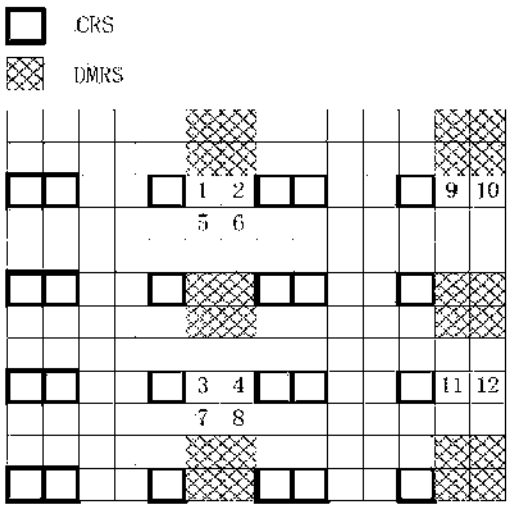

CRS
DMRS
1 2
9 10
5 6
3 4
11 12
7 8

图 3

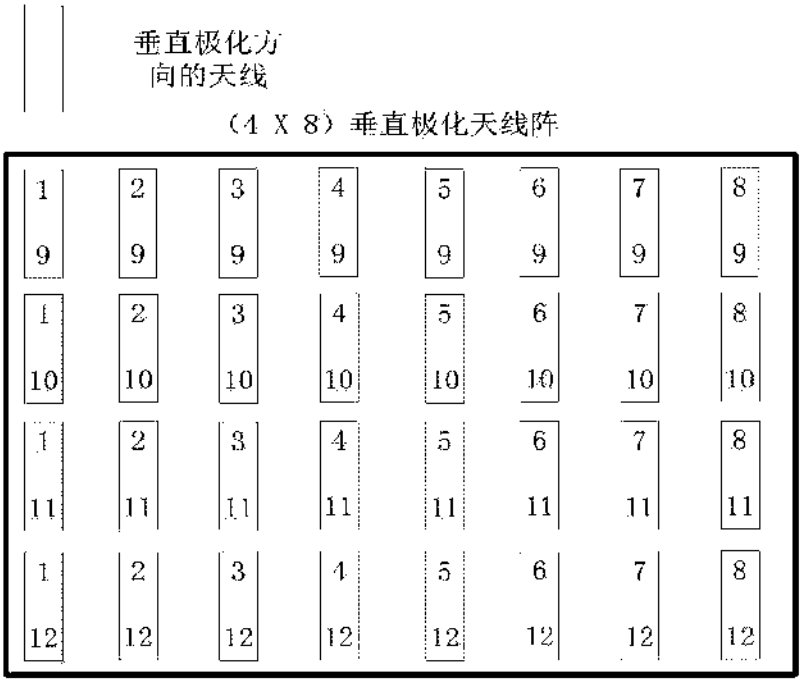

垂直极化方向的天线
(4 X 8) 垂直极化天线阵
1 9
2 9
3 9
4 9
5 9
6 9
7 9
8 9
1 10
2 10
3 10
4 10
5 10
6 10
7 10
8 10
1 11
2 11
3 11
4 11
5 11
6 11
7 11
8 11
1 12
2 12
3 12
4 12
5 12
6 12
7 12
8 12

图 4

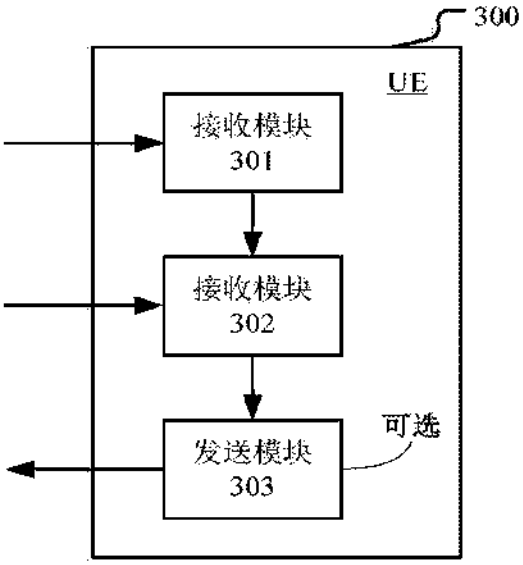

300
UE
接收模块
301
接收模块
302
发送模块
303
可选

图 5

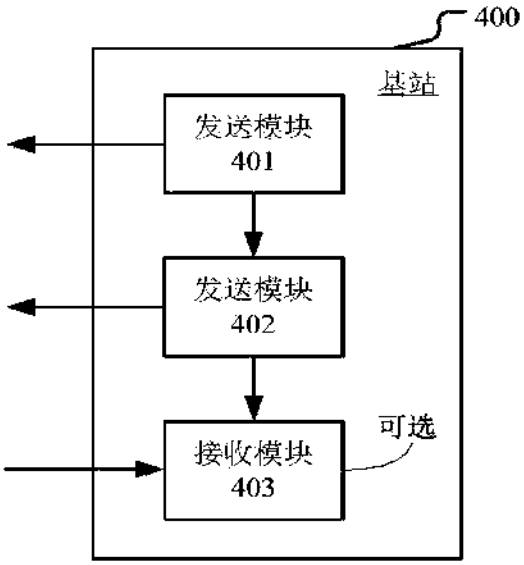

400
基站
发送模块
401
发送模块
402
接收模块
403
可选

图 6

(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

(43) 국제공개일
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(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).

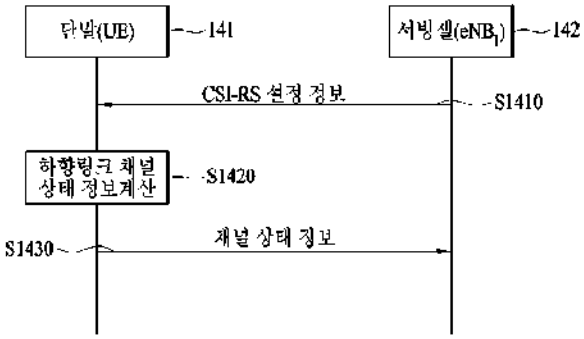
(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, 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_1 number of antenna ports is carried out by a terminal, wherein the method comprises the steps of: configuring each of the N_1 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 N1개의 안테나 포트를 통해 전송되는 하향링크 채널에 대한 채널 상태 보고를 위한 방법에 있어서, 상기 방법은 단말에 의해 수행되며, 상기 N1개의 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

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 사용자 데이터 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 리모드 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 액세스 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 액세스 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 듀플렉스(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, $N_{RB}^{DL}*N_{sc}^{RB}$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}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 $N_{symb}^{DL}*N_{sc}^{RB}$개의 자원요소로 구성된다. 자원격자 내 각 자원요소는 일 슬롯 내 인덱스 쌍 (k, l)에 의해 고유하게 정의될 수 있다. k는 주파수 도메인에서 0부터 $N_{RB}^{DL}*N_{sc}^{RB}$-1까지 부여되는 인덱스이며, l은 시간 도메인에서 0부터 N_{symb}^{DL}-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, 로컬라이즈드 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-특성(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 이러 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 제이 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	$u_2=[1\ \ 1\ \ -1\ \ 1]^T$	$W_2^{\{1\}}$	$W_2^{\{12\}}/\sqrt{2}$	$W_2^{\{124\}}/\sqrt{3}$	$W_2^{\{1214\}}/2$
3	$u_3=[1\ \ j\ \ 1\ \ -j]^T$	$W_3^{\{1\}}$	$W_3^{\{12\}}/\sqrt{2}$	$W_3^{\{123\}}/\sqrt{3}$	$W_3^{\{1214\}}/2$
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	$u_{10}=[1\ \ 1\ \ 1\ \ -1]^T$	$W_0^{\{1\}}$	$W_{10}^{\{13\}}/\sqrt{2}$	$W_{10}^{\{123\}}/\sqrt{3}$	$W_{10}^{\{1324\}}/2$
11	$u_{11}=[1\ \ j\ \ -1\ \ j]^T$	$W_1^{\{1\}}$	$W_{11}^{\{13\}}/\sqrt{2}$	$W_{11}^{\{134\}}/\sqrt{3}$	$W_{11}^{\{1324\}}/2$
12	$u_{12}=[1\ \ -1\ \ -1\ \ 1]^T$	$W_2^{\{1\}}$	$W_{12}^{\{12\}}/\sqrt{2}$	$W_{12}^{\{123\}}/\sqrt{3}$	$W_{12}^{\{1234\}}/2$
13	$u_{13}=[1\ \ -1\ \ 1\ \ -1]^T$	$W_3^{\{1\}}$	$W_{13}^{\{13\}}/\sqrt{2}$	$W_{13}^{\{123\}}/\sqrt{3}$	$W_{13}^{\{1324\}}/2$
14	$u_{14}=[1\ \ 1\ \ -1\ \ -1]^T$	$W_4^{\{1\}}$	$W_{14}^{\{13\}}/\sqrt{2}$	$W_{14}^{\{123\}}/\sqrt{3}$	$W_{14}^{\{1324\}}/2$
15	$u_{15}=[1\ \ 1\ \ 1\ \ 1]^T$	$W_5^{\{1\}}$	$W_{15}^{\{12\}}/\sqrt{2}$	$W_{15}^{\{123\}}/\sqrt{3}$	$W_{15}^{\{1234\}}/2$

[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 4x4 단위행렬을 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 이기서, 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 두 개의 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 포드를 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(수파수와 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 포드 그룹내의 포드들에게 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 $E_a=T\cdot P_a/K$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. 이기서, 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]

$$z = Bx = \left[b_0 \;\; b_1 \cdots b_{N_t-1} \right] x$$

[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]

$$\mathbf{x} = \sqrt{E_a}\mathbf{W}\mathbf{s} = \sqrt{E_a}\begin{bmatrix} w_{0,0} & w_{0,1} & \cdots & w_{0,R-1} \\ w_{1,0} & w_{1,1} & \cdots & w_{1,R-1} \\ \vdots & \vdots & \ddots & \vdots \\ w_{N_t-1,0} & w_{N_t-1,1} & \cdots & w_{N_t-1,R-1} \end{bmatrix} \begin{bmatrix} s_0 \\ s_1 \\ \vdots \\ s_{R-1} \end{bmatrix}$$

[133] 수학식 3

[수식3]

$$\mathbf{z} = \mathbf{Bx} = \sqrt{E_a}\mathbf{BWs} = \sqrt{E_a}\begin{bmatrix} w'_{0,0} & w'_{0,1} & \cdots & w'_{0,R-1} \\ w'_{1,0} & w'_{1,1} & \cdots & w'_{1,R-1} \\ \vdots & \vdots & \ddots & \vdots \\ w'_{N_t-1,0} & w'_{N_t-1,1} & \cdots & w'_{N_t-1,R-1} \end{bmatrix}\begin{bmatrix} s_0 \\ s_1 \\ \vdots \\ s_{R-1} \end{bmatrix}.$$

[134] 수학식3의 전송 신호는 채널을 통과한 후에 N_r개의 수신 안테나를 갖는 수신기에 수신되는데, 수신 신호는 다음의 수학식으로 표현될 수 있다. 여기서, H는 $N_t \times N_t$채널 행렬을 나타내며, n은 $N_t \times 1$ 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]

$$\mathbf{H}\cdot\mathbf{B} = \tilde{\mathbf{H}} = \left[\tilde{\mathbf{h}}_0 \quad \tilde{\mathbf{h}}_1 \quad \cdots \quad \tilde{\mathbf{h}}_{N_t-1}\right]$$

[138] 유효 채널 행렬

$\tilde{\mathbf{H}}$

는 수학식 5처럼 N_t개의 채널 열벡터로 표현될 수 있는데, 여기서

$\tilde{\mathbf{h}}_n$

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

$\tilde{\mathbf{h}}_n$

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)이이야 한다. 여기서 첫 번째 엘리먼트인 w_0의 크기는

$\sqrt{N_t}$

인 것이 바람직한데, 이는 데이터 심볼이 $N_t \cdot E_s$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 $RE(k_i,l,n_j)$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 디스조인드(disjoint)하게 그룹핑하도록 한다. 도 11의 안테나 포트 인덱스를 고려하여 $i \cdot M_f$ 번째 안테나 포트부터 $(i+1) \cdot M_f-1$번째 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 $(i+1) \cdot M_t-1$번째 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 $Mt=Nh$로 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 포드는 N_h개의 안테나 엘리먼드에 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 포드 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 $M_t(m)$로 정의하면, 다음의 관계를 만족해야 한다.

[181] 수학식 12

[수식12]

$$N_t = \sum_{m=0}^{M_t-1} M_f(m)$$

[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 포드 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

$\mathbf{W}_D^{(r)}$

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

$\mathbf{W}_D^{(r)}$

을 보고하며, 선택된 안테나 포트 그룹 각각에 적용되는 프리코딩을 위해 R_V개의 랭크 $R_H(r)$와 프리코딩 행렬

$\mathbf{W}_r^{(H)}$

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

$\mathbf{W}_D^{(r)}$

의 보고 주기보다 크거나 같을 수 있다. 즉, 랭크 R_V가 500 서브프레임마다 한번 보고되면

$\mathbf{W}_D^{(r)}$

는 100 서브프레임마다 한번 보고되도록 설정될 수 있다. 또한, 프리코딩 행렬

$\mathbf{W}_D^{(r)}$

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

$\mathbf{W}_D^{(r)}$

의 대역의 크기보다 크거나 같을 수 있다. 즉, 랭크 R_V가 100 RB마다 한번 결정되어 보고되면

$\mathbf{W}_D^{(r)}$

는 20 RB마다 한번 결정되어 보고될 수 있다. 또는, 랭크 R_V가 시스템 대역에 걸쳐 하나의 값이 보고되지만

$\mathbf{W}_D^{(r)}$

는 서브 대역 별로 각각 보고될 수 있다. 또한, 프리코딩 행렬

$\mathbf{W}_D^{(r)}$

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]

$$\mathbf{W}_D = \left[\mathbf{W}_D^{(V)} \otimes \mathbf{w}_0^{(H)} \quad \mathbf{W}_D^{(V)} \otimes \mathbf{w}_1^{(H)} \quad \cdots \quad \mathbf{W}_D^{(V)} \otimes \mathbf{w}_{R_H-1}^{(H)}\right]$$

[207] 여기서,

$$\mathbf{W}_D^{(H)} = \left[\mathbf{w}_0^{(H)} \quad \mathbf{w}_1^{(H)} \quad \cdots \quad \mathbf{w}_{R_H-1}^{(H)}\right]$$

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

$\mathbf{W}_D^{(r)}$

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,

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 레이티의 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.

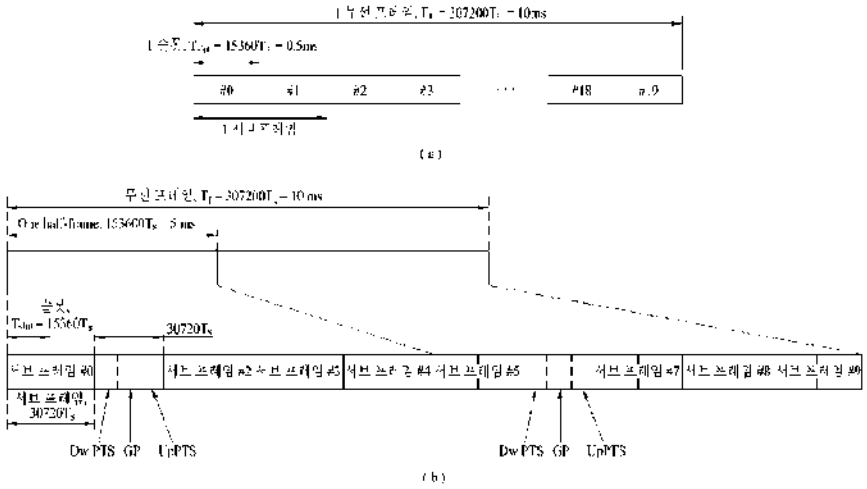
[청구항 9] 제7항에 있어서, 상기 선택된 안테나 포트 그룹에 적용될 프리코딩 행렬은 상수 모듈러스(constant modulus) 코드북에서 선택되는 것을 특징으로 하는, 단말.

[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.

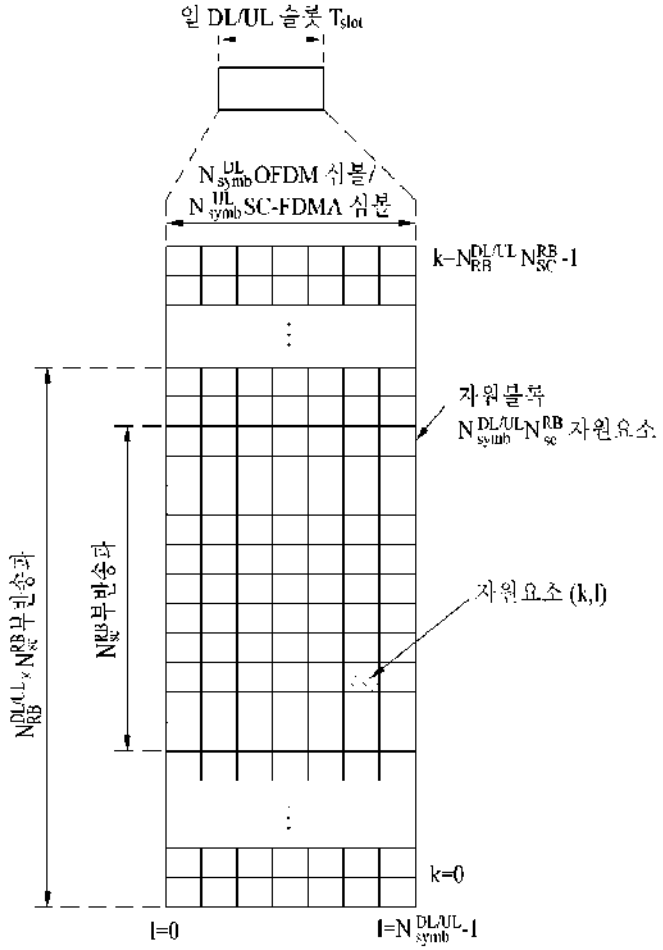
[청구항 11] 제10항에 있어서, 상기 비활성화된 안테나 포트 그룹을 선택하기 위한 프리코딩 행렬은 상기 채널 상태 정보에서 제외되는 것을 특징으로 하는, 단말.

[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.

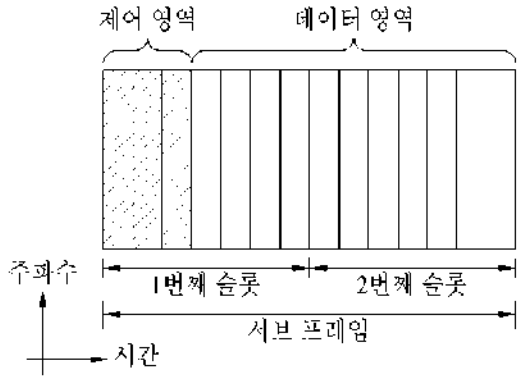
[도1]


#0
#1
#2
#3
#18
#19
(a)
#0
#1
#2
#3
#4
#5
#6
#7
#8
#9
DwPTS
GP
UpPTS
DwPTS
GP
UpPTS
(b)

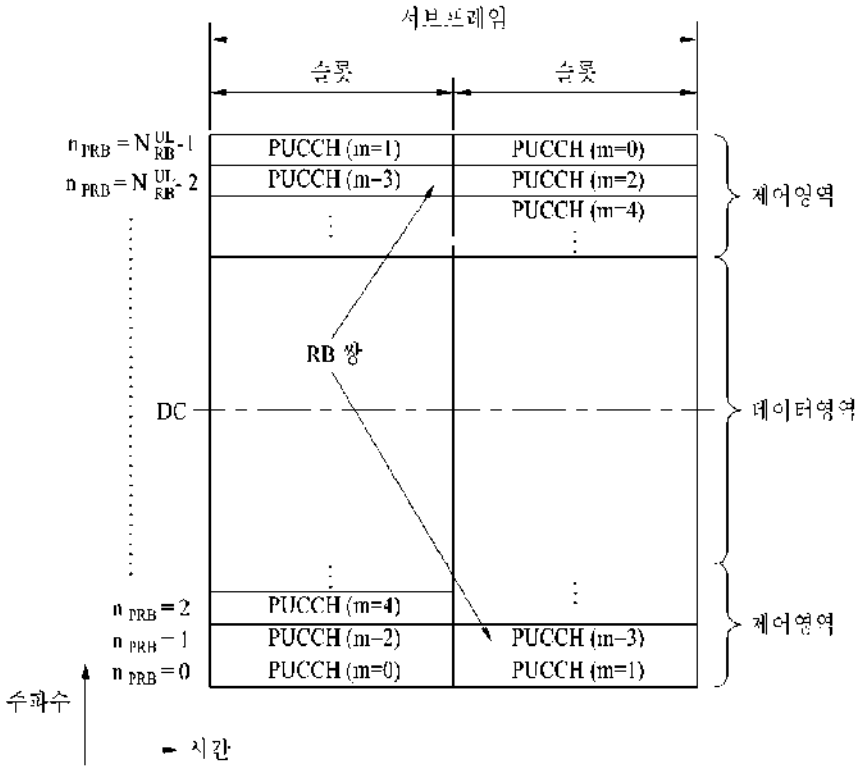
[도2]


1 DL/UL 슬롯 T_{slot}
$N^{DL/UL}_{symb}$ 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
$l=N^{DL/UL}_{symb}-1$

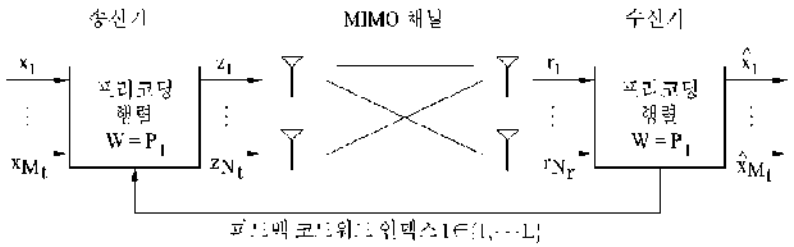
[도3]


제어 영역
데이터 영역
주파수
1번째 슬롯
2번째 슬롯
서브 프레임
시간

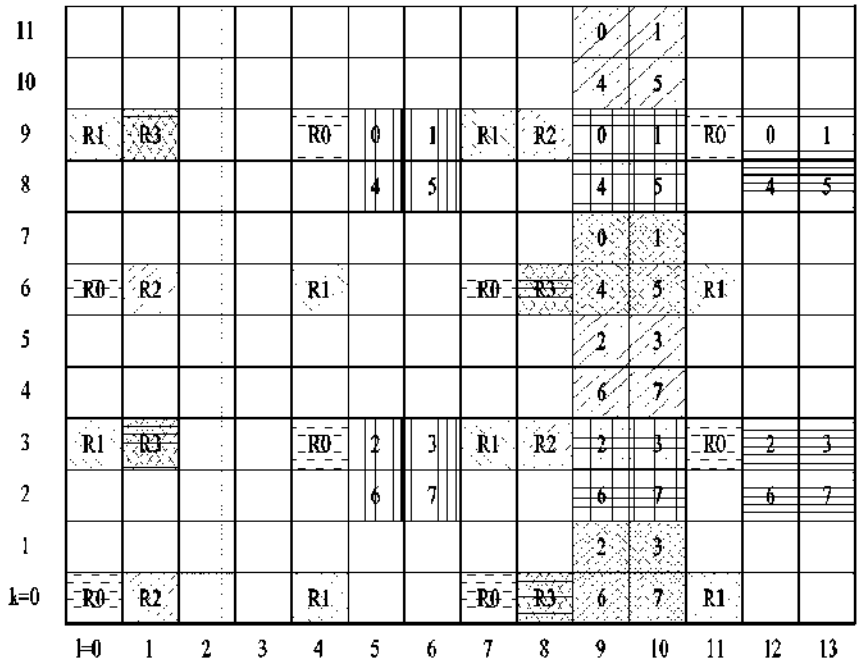
[도4]


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)
제어영역
RB 쌍
DC
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

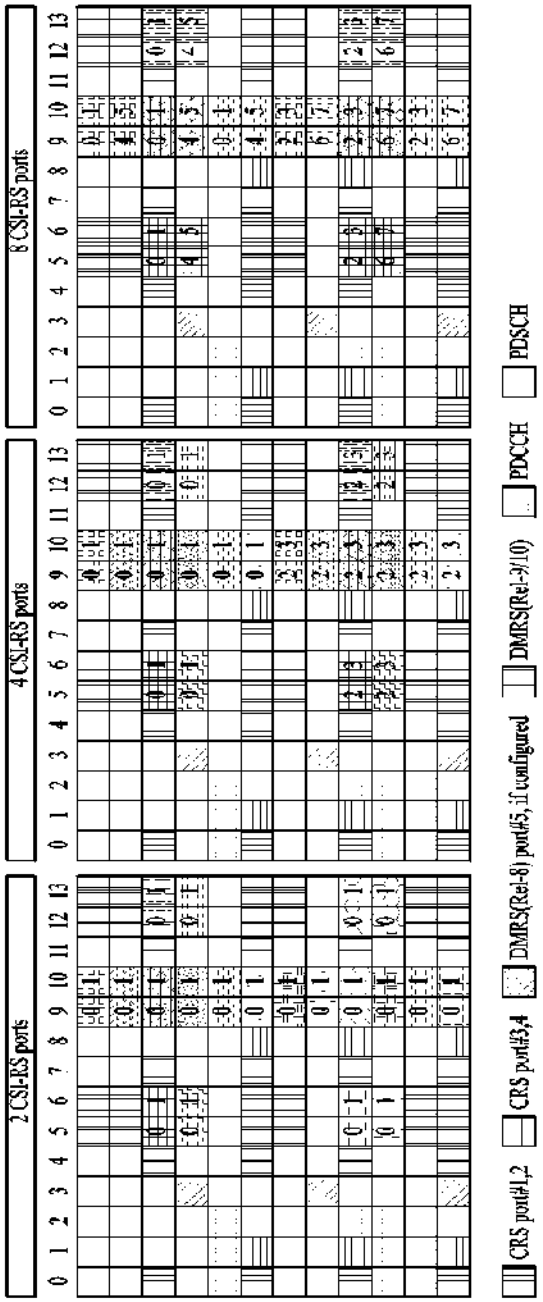
[도5]


송신기
MIMO 채널
수신기
x_1
x_{M_t}
프리코딩 행렬 $W = P_i$
z_1
z_{N_t}
r_1
r_{N_r}
프리코딩 행렬 $W = P_i$
$\hat{x}_1$
$\hat{x}_{M_t}$
피드백 코드워드 인덱스 $i \in \{1, \cdots, L\}$

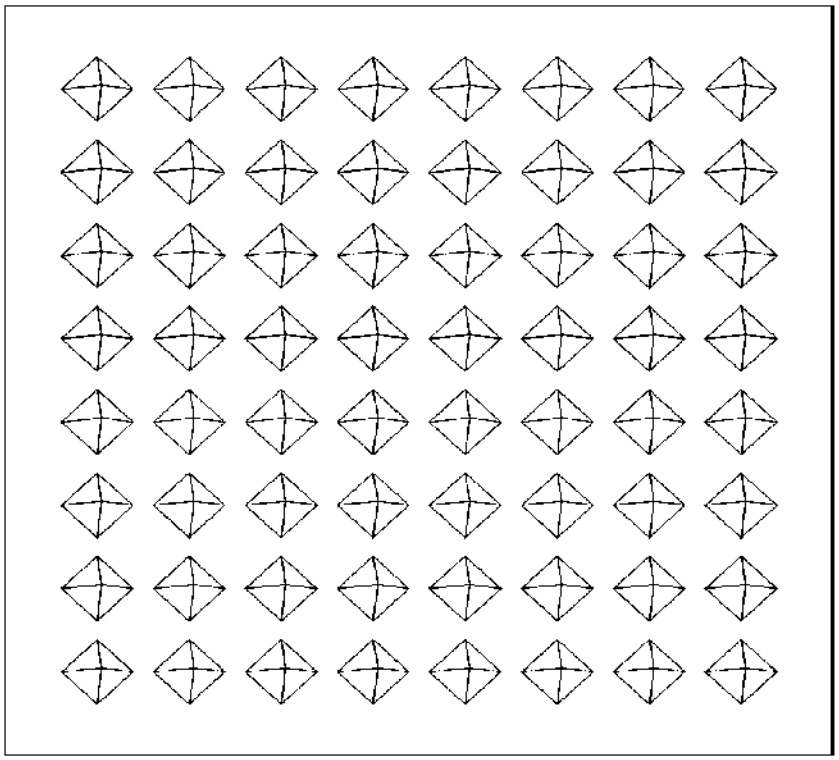
[도6]


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 R1 R2 R0 R2 R1 R0 R3 R1 R3 R0 R2 R0 R3 R1
0 1 2 3 4 5 6 7

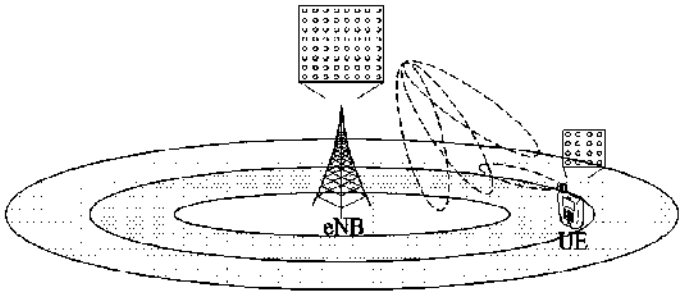
[도7]


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

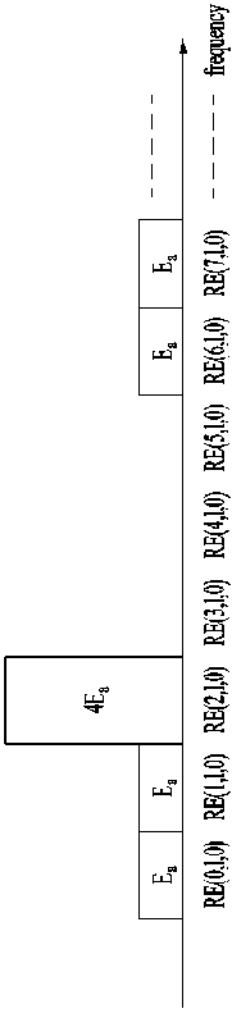
[도8]



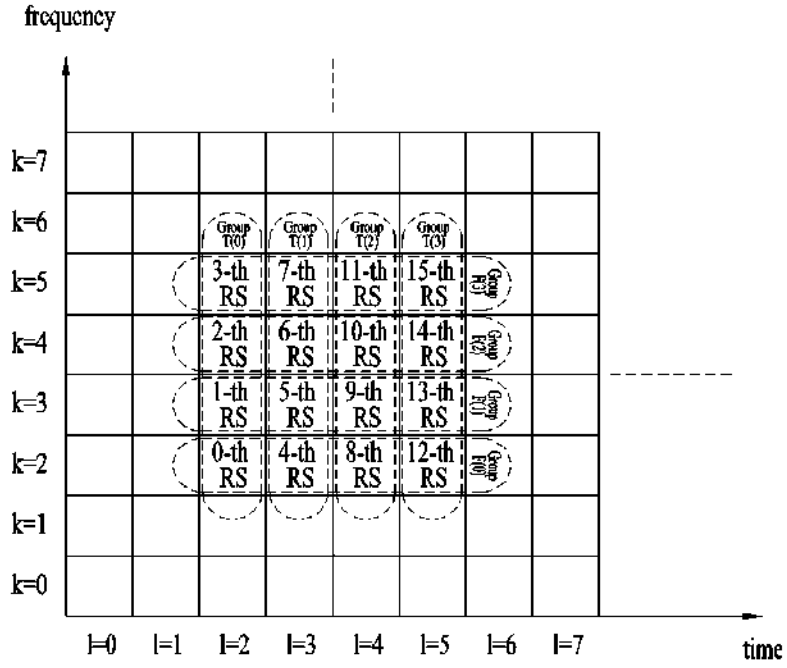
[도9]



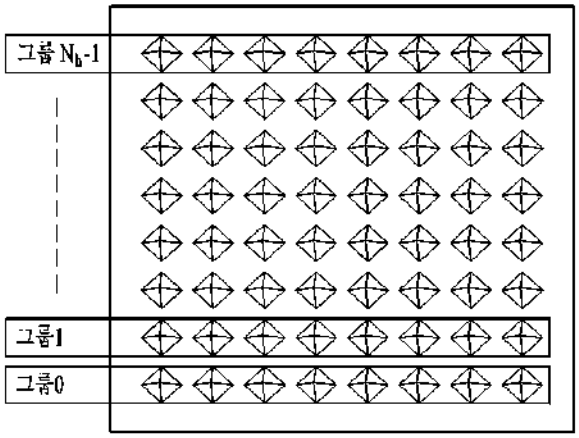
[도10]


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
E_a
$4E_a$
E_a
E_a

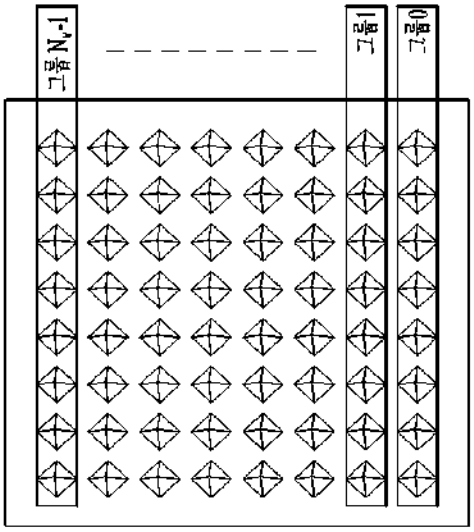
[도11]


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 R(3)
Group R(2)
Group R(1)
Group R(0)
l=0
l=1
l=2
l=3
l=4
l=5
l=6
l=7
time

[도12]

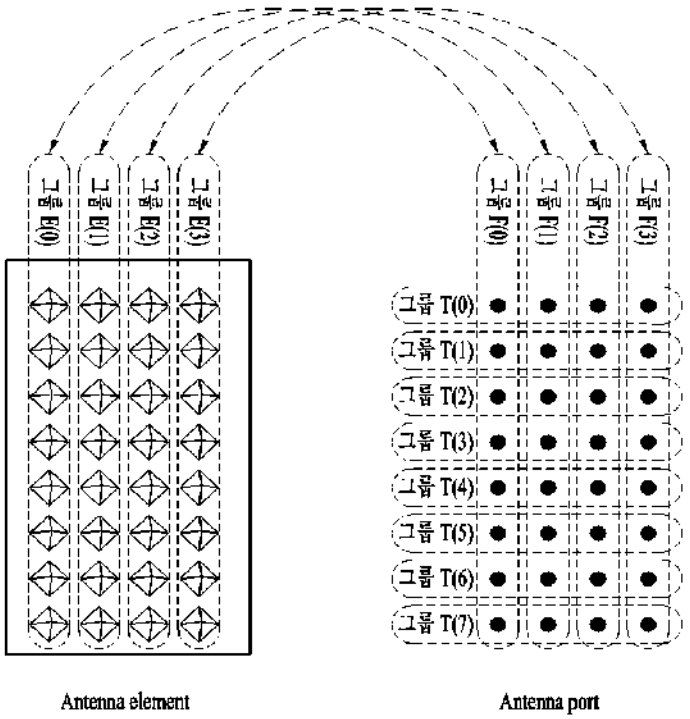


(b)

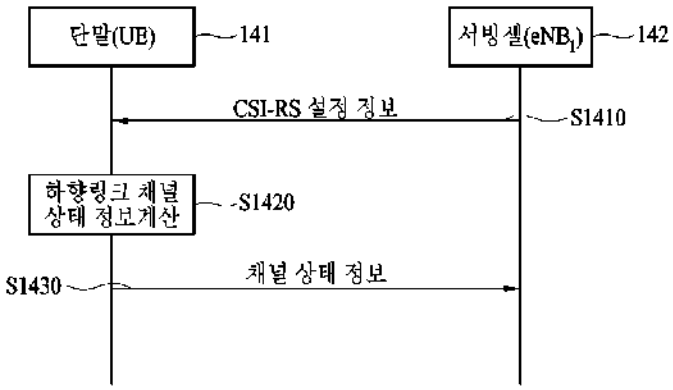


(a)

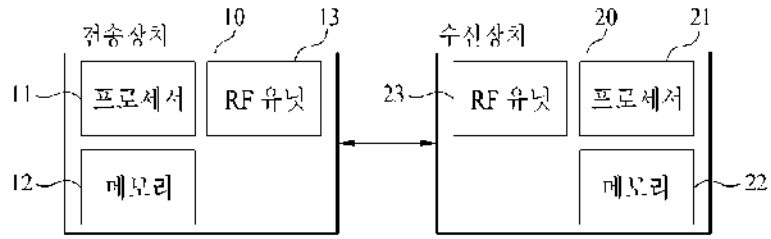
[도13]


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
서빙 셀(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)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2015/007995

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 2788934 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

국제조사보고서

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)

국제조사보고서
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
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(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)

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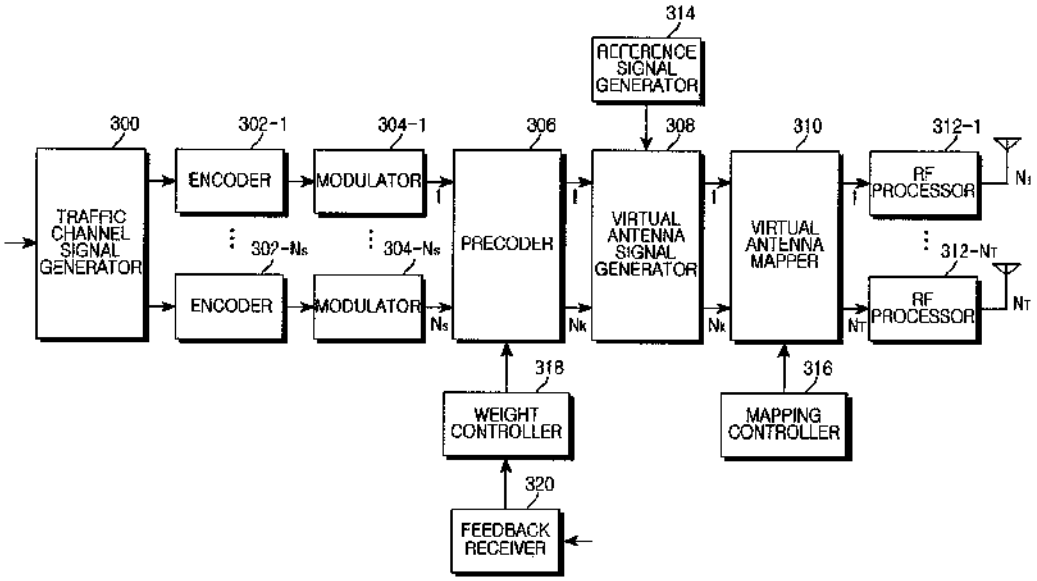
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(57) **ABSTRACT**

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.



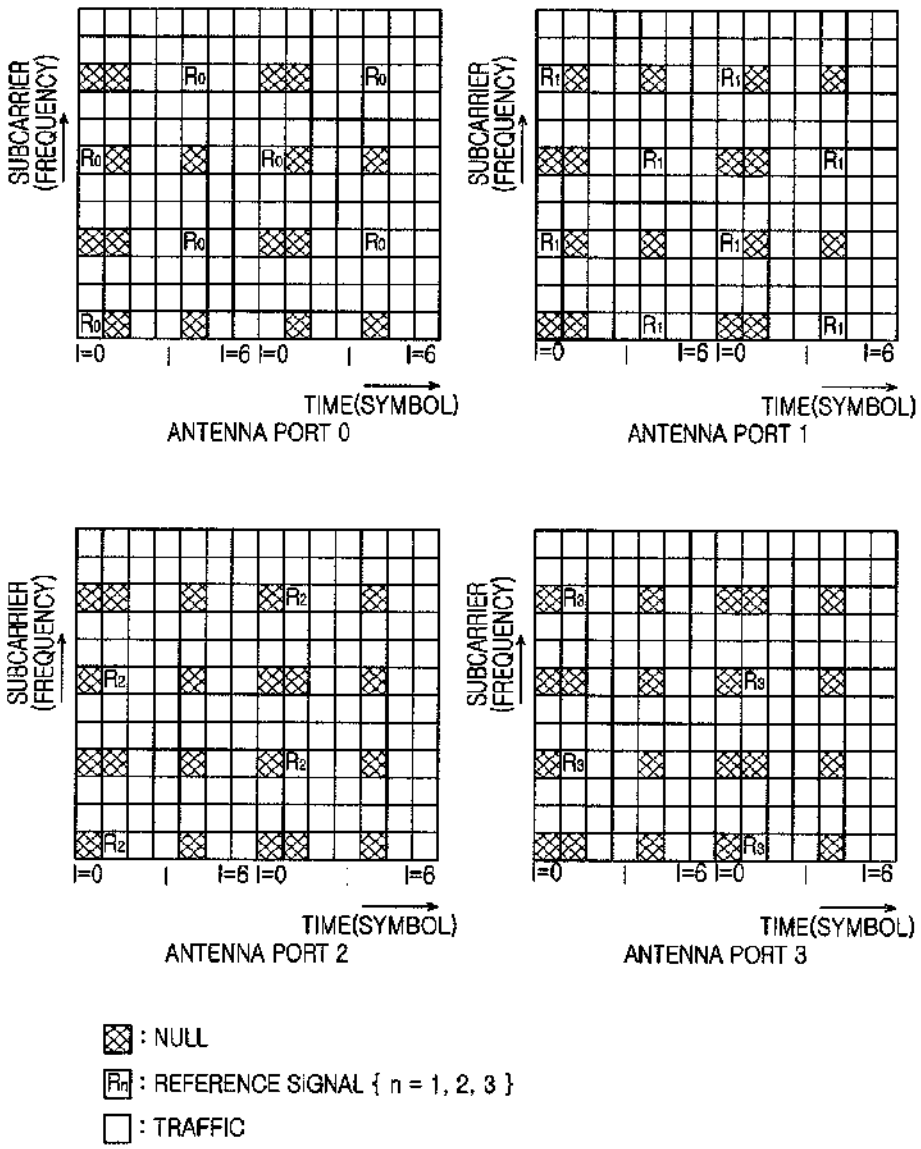


FIG.1
(PRIOR ART)

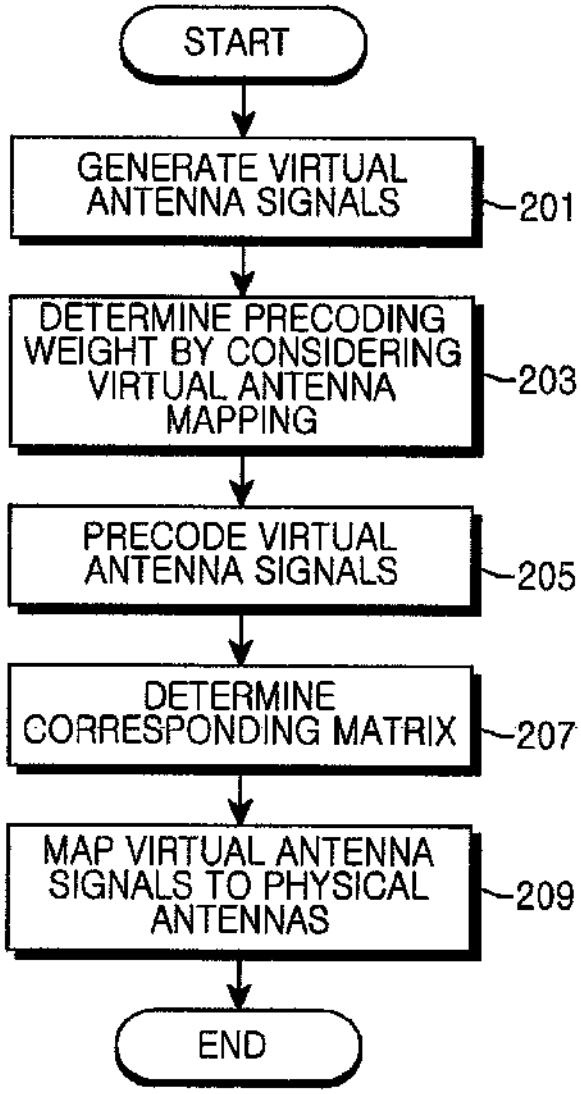

START
GENERATE VIRTUAL ANTENNA SIGNALS
201
DETERMINE PRECODING WEIGHT BY CONSIDERING VIRTUAL ANTENNA MAPPING
203
PRECODE VIRTUAL ANTENNA SIGNALS
205
DETERMINE CORRESPONDING MATRIX
207
MAP VIRTUAL ANTENNA SIGNALS TO PHYSICAL ANTENNAS
209
END

FIG.2

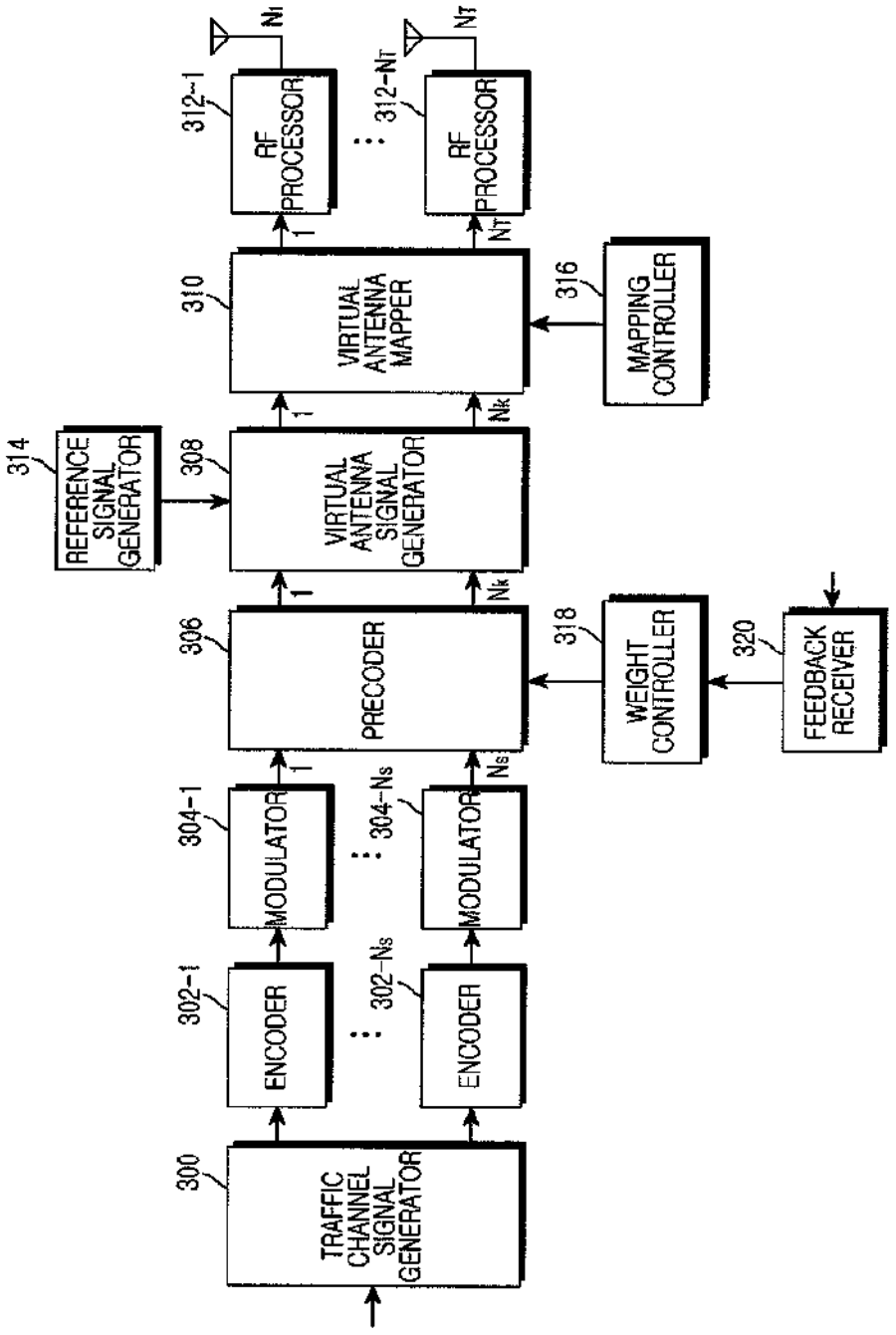

TRAFFIC CHANNEL SIGNAL GENERATOR
300
ENCODER
302-1
302-Ns
MODULATOR
304-1
304-Ns
PRECODER
306
VIRTUAL ANTENNA SIGNAL GENERATOR
308
REFERENCE SIGNAL GENERATOR
314
VIRTUAL ANTENNA MAPPER
310
MAPPING CONTROLLER
316
RF PROCESSOR
312-1
312-Nt
WEIGHT CONTROLLER
318
FEEDBACK RECEIVER
320
1
Ns
Nk
Nt

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 and 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 (1/2) 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.

$$\text{DFT Matrix}\quad \begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \cdot \begin{bmatrix} y_0 \\ y_1 \\ y_2 \\ y_3 \end{bmatrix} \qquad \text{[Eqn. 1]}$$

$$\text{Hadamard Matrix}\quad \begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & 1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix} \cdot \begin{bmatrix} y_0 \\ y_1 \\ y_2 \\ y_3 \end{bmatrix}$$

[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.

$$\begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \cdot \frac{1}{2}\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} \cdot [W_0] \qquad \text{[Eqn. 2]}$$

[0034] In Equation 2, y_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.

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.

$$|a| = |b| = |c| = |d| = |e| = |f| = |g| = |h| = 1 \qquad \text{[Eqn. 4]}$$
$$d = -\frac{a^*}{b^*}c,\ h = -\frac{e^*}{f^*}g$$

[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

[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.

$$\begin{bmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} a & 0 & b & 0 \\ 0 & e & 0 & f \\ c & 0 & d & 0 \\ 0 & g & 0 & h \end{bmatrix}\begin{bmatrix} y_0 \\ y_1 \\ y_2 \\ y_3 \end{bmatrix} \qquad \text{[Eqn. 3]}$$

[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

[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.

$$\text{i) } a=jb,\ c=-jd \text{ or } a=-jb,\ c=jd$$
$$\text{ii) } e=jf,\ g=-jh \text{ or } e=-jf,\ g=jh \qquad \text{[Eqn. 5]}$$

[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.

$$\frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & c & 0 & jc \\ c & 0 & -jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & c & 0 & jc \\ c & 0 & jc & 0 \\ 0 & g & 0 & -jg \end{bmatrix} \quad \text{[Eqn. 6]}$$

$$\text{or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & -jc & 0 \\ 0 & g & 0 & jg \end{bmatrix} \text{ or } \frac{1}{\sqrt{2}}\begin{bmatrix} a & 0 & -ja & 0 \\ 0 & e & 0 & -je \\ c & 0 & jc & 0 \\ 0 & g & 0 & jg \end{bmatrix}$$

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 LTE 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_t. Herein, N_t 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_t 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.

* * * * *

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(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)

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(2), (4) Date: **Jul. 29, 2014**

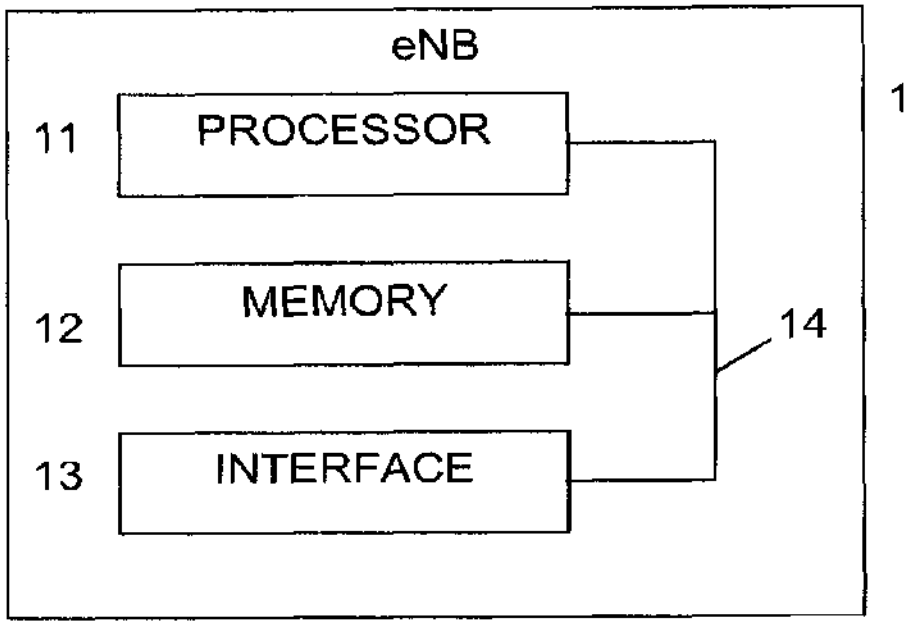
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(57) **ABSTRACT**

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



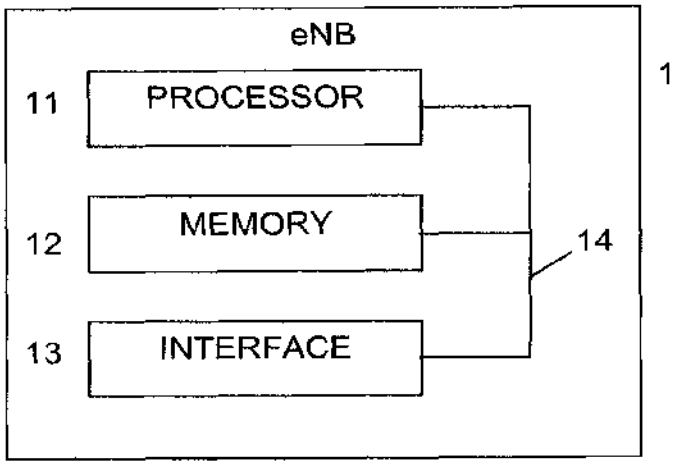

eNB
1
11
PROCESSOR
12
MEMORY
14
13
INTERFACE

Fig. 1

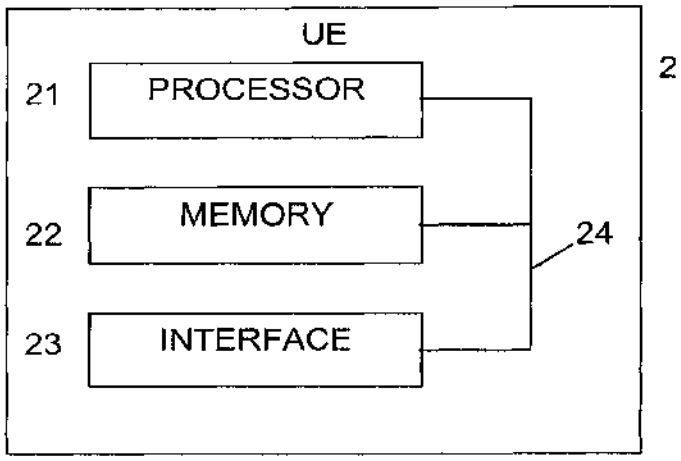

UE
2
21
PROCESSOR
22
MEMORY
24
23
INTERFACE

Fig. 2

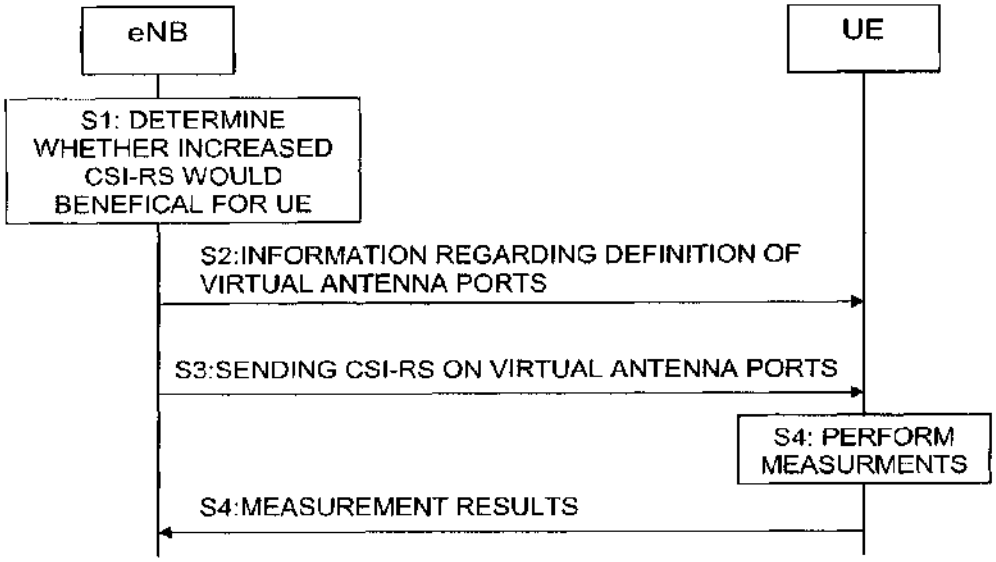

eNB
UE
S1: DETERMINE WHETHER INCREASED CSI-RS WOULD BENEFICAL FOR UE
S2:INFORMATION REGARDING DEFINITION OF VIRTUAL ANTENNA PORTS
S3:SENDING CSI-RS ON VIRTUAL ANTENNA PORTS
S4: PERFORM MEASURMENTS
S4:MEASUREMENT RESULTS

Fig. 3

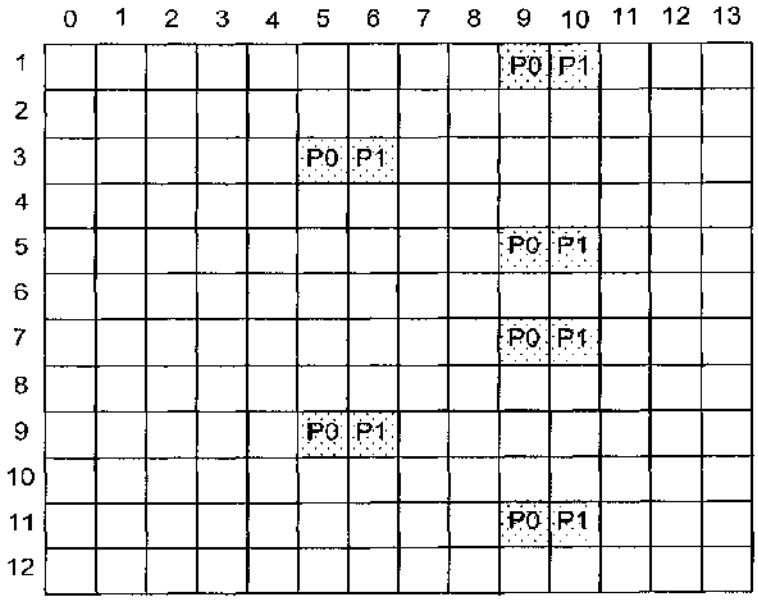

0 1 2 3 4 5 6 7 8 9 10 11 12 13
1 2 3 4 5 6 7 8 9 10 11 12
P0 P1
P0 P1
P0 P1
P0 P1
P0 P1
P0 P1

Fig. 4

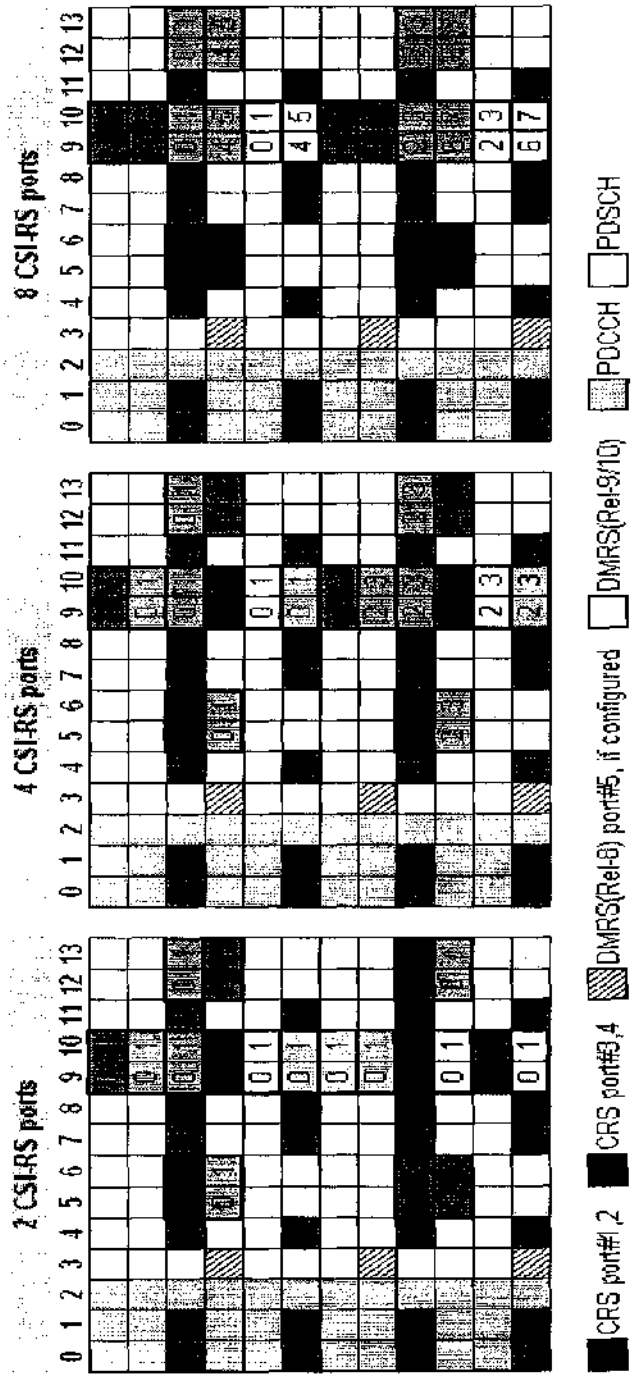
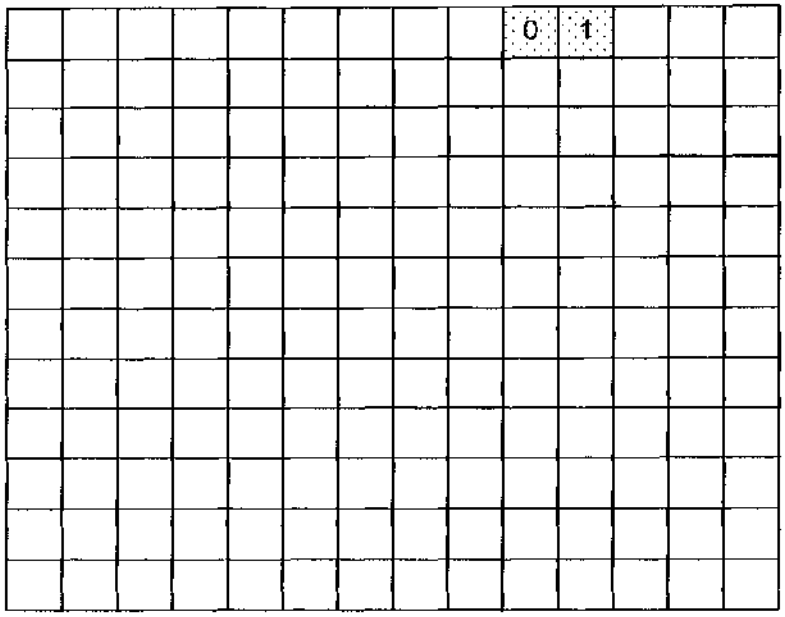

2 CSI-RS ports
4 CSI-RS ports
8 CSI-RS ports
CRS port#1,2
CRS port#3,4
DMRS(Rel-8) port#5, if configured
DMRS(Rel-9/10)
PDCCH
PDSCH

Fig. 5



CELL 1

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 (Rel.10 feature), coherent joint transmission (which might be an important

[0024] COMP candidate in current Rel.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 S1, 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 S3 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 S4, the UE performs measurements (e.g., RRM measurements) and sends the measurement results to the ENB in S4.

[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 P1, 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 Rel.10CSI-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.

* * * * *

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(54) **METHOD AND APPARATUS FOR TRANSMITTING CHANNEL STATE INFORMATION REFERENCE SIGNAL**

(71) Applicant: **Electronics and Telecommunications Research Institute**, Daejeon (KR)

(72) Inventors: **Sung-Hyun MOON**, Daejeon (KR); **Wooram SHIN**, Daejeon (KR); **Cheulsoon KIM**, Daejeon (KR); **Young Jo KO**, Daejeon (KR)

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(57) **ABSTRACT**

A base station includes a plurality of first resource elements (REs) corresponding to at least two of a second orthogonal frequency division multiplexing (OFDM) symbol, a third OFDM symbol, and a fourth OFDM symbol of a first time slot, in a first CSI-RS resource pool configured in a first subframe including the first time slot and a second time slot subsequent to the first time slot. Furthermore, the base station transmits a CSI-RS at least one of REs included in the first CSI-RS resource pool.

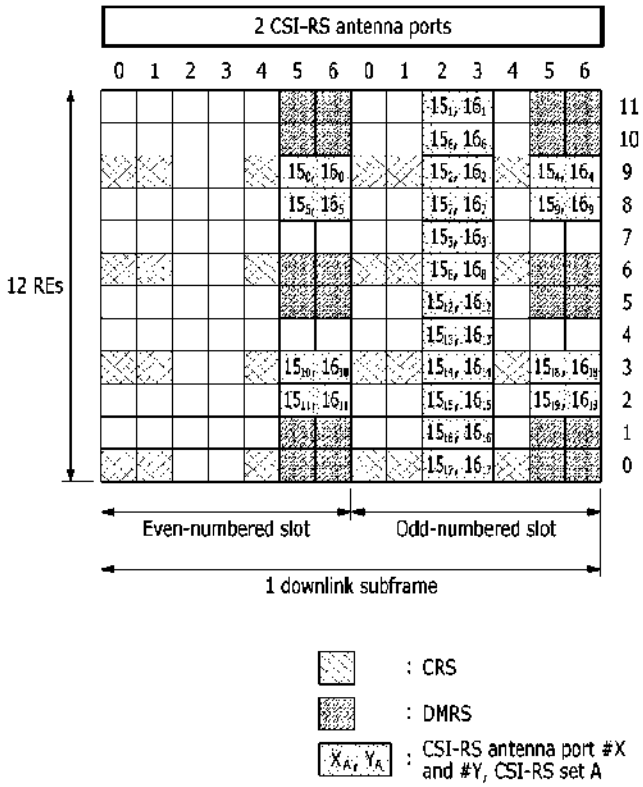


FIG. 1

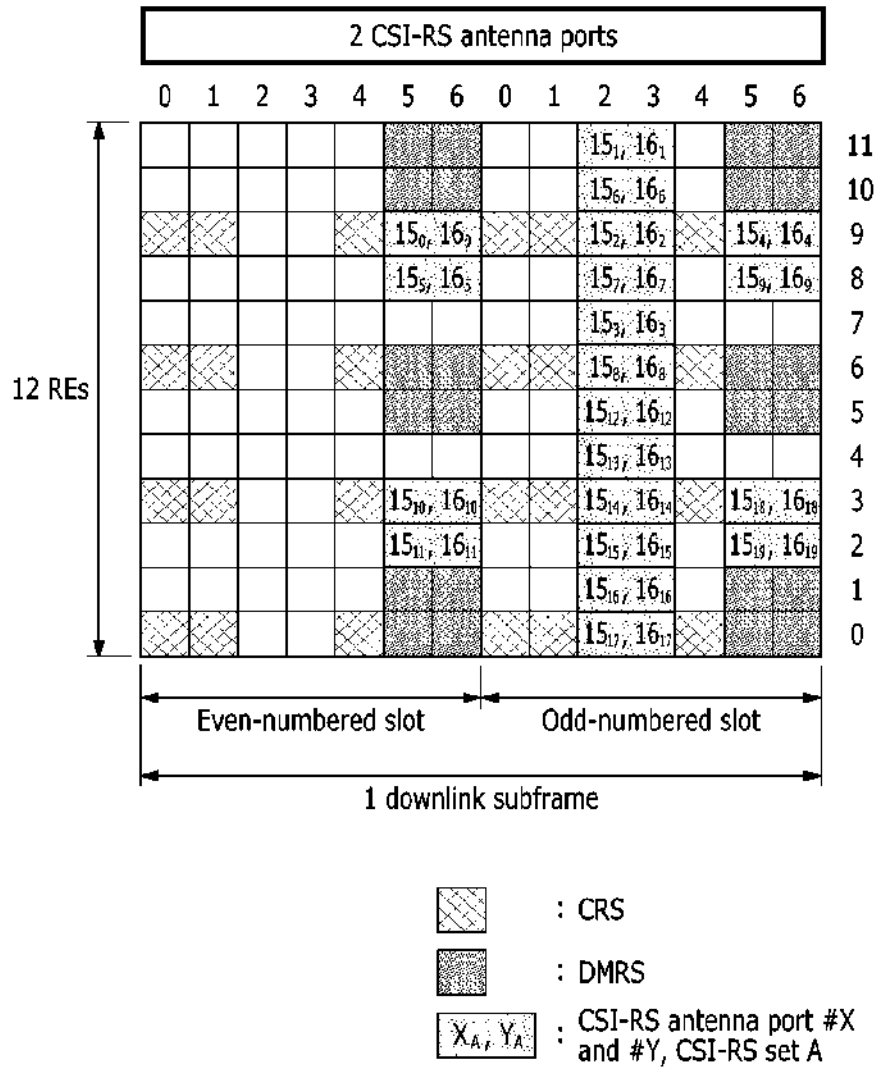

2 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 2

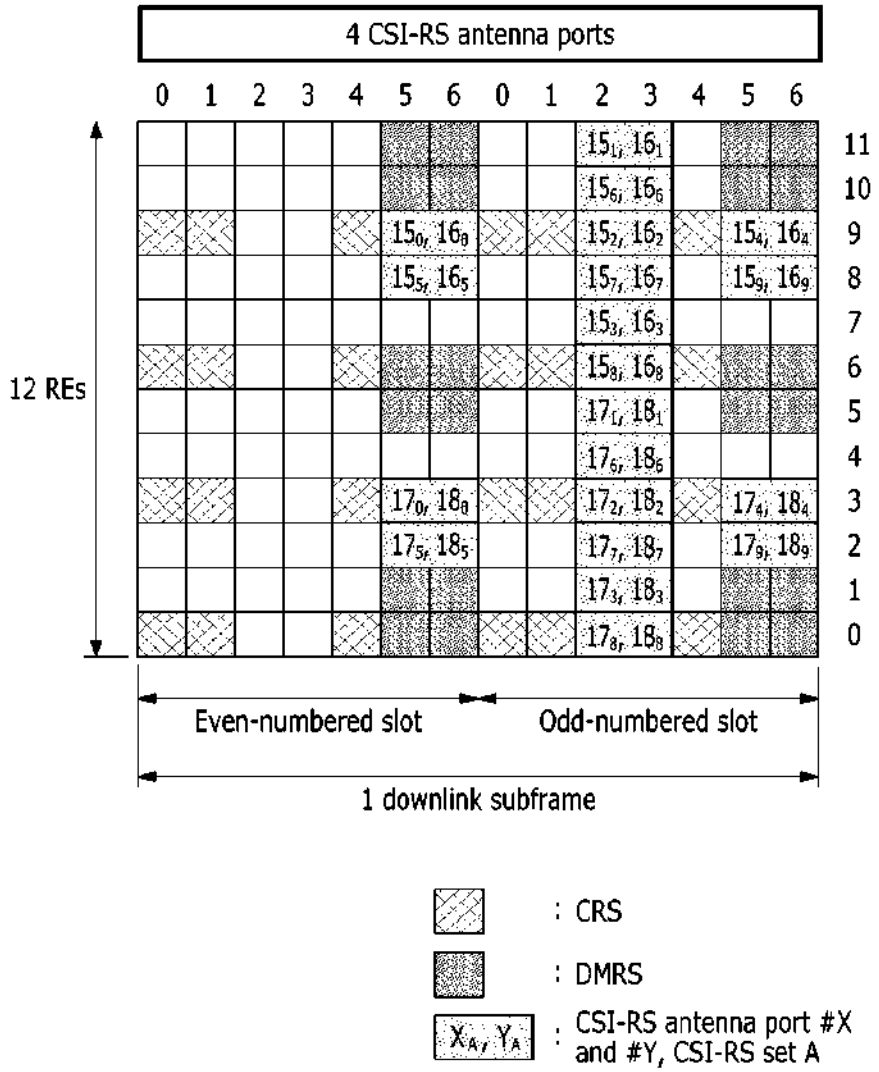

4 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 3

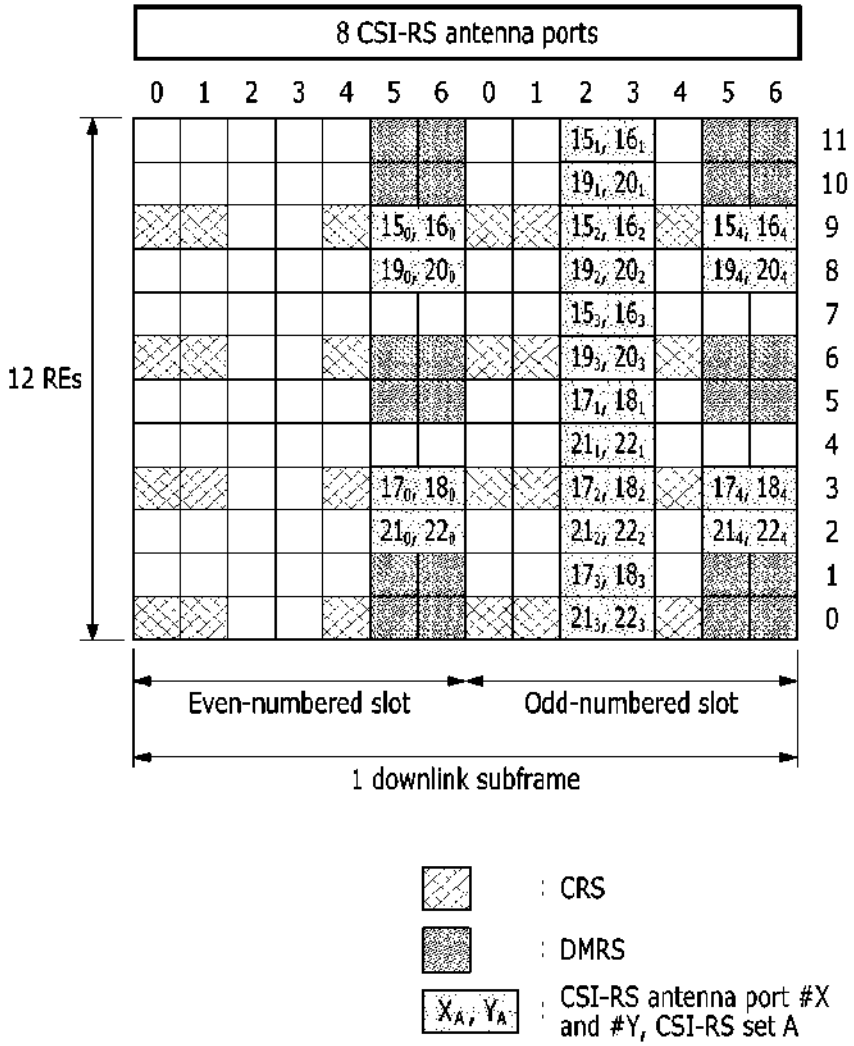

8 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 4

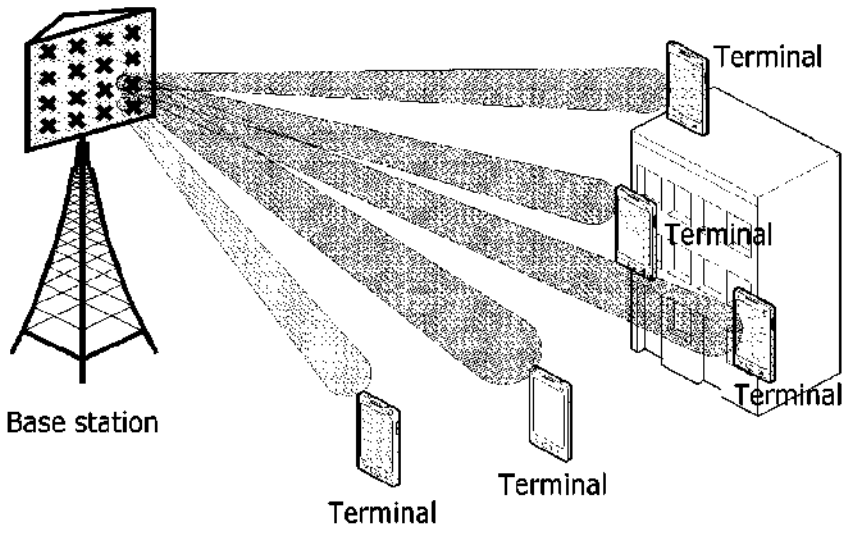

Terminal
Terminal
Terminal
Base station
Terminal
Terminal

FIG. 5A

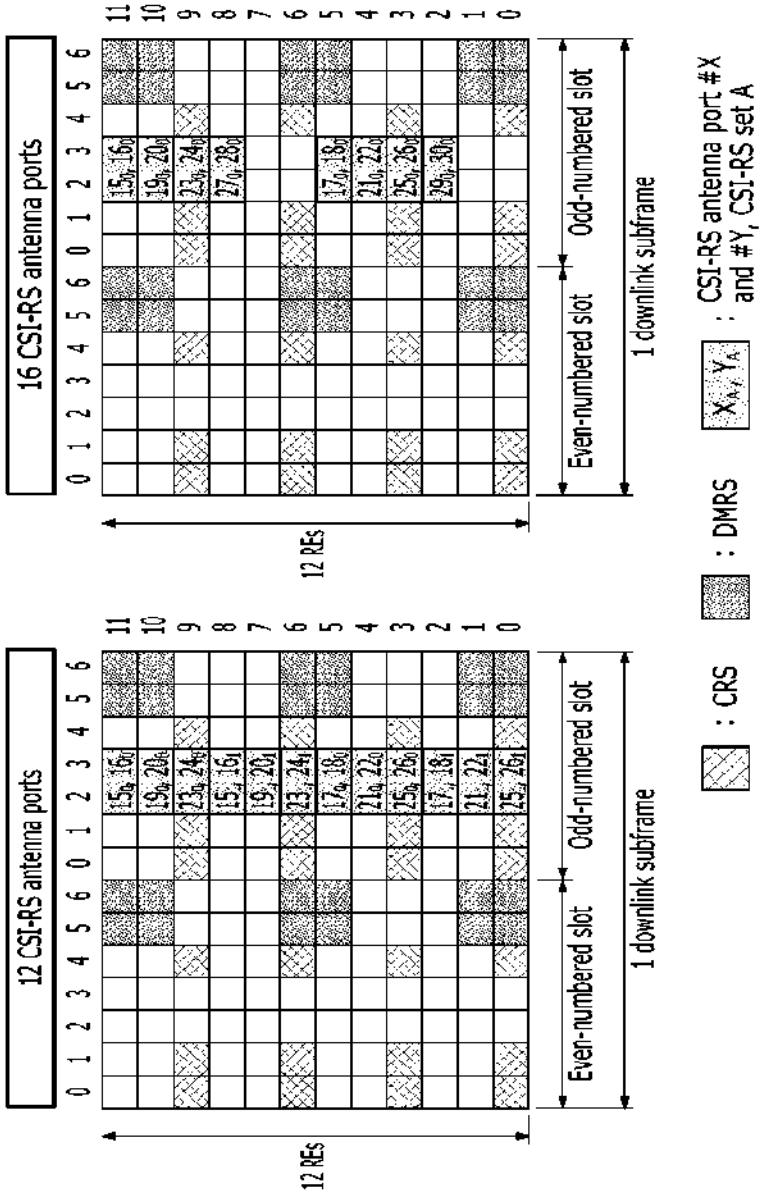

12 CSI-RS antenna ports
16 CSI-RS antenna ports
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 5B

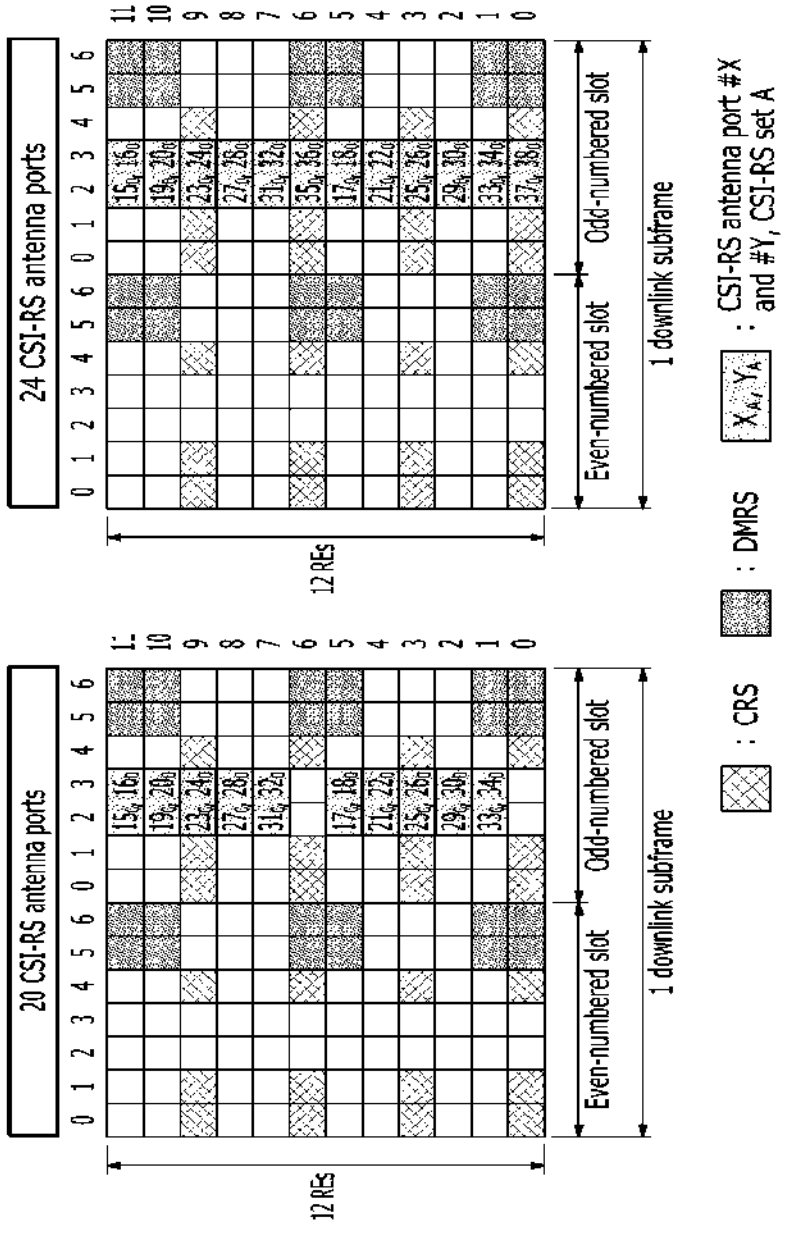

24 CSI-RS antenna ports
20 CSI-RS antenna ports
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 6

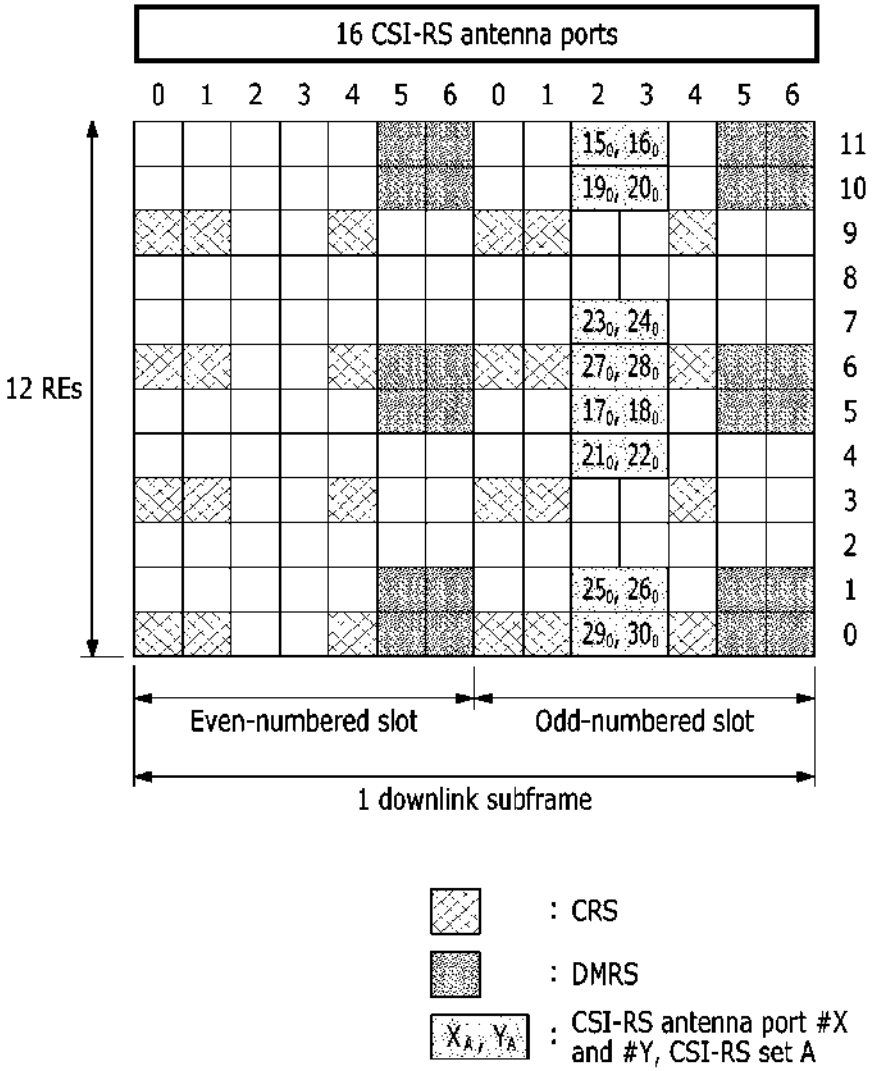

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 7

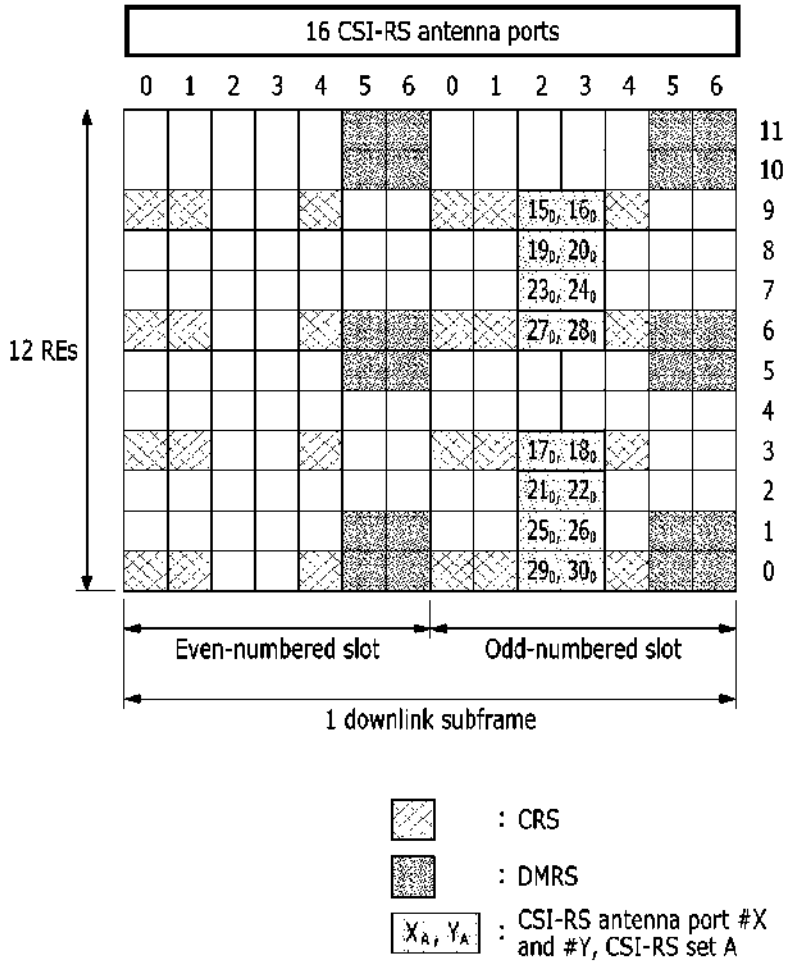

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
$15_0, 16_0$
$19_0, 20_0$
$23_0, 24_0$
$27_0, 28_0$
$17_0, 18_0$
$21_0, 22_0$
$25_0, 26_0$
$29_0, 30_0$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A : CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 8

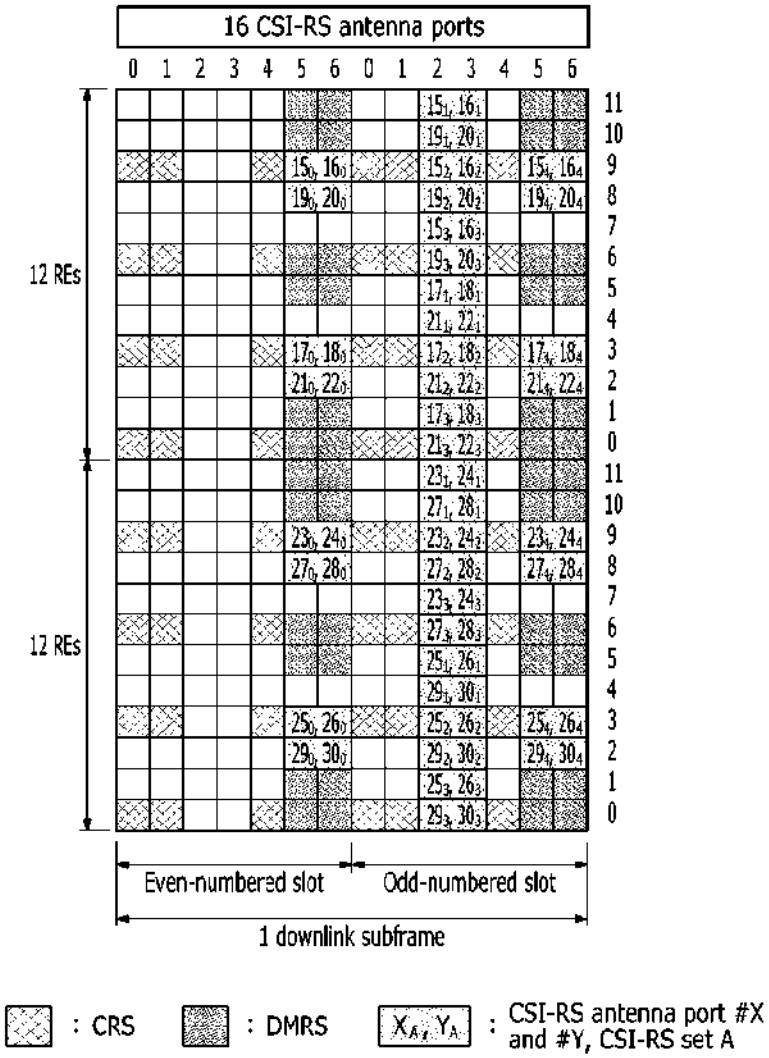

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 9

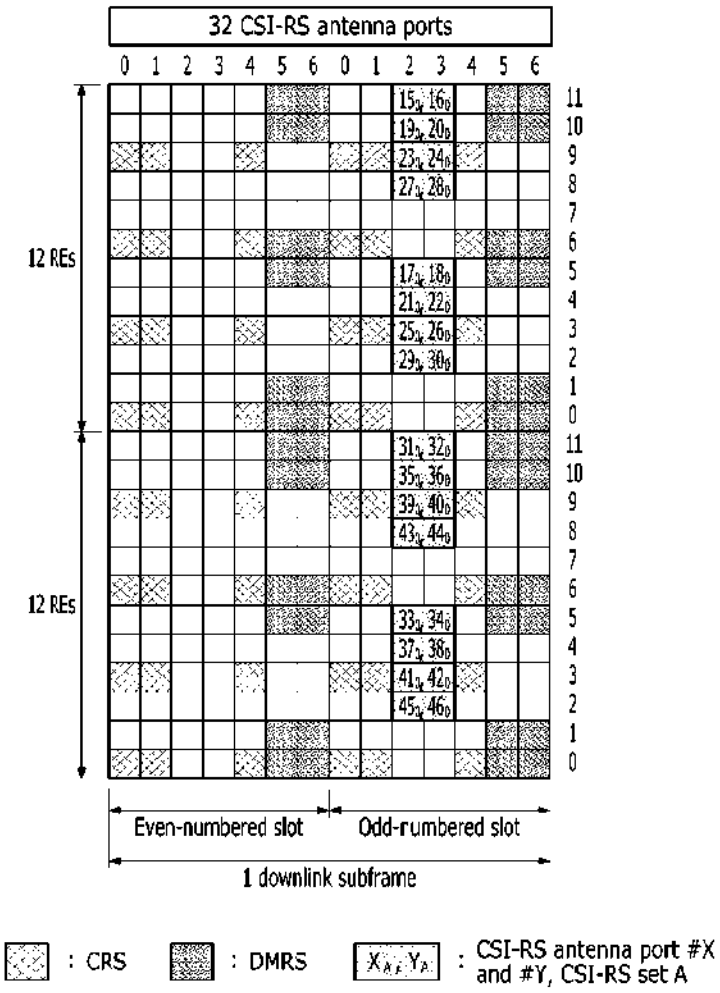

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
12 REs
Even-numbered slot
Odd-rumbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 10

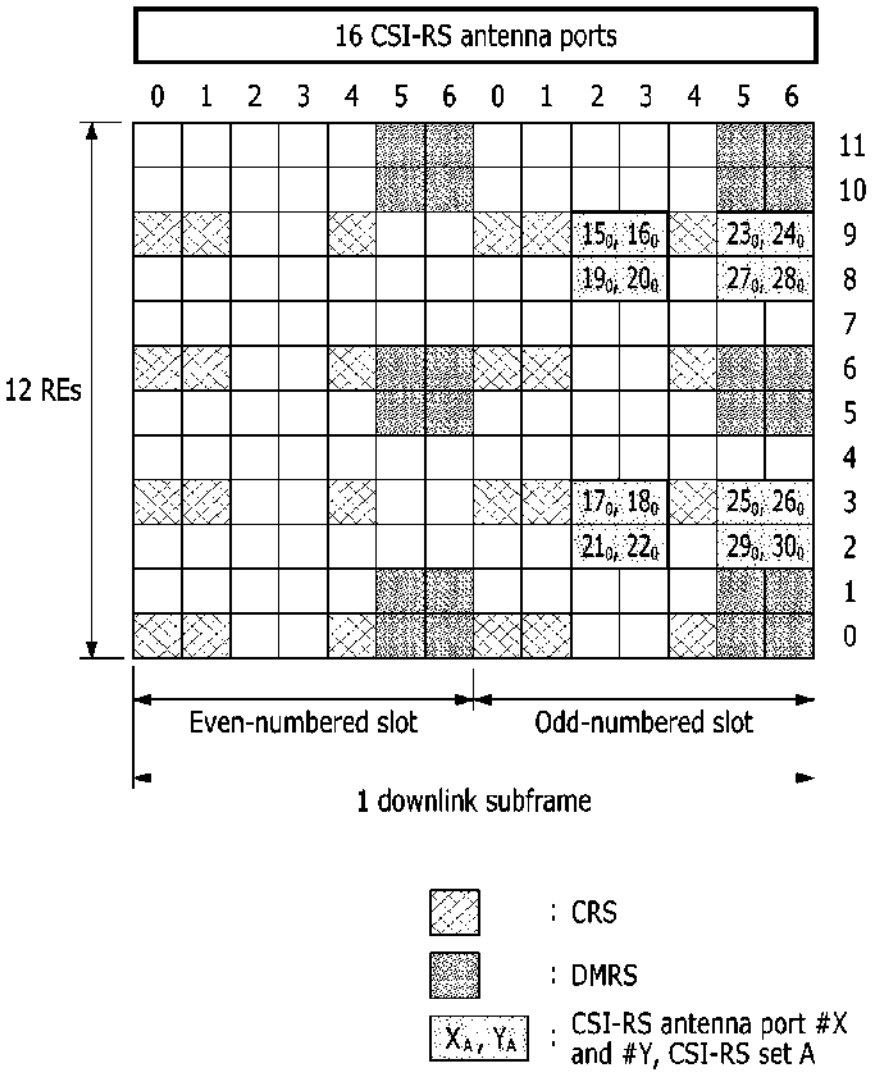

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
$15_0, 16_0$
$23_0, 24_0$
$19_0, 20_0$
$27_0, 28_0$
$17_0, 18_0$
$25_0, 26_0$
$21_0, 22_0$
$29_0, 30_0$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 11

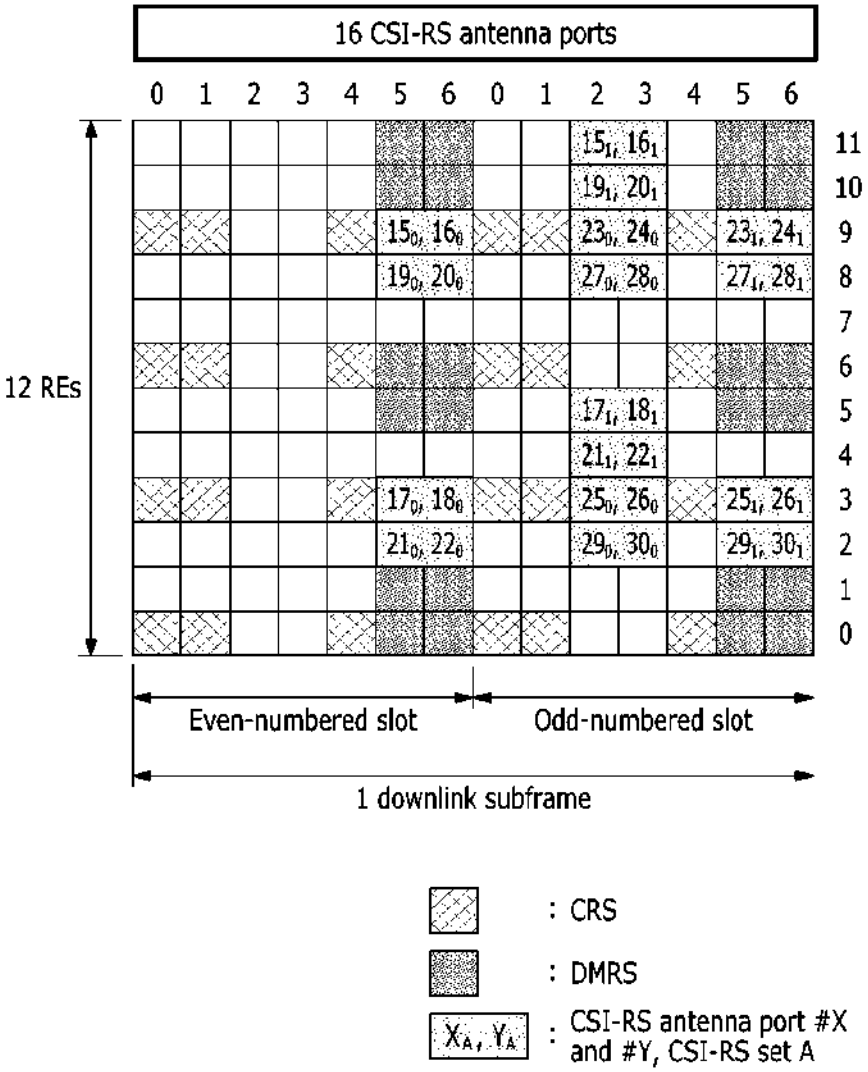

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
$15_1, 16_1$
$19_1, 20_1$
$15_0, 16_0$
$23_0, 24_0$
$23_1, 24_1$
$19_0, 20_0$
$27_0, 28_0$
$27_1, 28_1$
$17_1, 18_1$
$21_1, 22_1$
$17_0, 18_0$
$25_0, 26_0$
$25_1, 26_1$
$21_0, 22_0$
$29_0, 30_0$
$29_1, 30_1$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 12

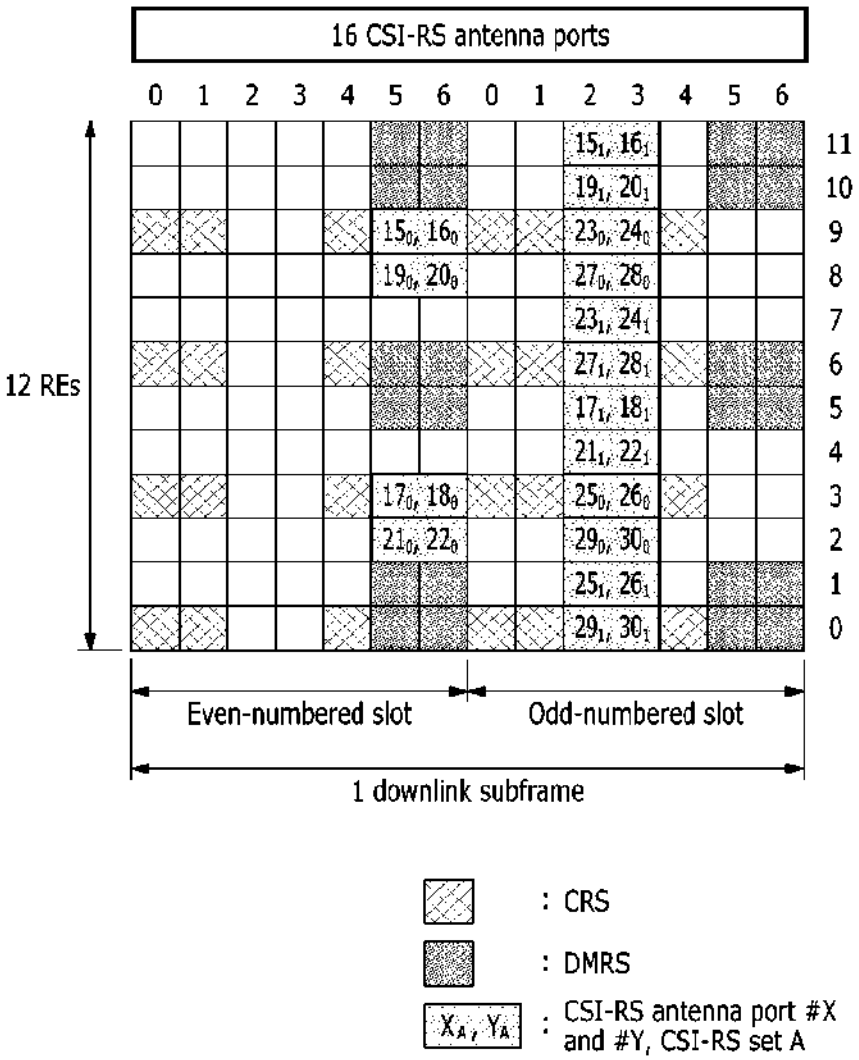

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 13

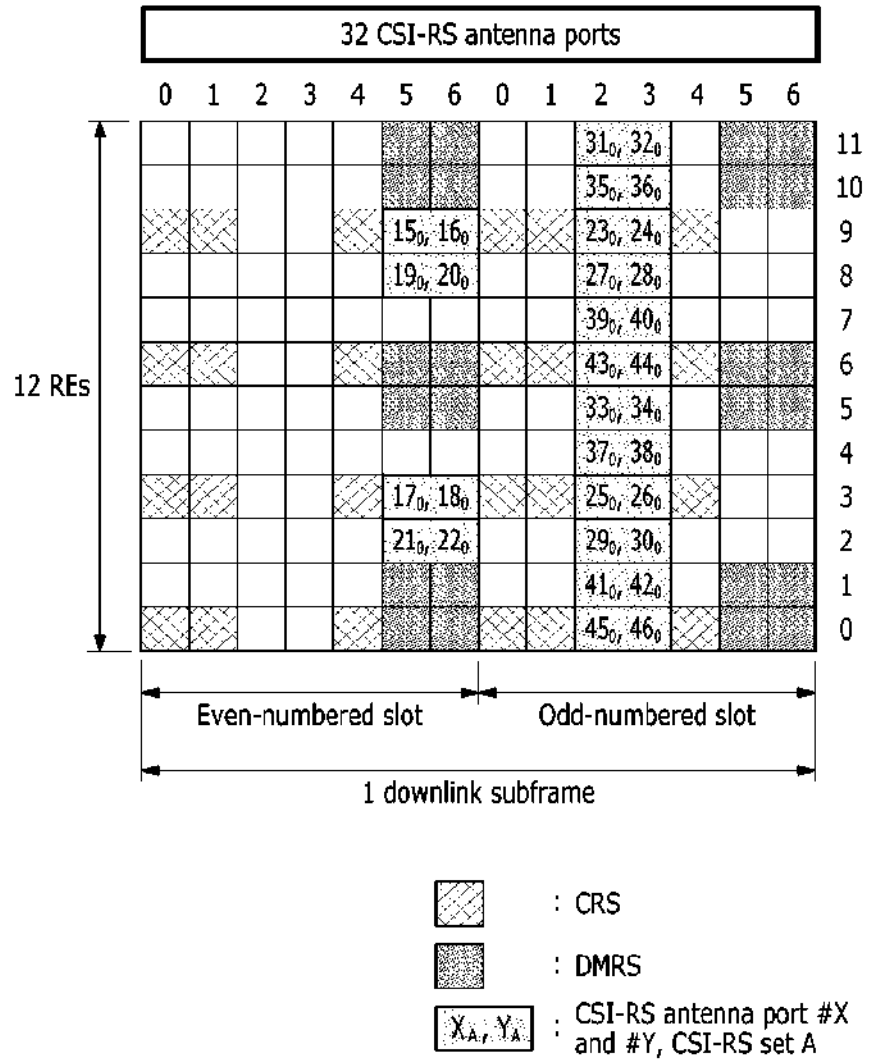

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 14

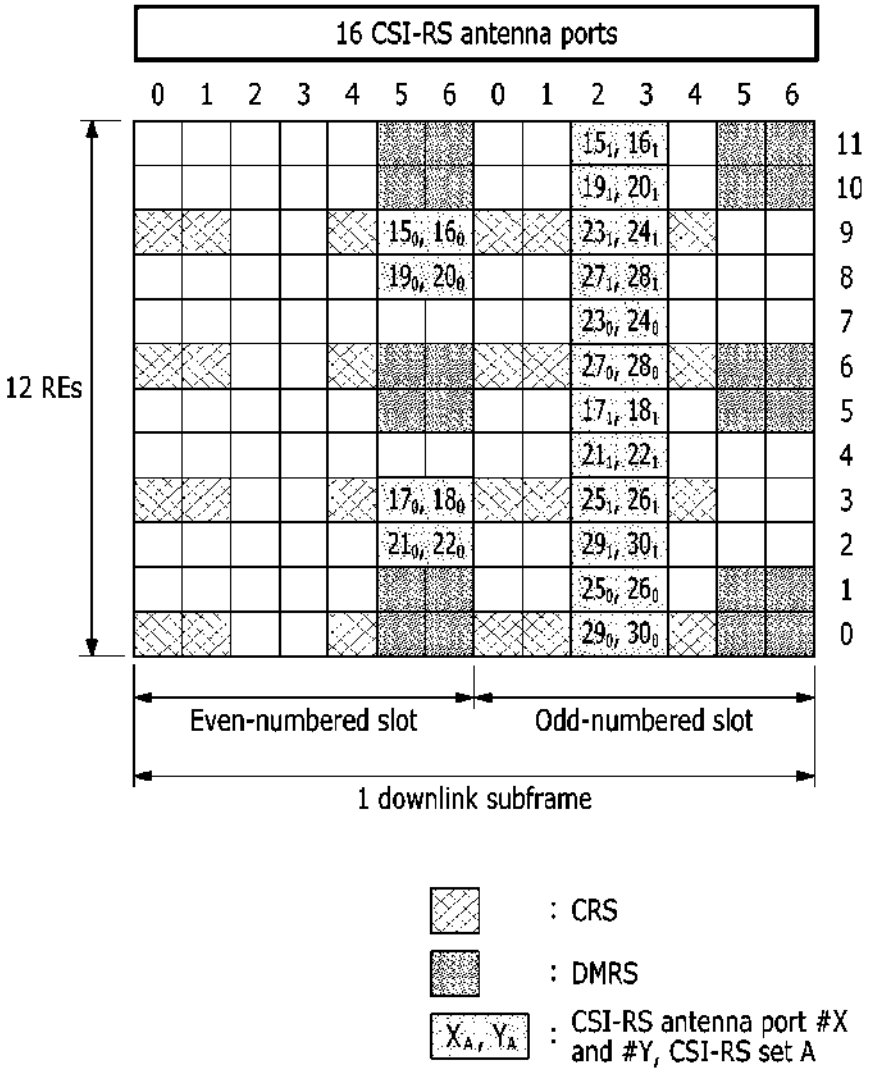

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 15

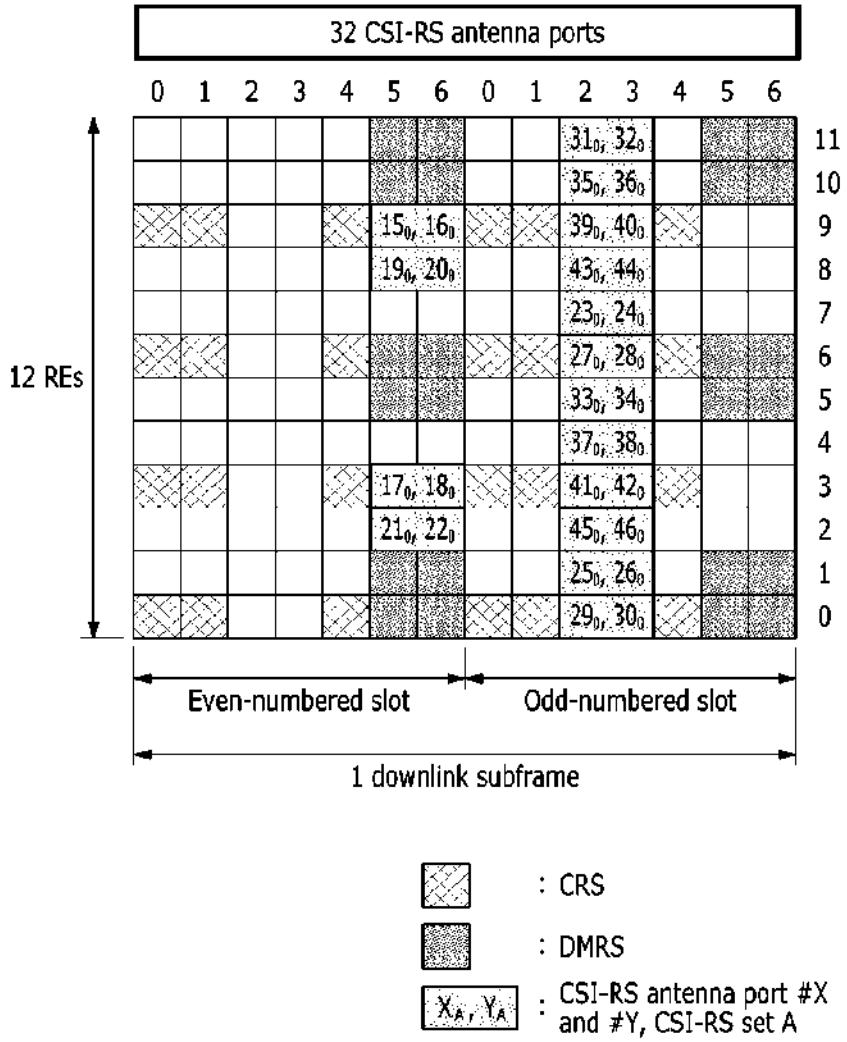

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 16

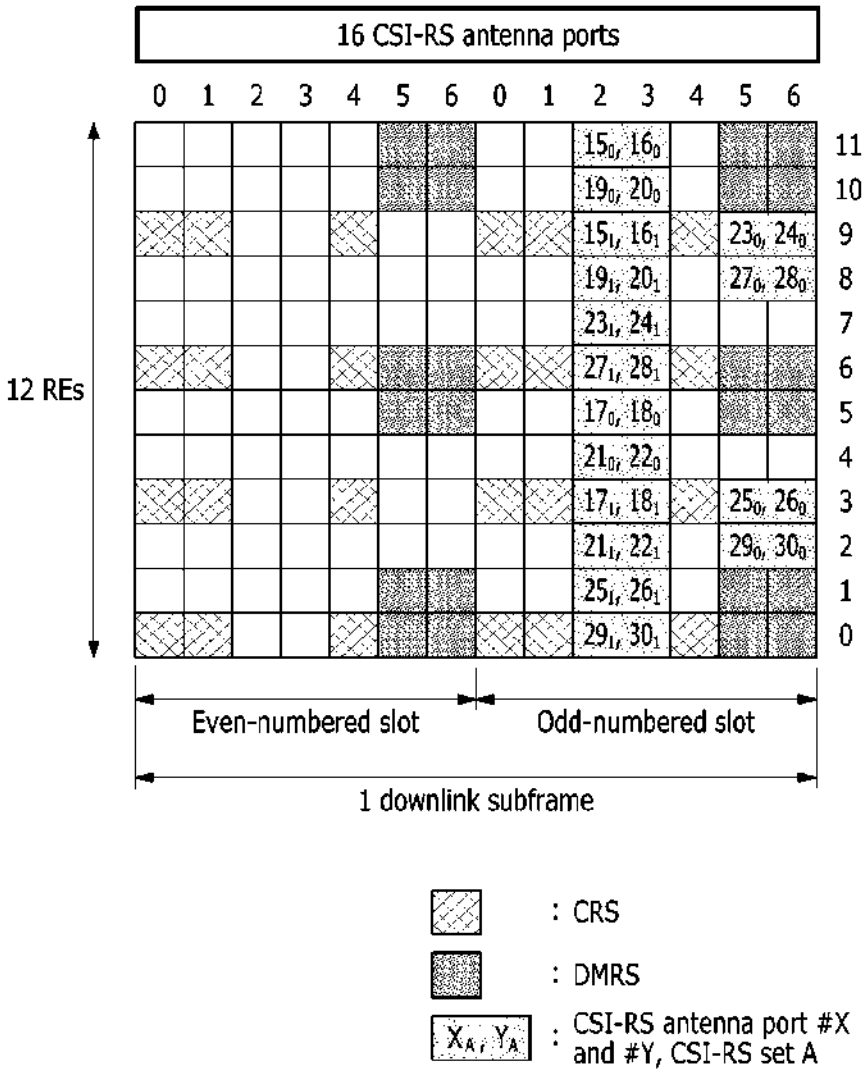

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 17

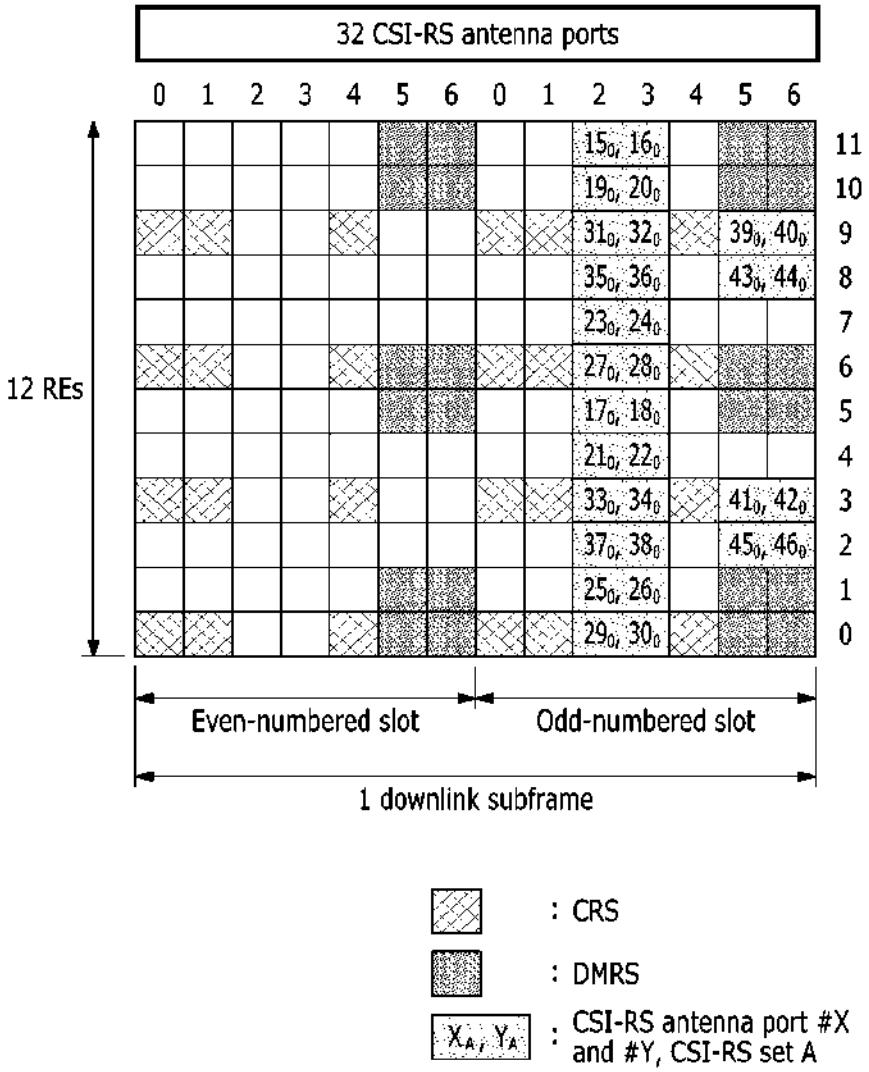

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 18

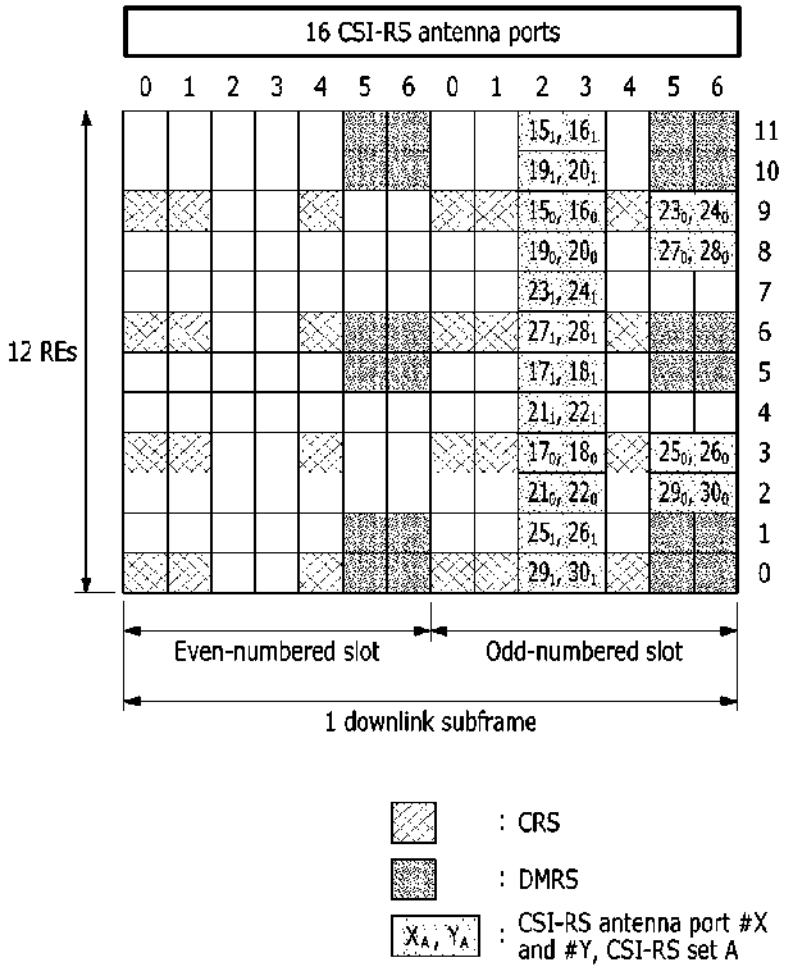

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 19

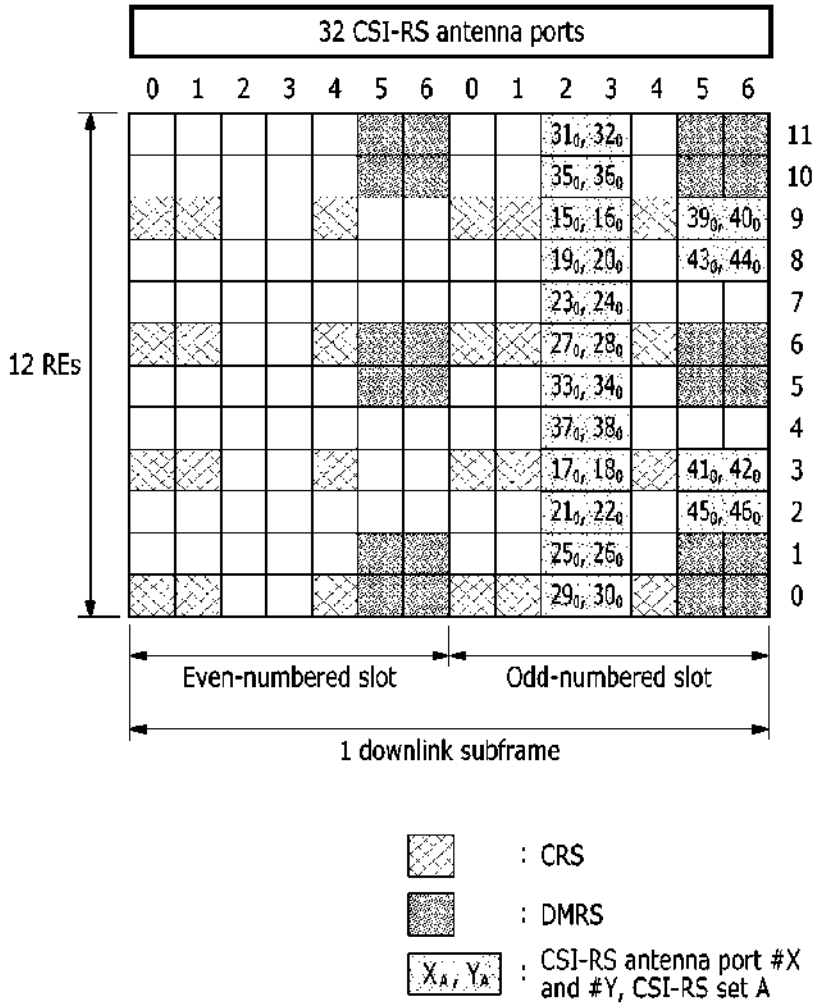

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 20

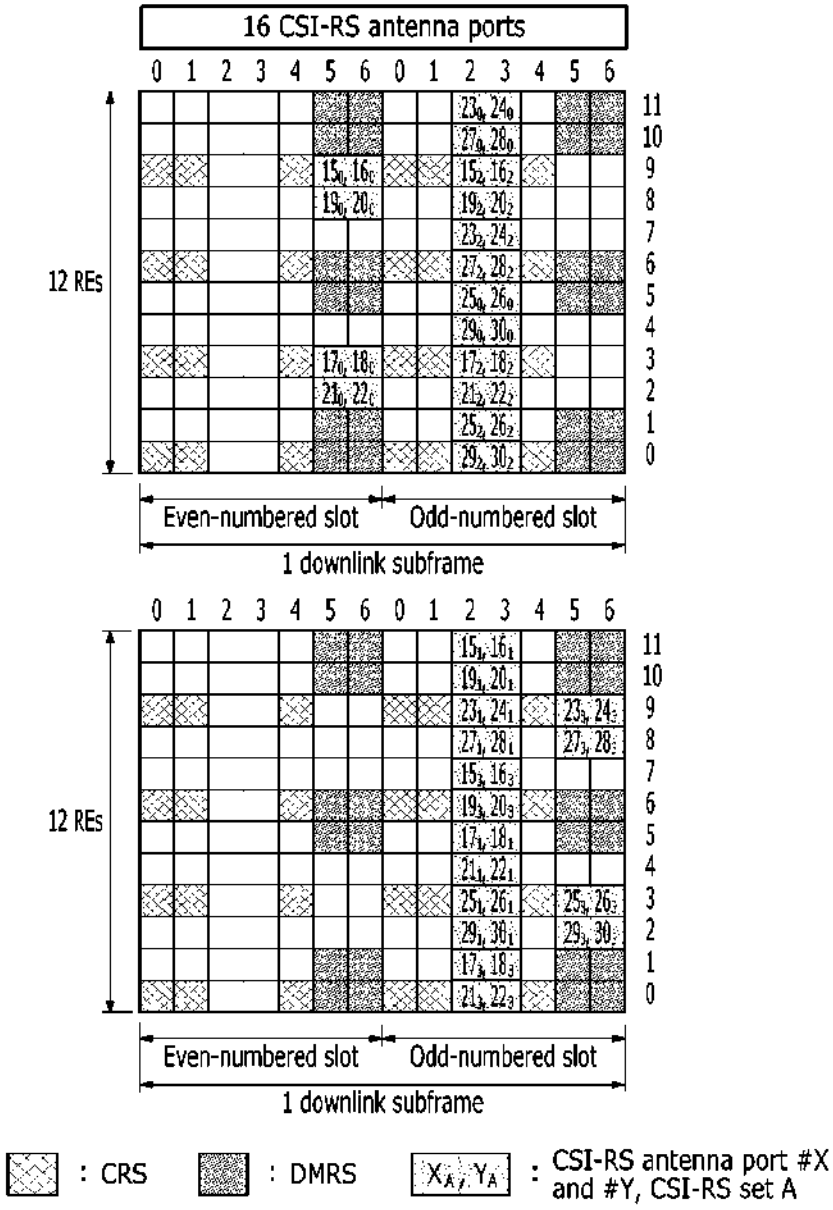

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 21

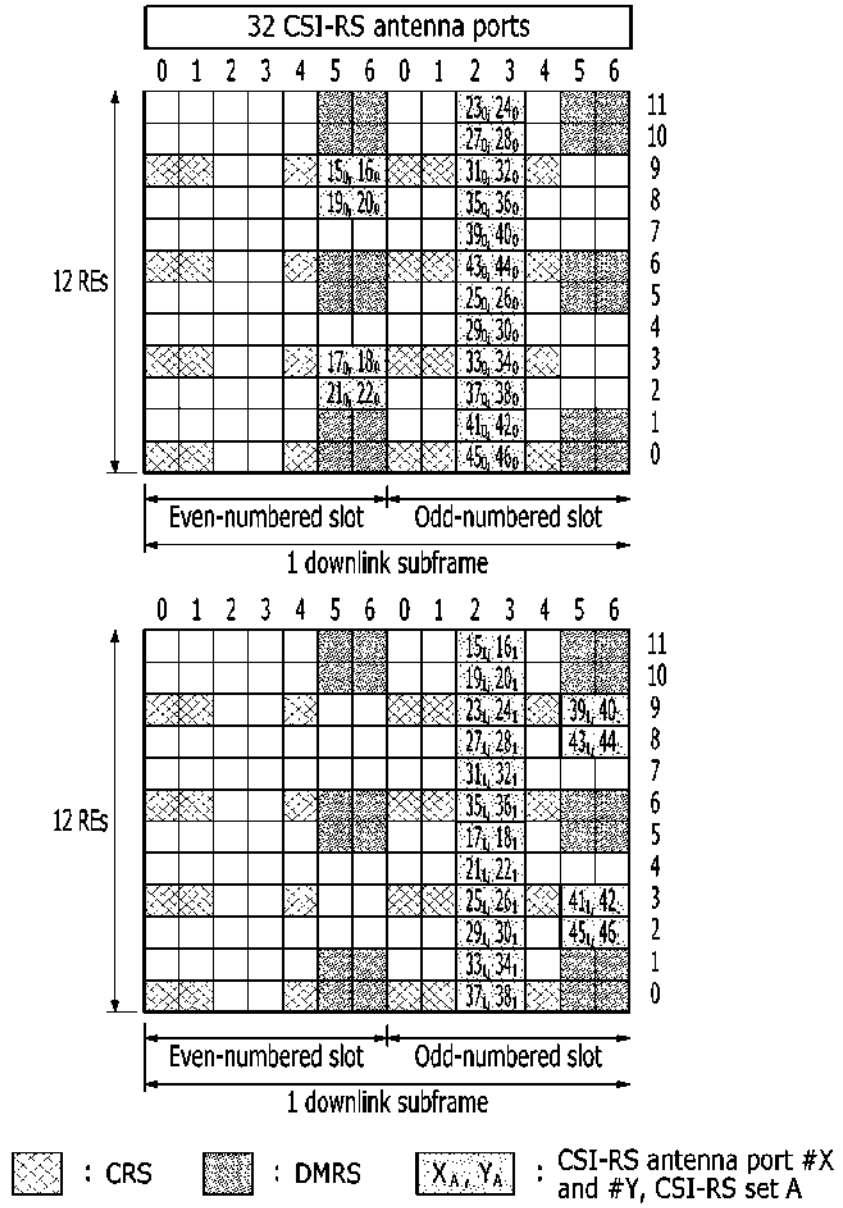

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 22A

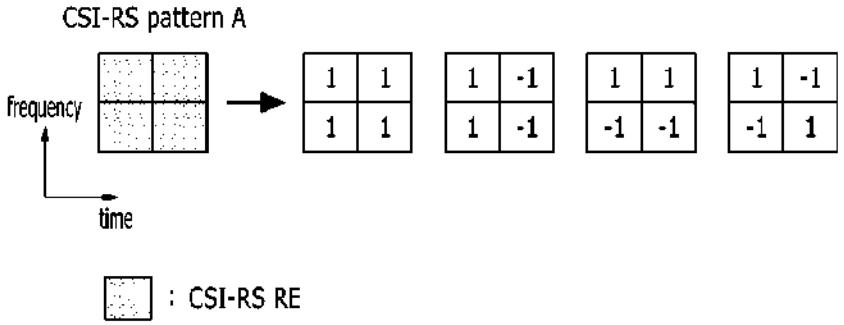


FIG. 22B

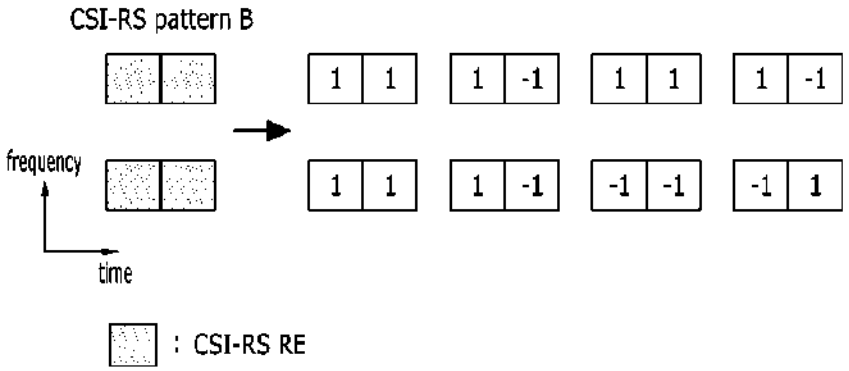


FIG. 23

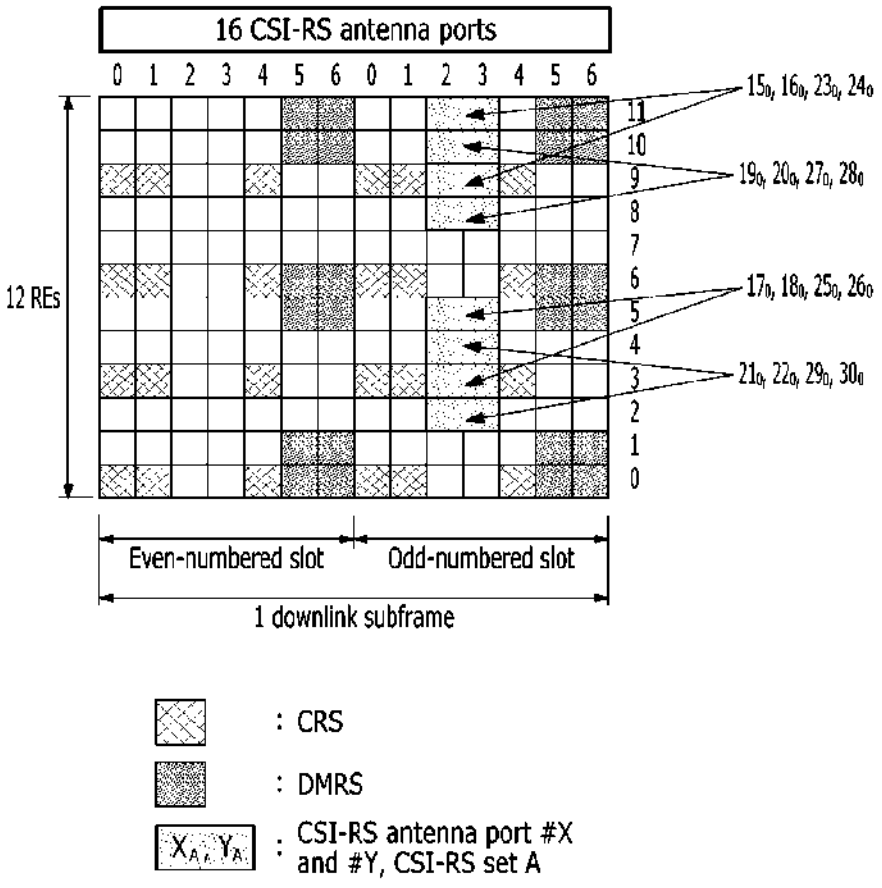

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
$15_0, 16_0, 23_0, 24_0$
$19_0, 20_0, 27_0, 28_0$
$17_0, 18_0, 25_0, 26_0$
$21_0, 22_0, 29_0, 30_0$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 24

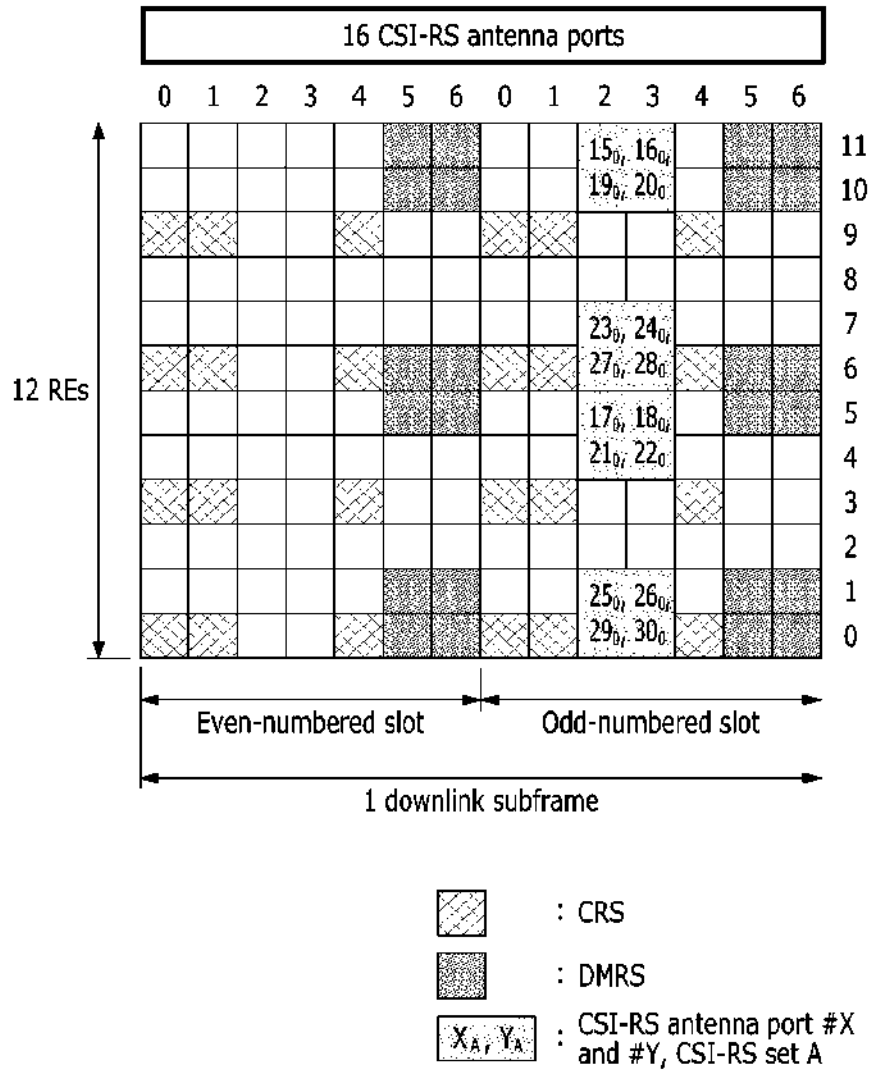

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 25

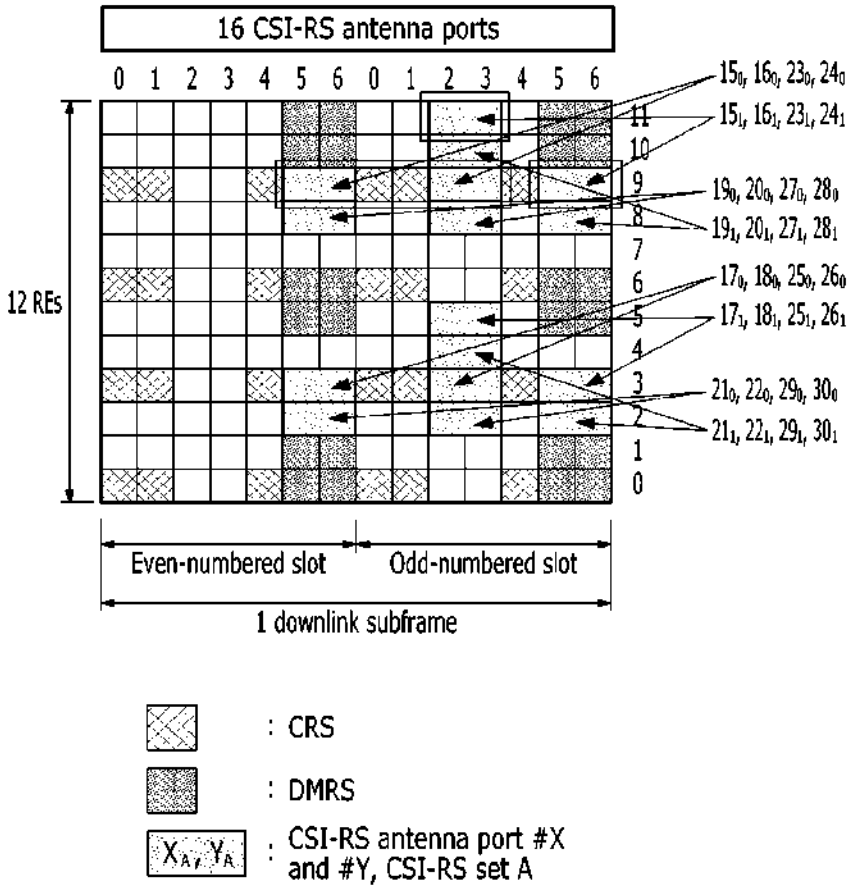

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
$15_0, 16_0, 23_0, 24_0$
$15_1, 16_1, 23_1, 24_1$
$19_0, 20_0, 27_0, 28_0$
$19_1, 20_1, 27_1, 28_1$
$17_0, 18_0, 25_0, 26_0$
$17_1, 18_1, 25_1, 26_1$
$21_0, 22_0, 29_0, 30_0$
$21_1, 22_1, 29_1, 30_1$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 26

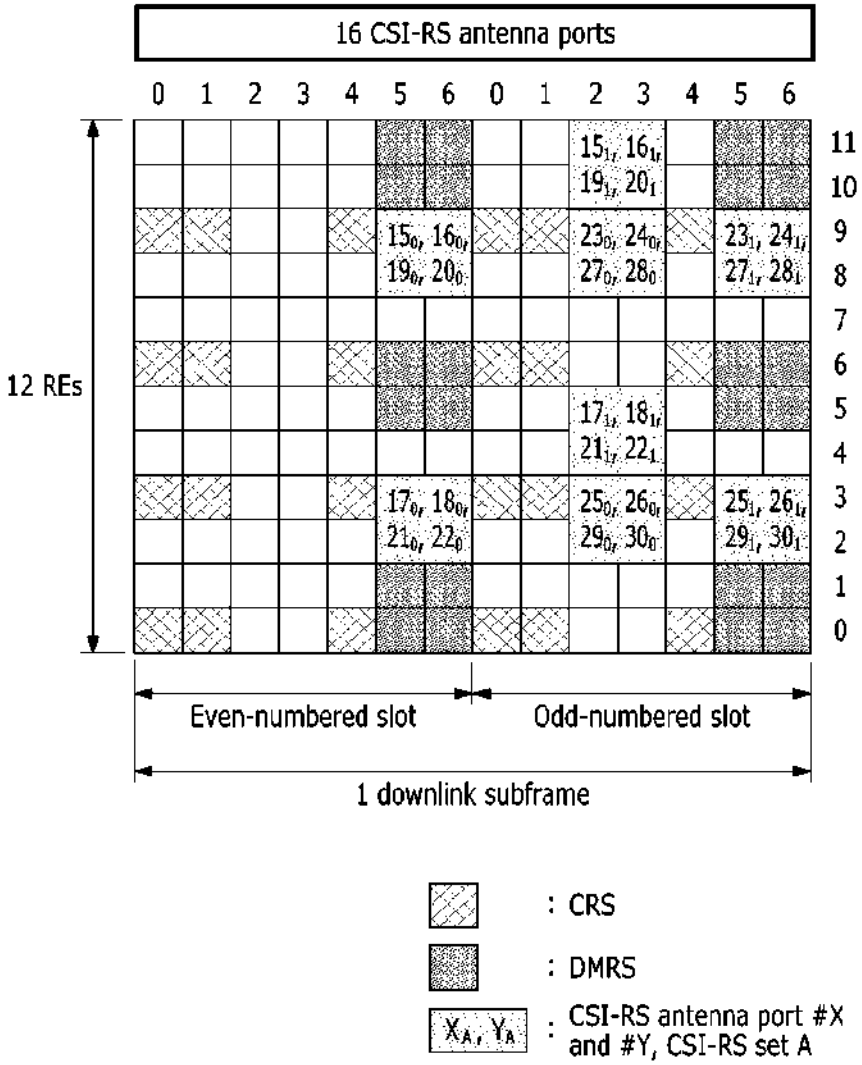

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 27

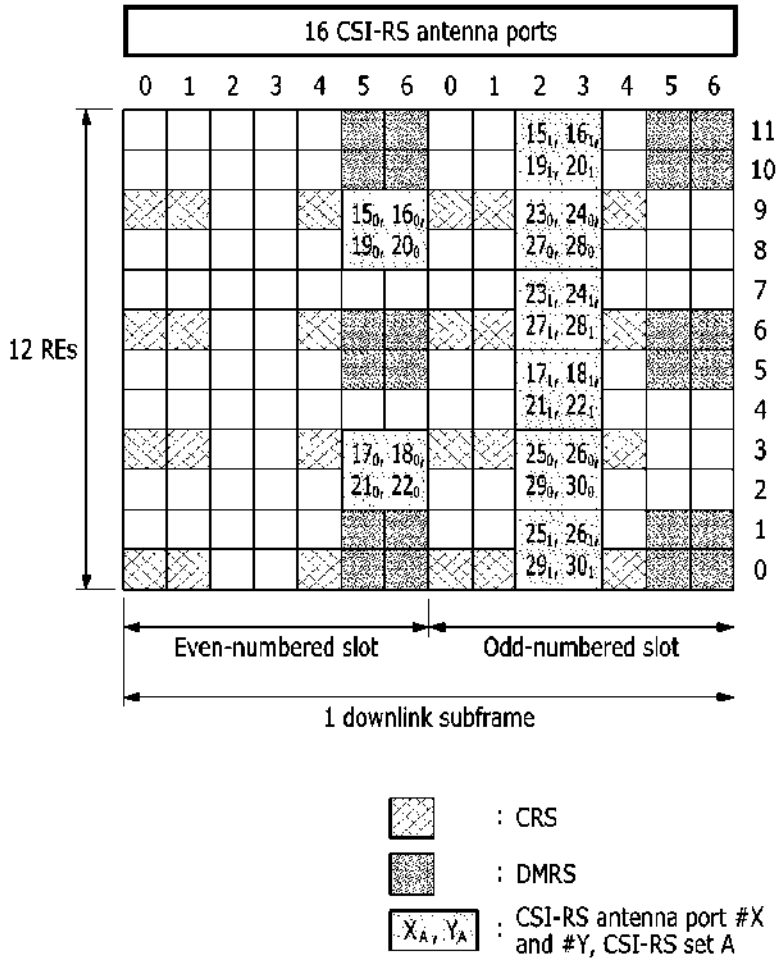

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 28

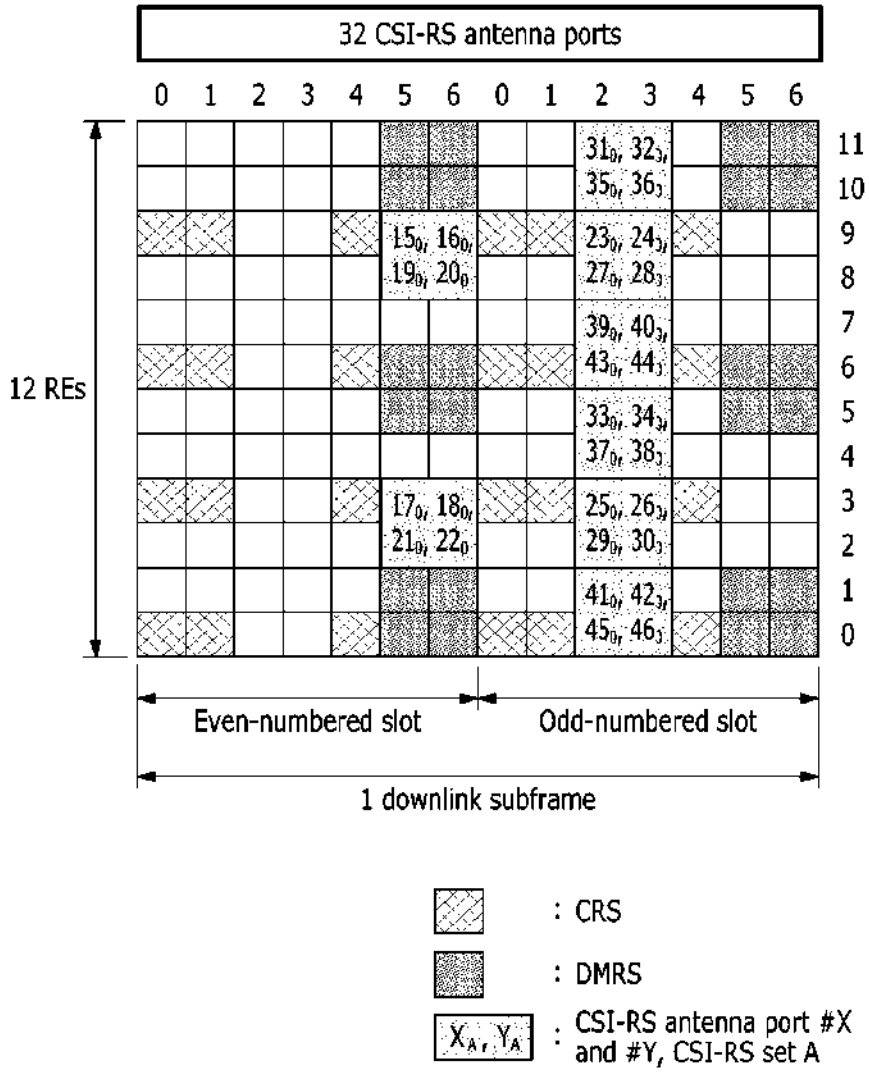

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 29

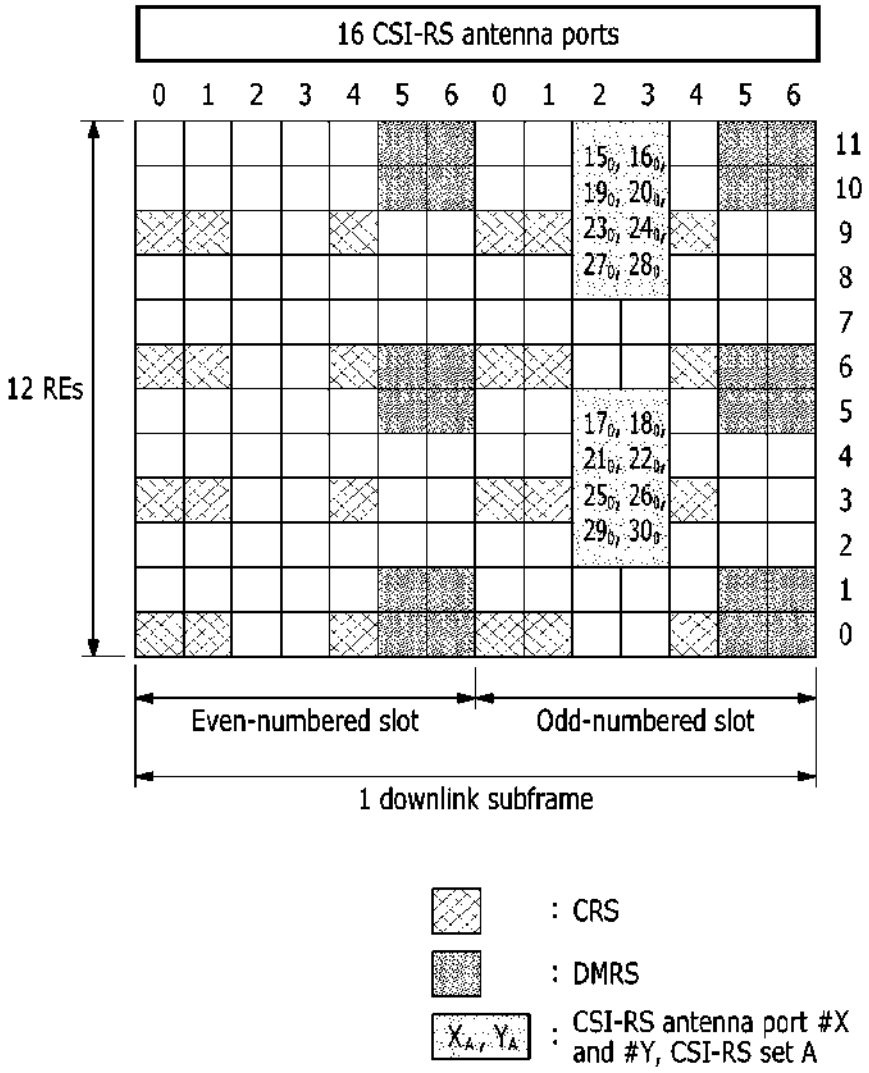

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
$15_0, 16_0$
$19_0, 20_0$
$23_0, 24_0$
$27_0, 28_0$
$17_0, 18_0$
$21_0, 22_0$
$25_0, 26_0$
$29_0, 30_0$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 30

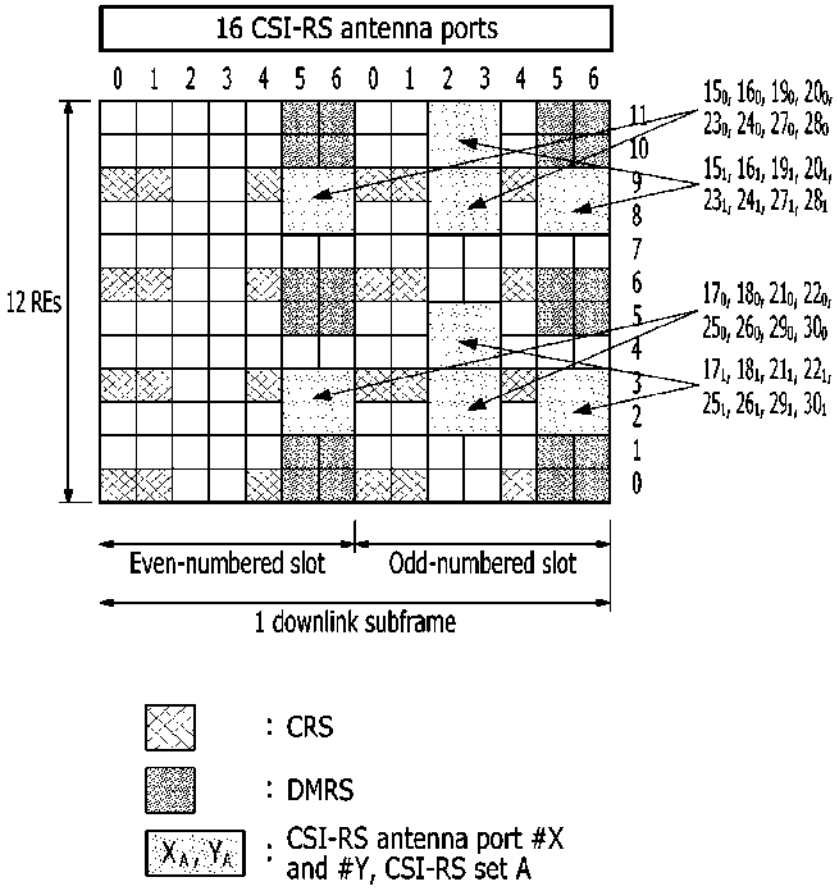

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
$15_0, 16_0, 19_0, 20_0, 23_0, 24_0, 27_0, 28_0$
$15_1, 16_1, 19_1, 20_1, 23_1, 24_1, 27_1, 28_1$
$17_0, 18_0, 21_0, 22_0, 25_0, 26_0, 29_0, 30_0$
$17_1, 18_1, 21_1, 22_1, 25_1, 26_1, 29_1, 30_1$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 31

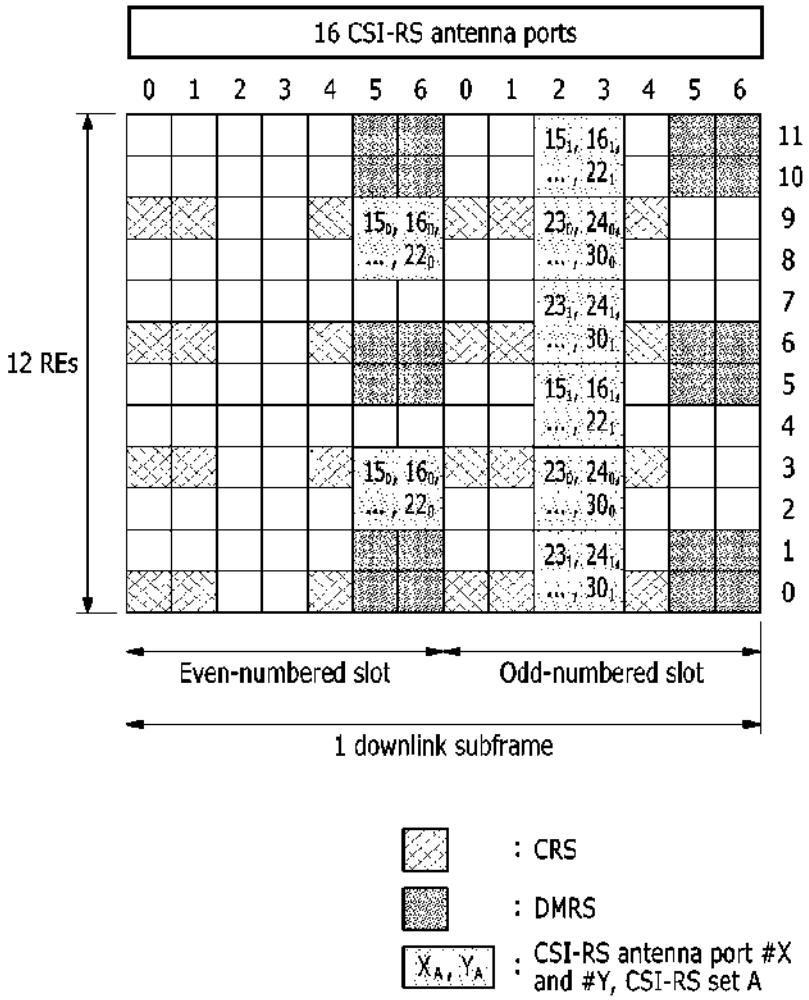

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 32

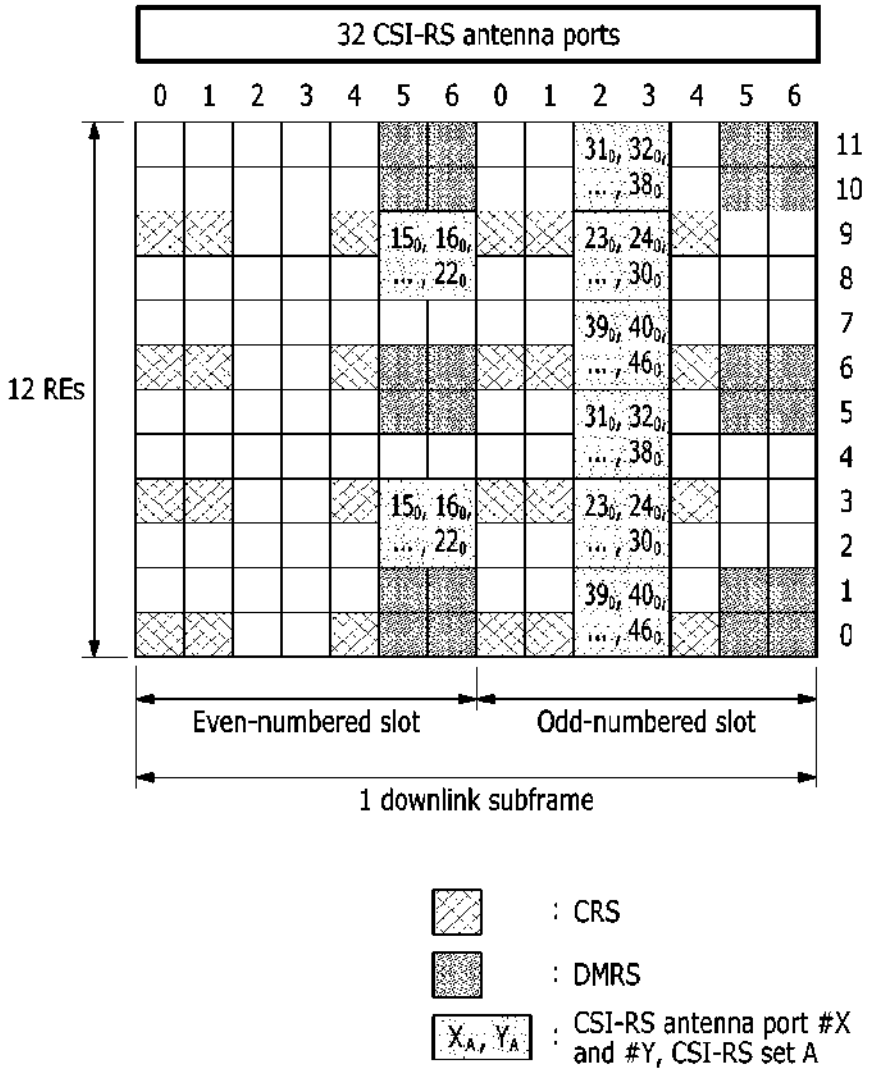

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 33

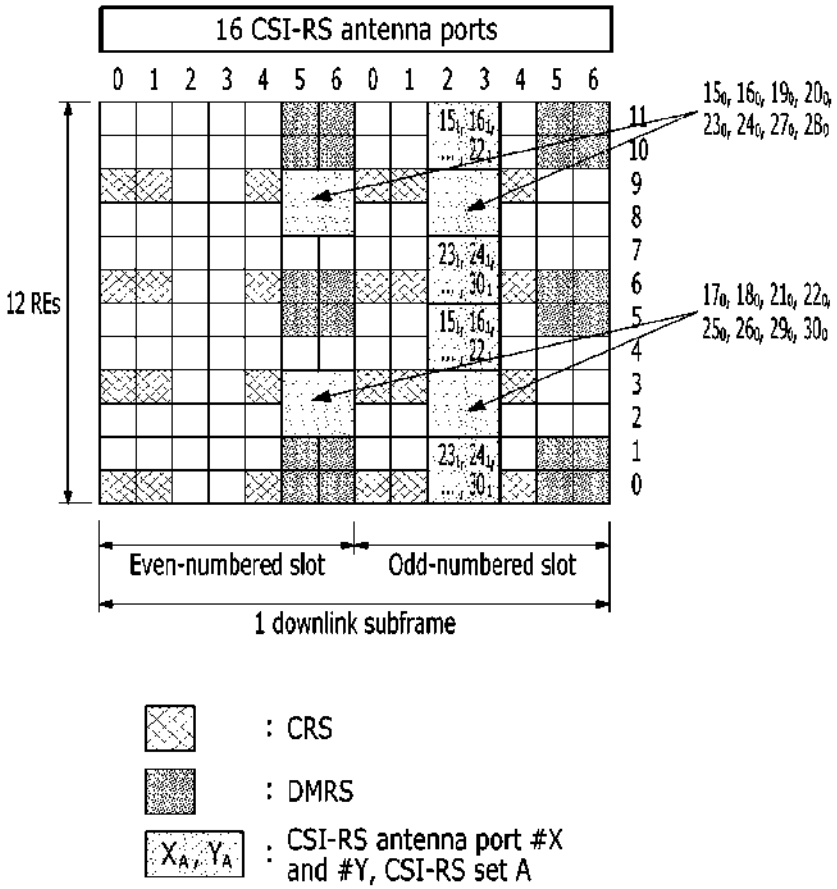

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 34

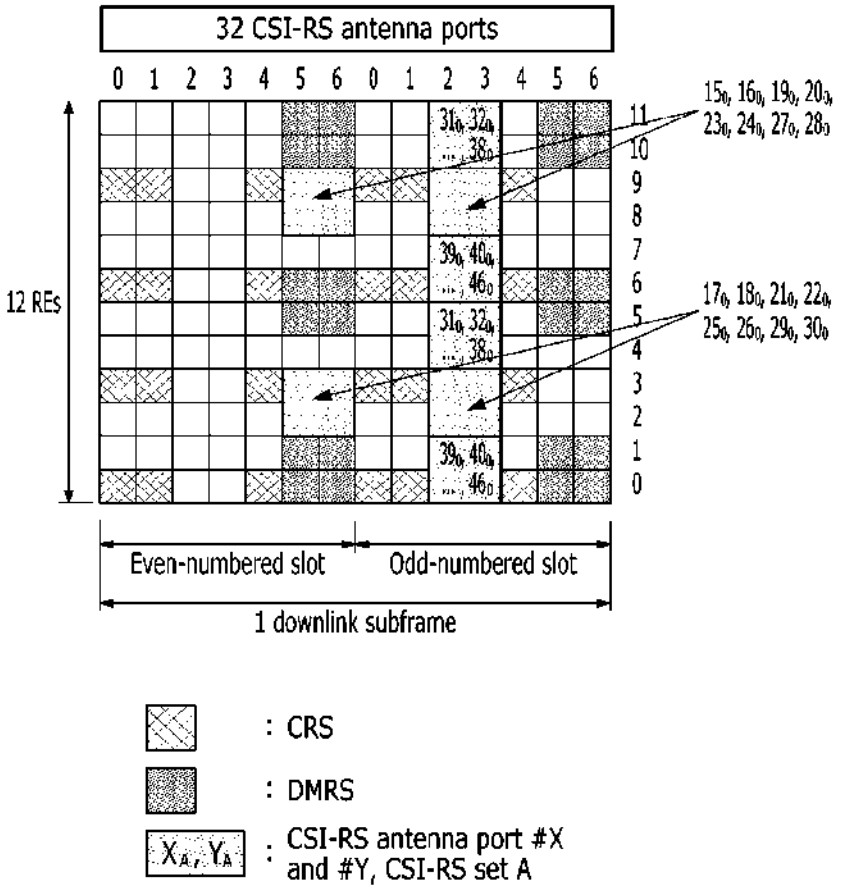

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
$15_0, 16_0, 19_0, 20_0,$
$23_0, 24_0, 27_0, 28_0$
$17_0, 18_0, 21_0, 22_0,$
$25_0, 26_0, 29_0, 30_0$
$31_0, 32_0$
38_0
$39_0, 40_0$
46_0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 35

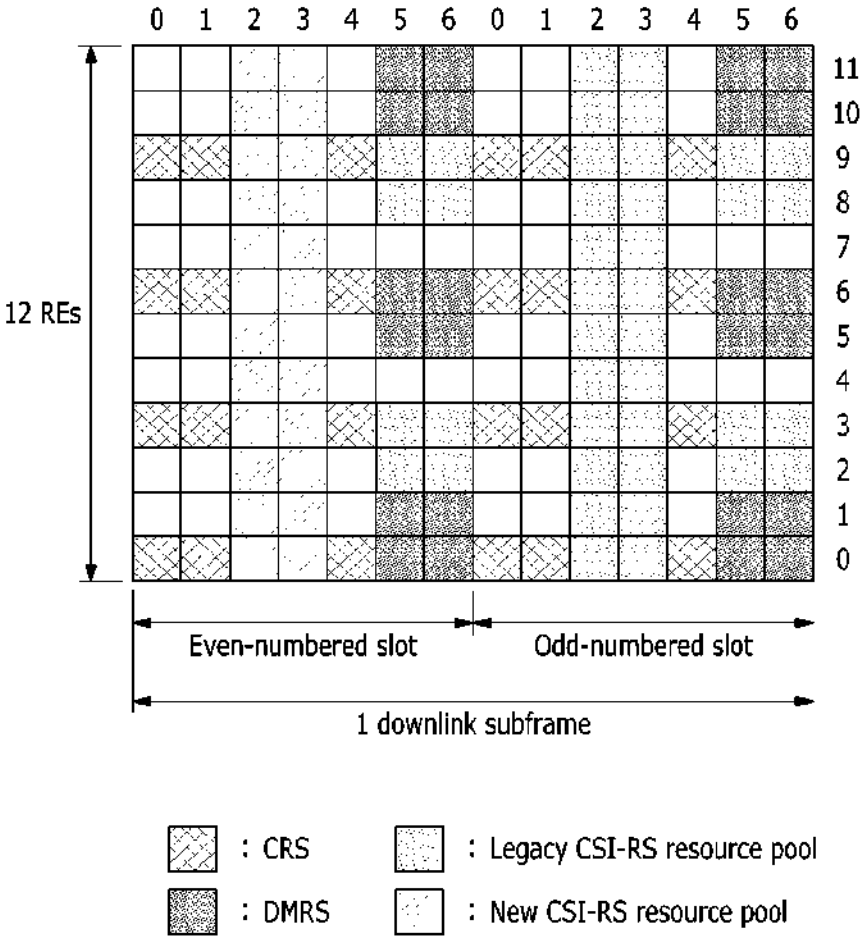

0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Legacy CSI-RS resource pool
: DMRS
: New CSI-RS resource pool

FIG. 36A

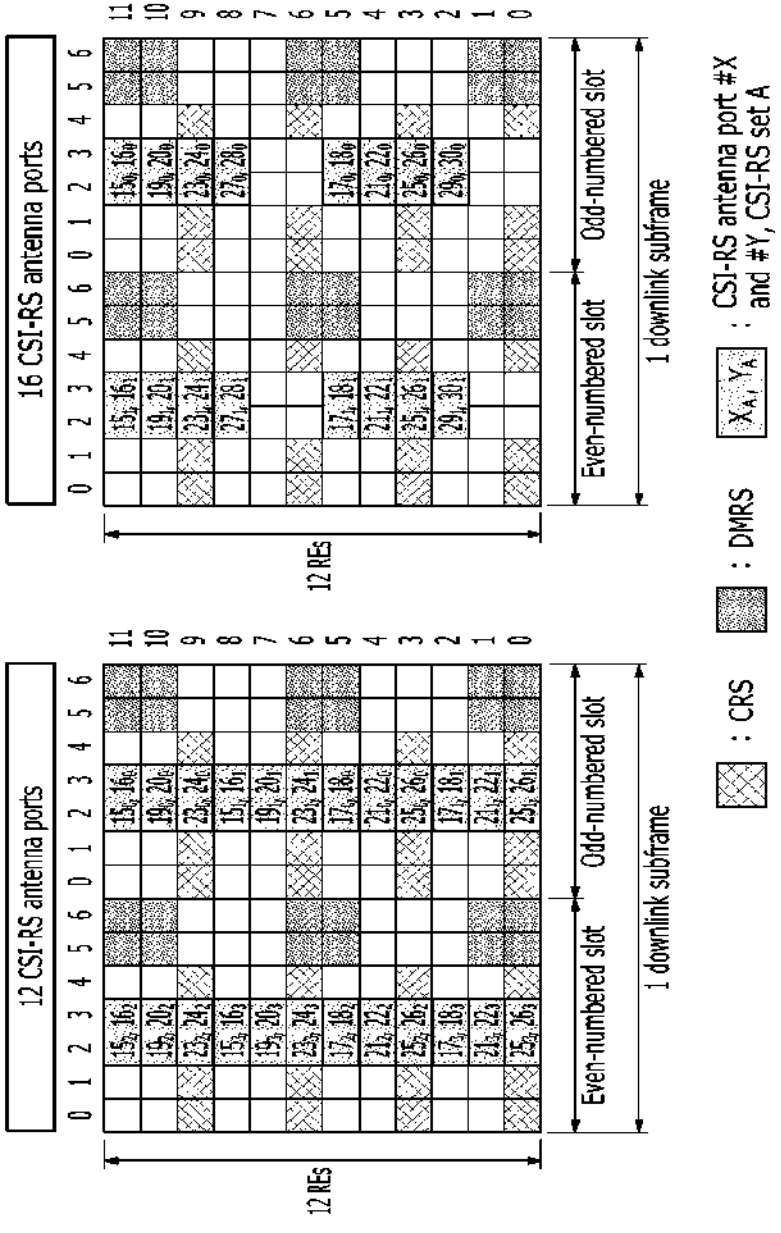

12 CSI-RS antenna ports
16 CSI-RS antenna ports
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 36B

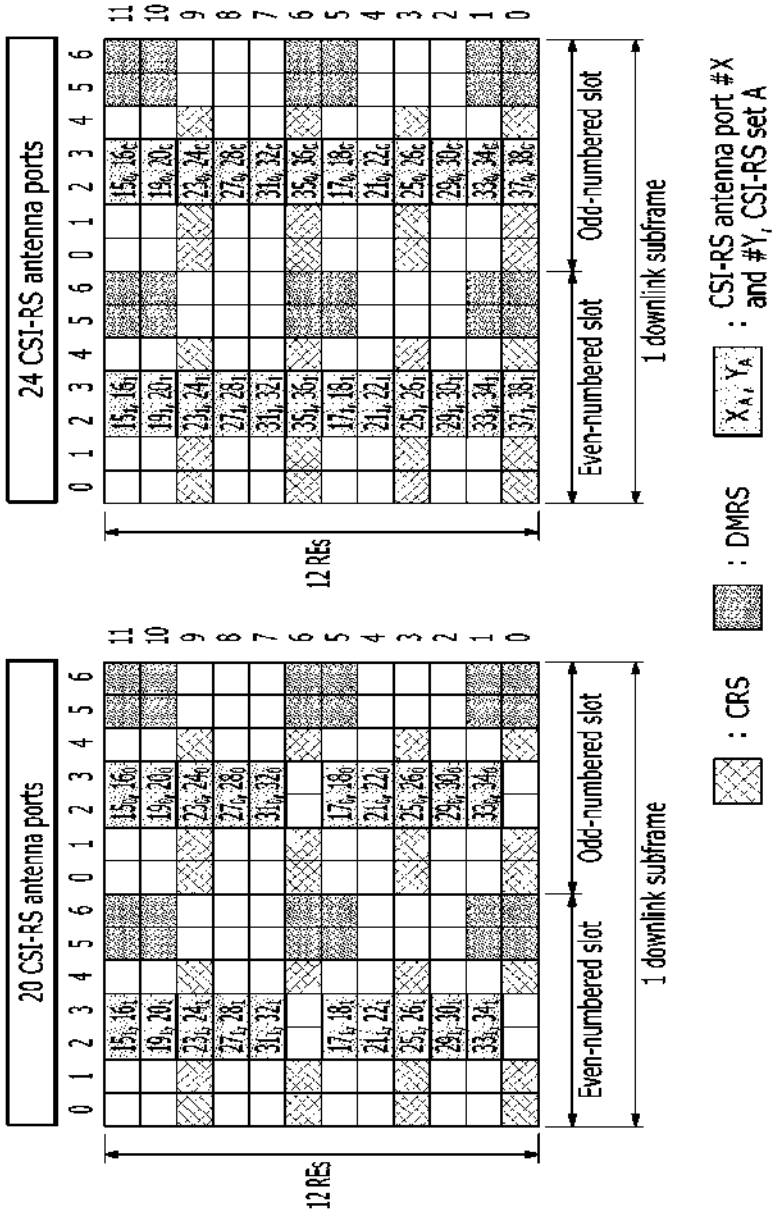

20 CSI-RS antenna ports
24 CSI-RS antenna ports
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 37

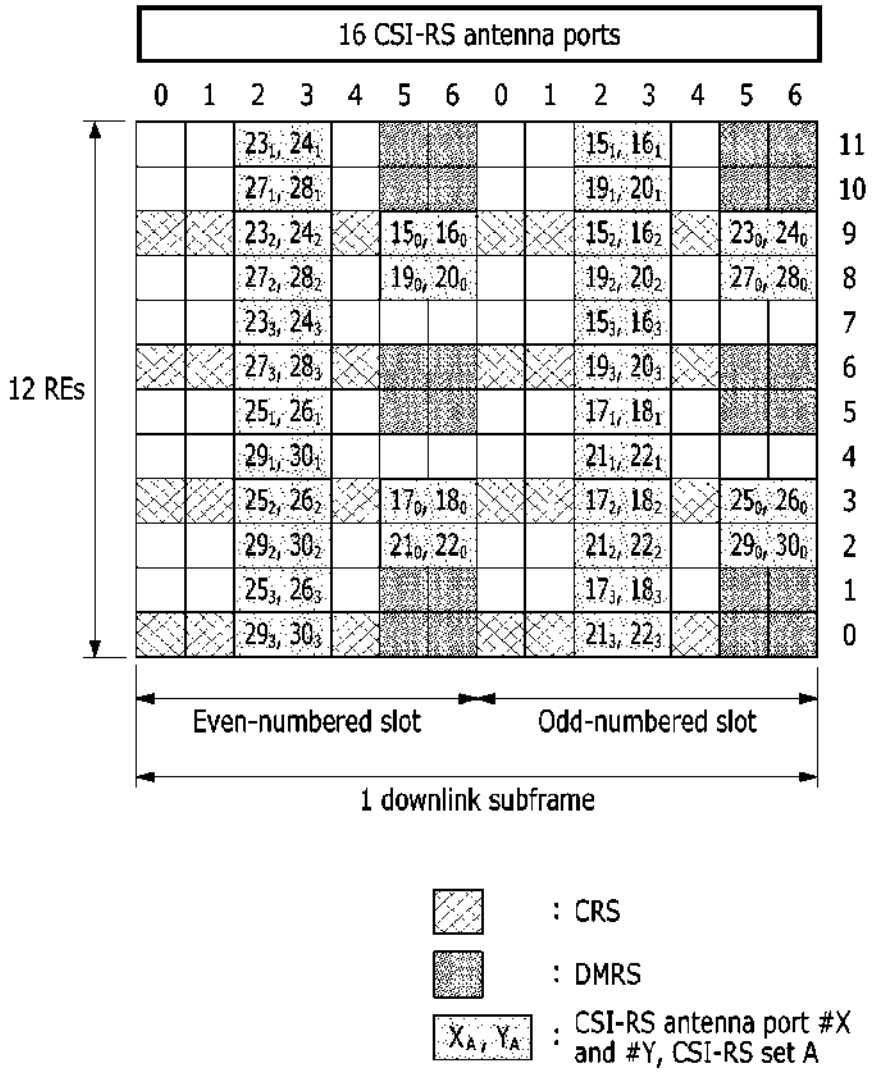

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 38

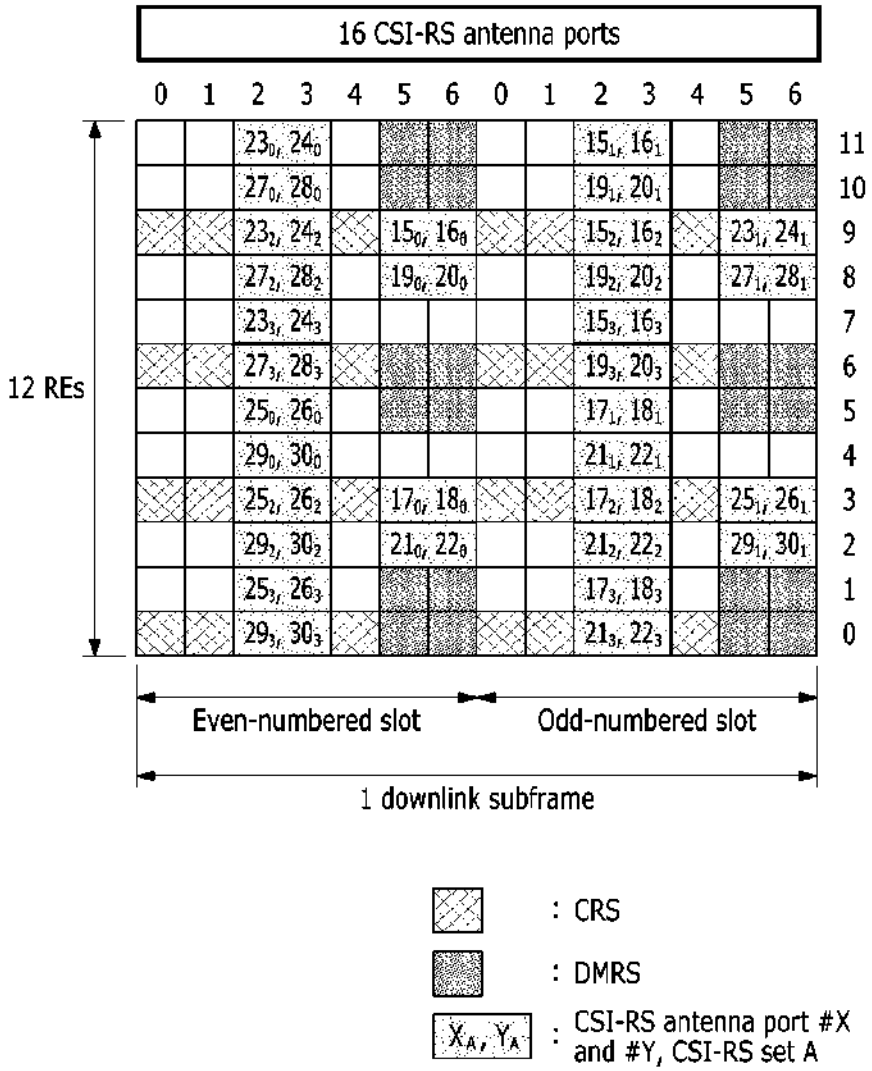

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 39

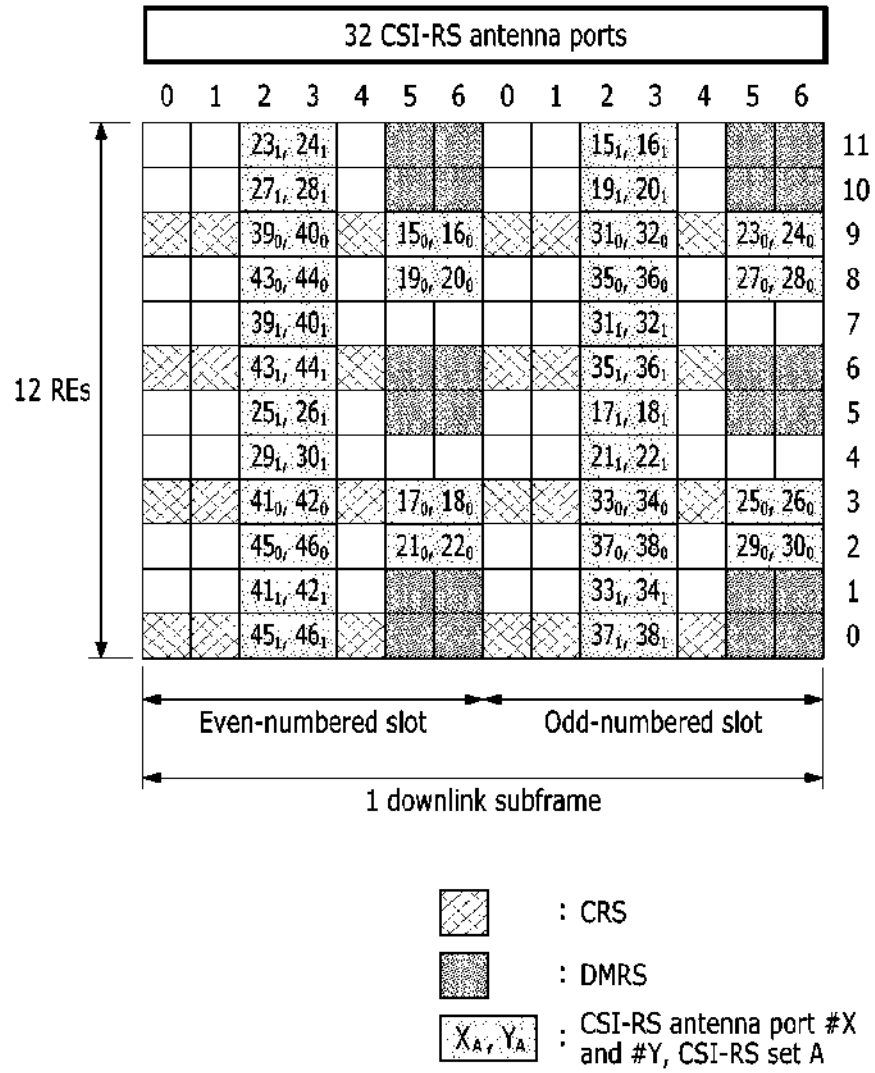

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 40

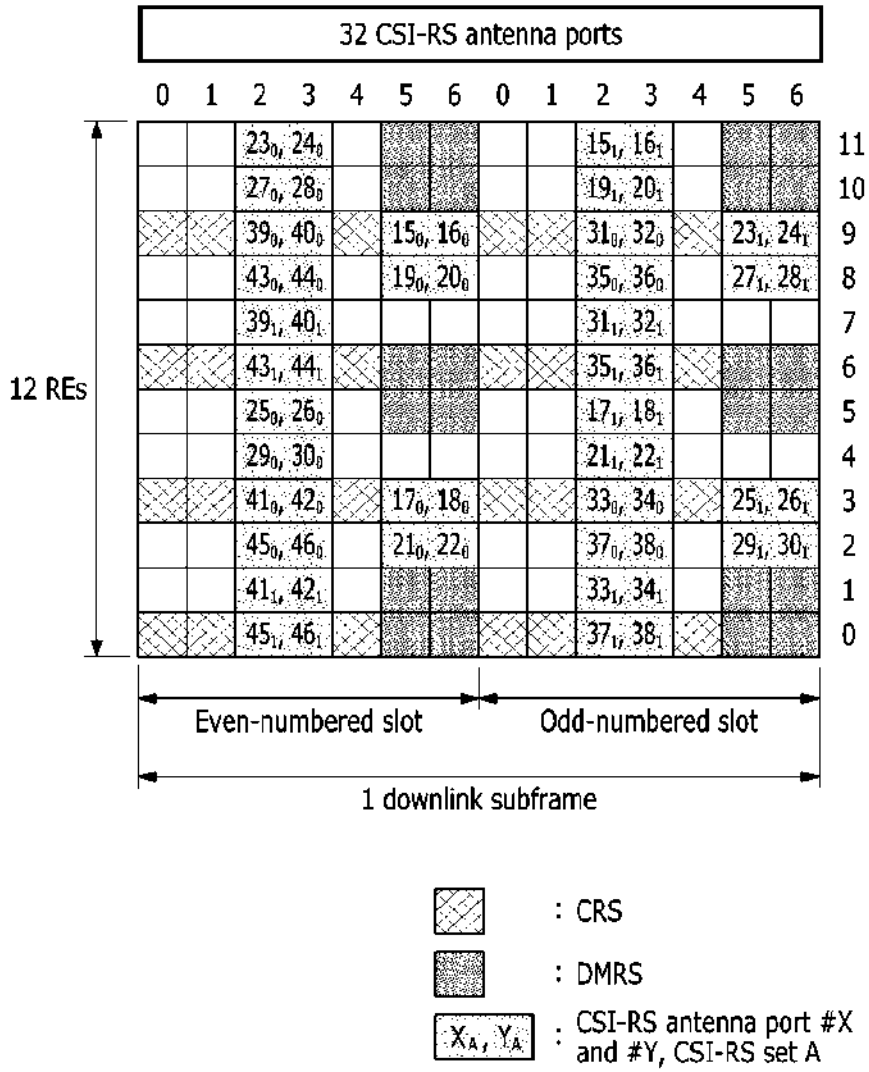

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 41

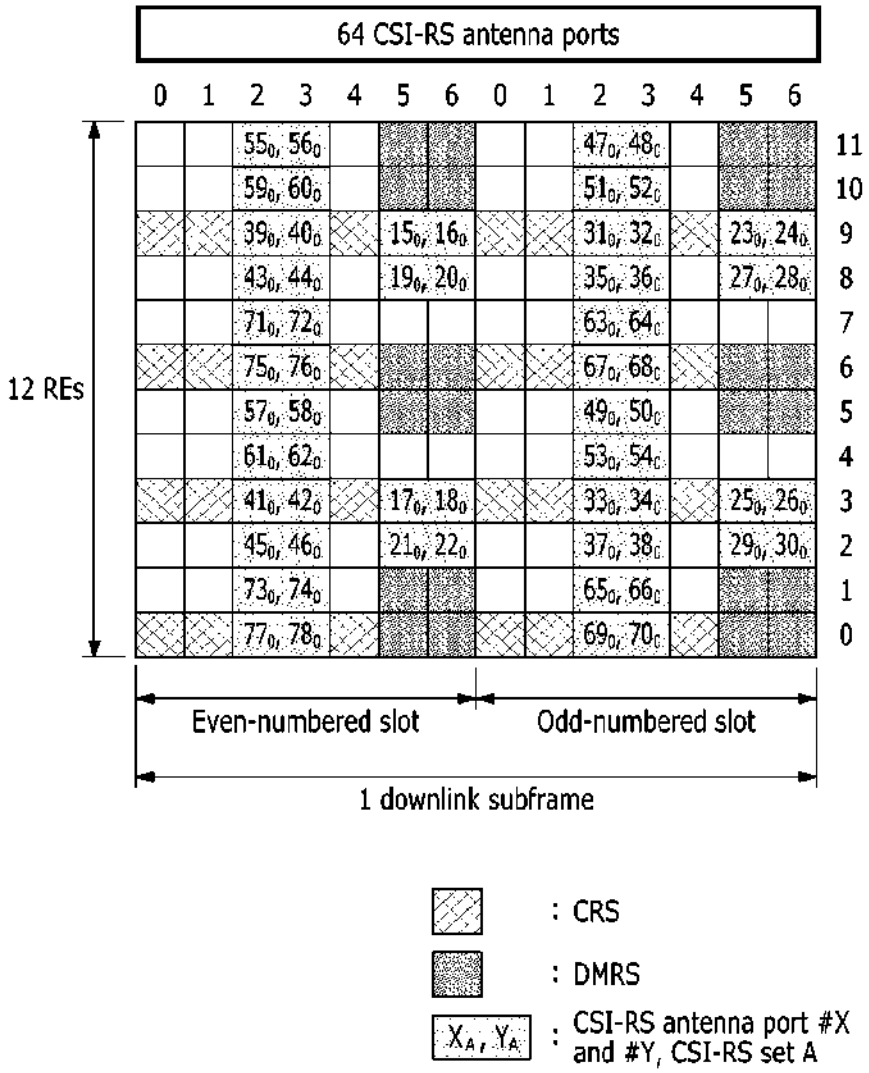

64 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 42

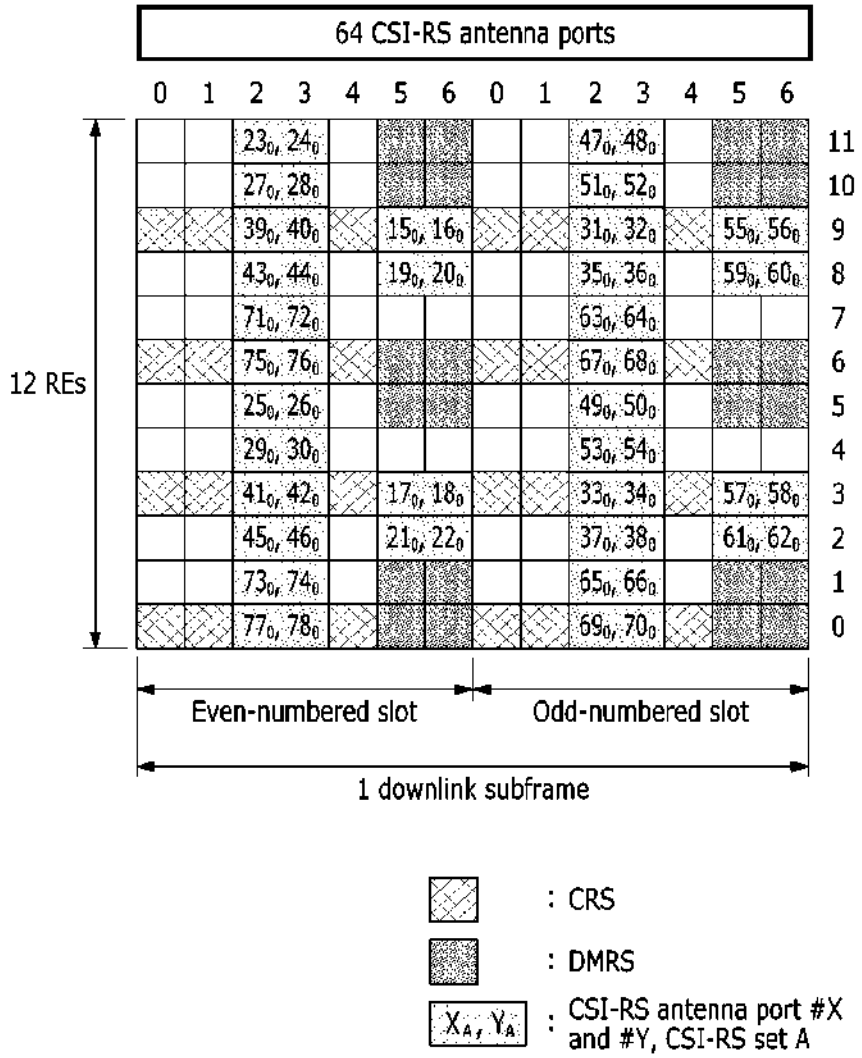

64 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 43

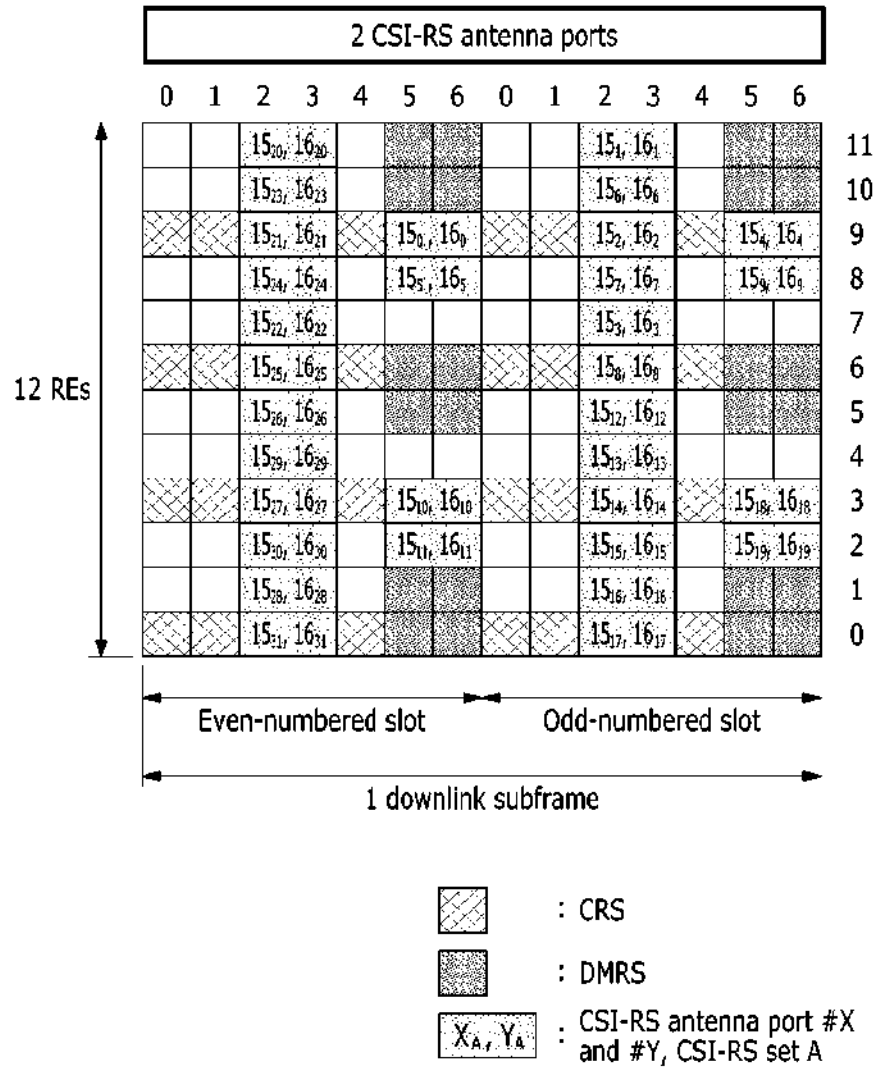

2 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 44

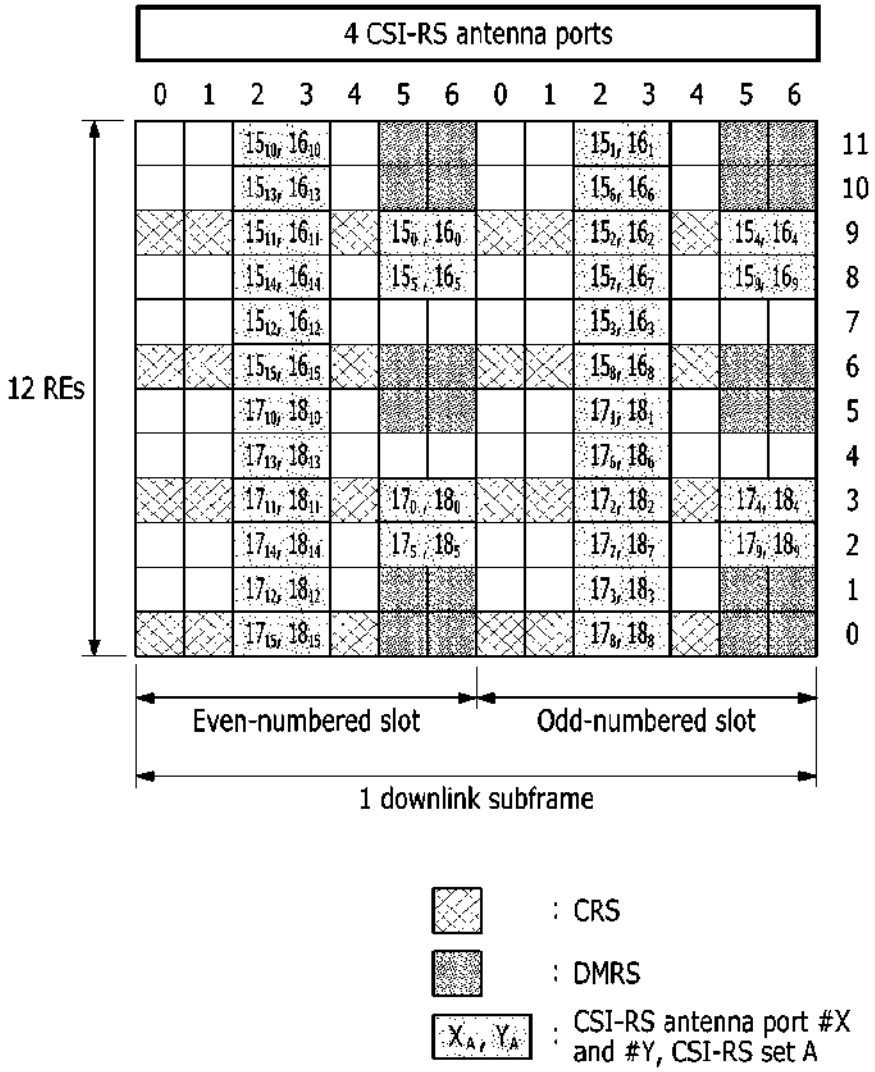

4 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 45

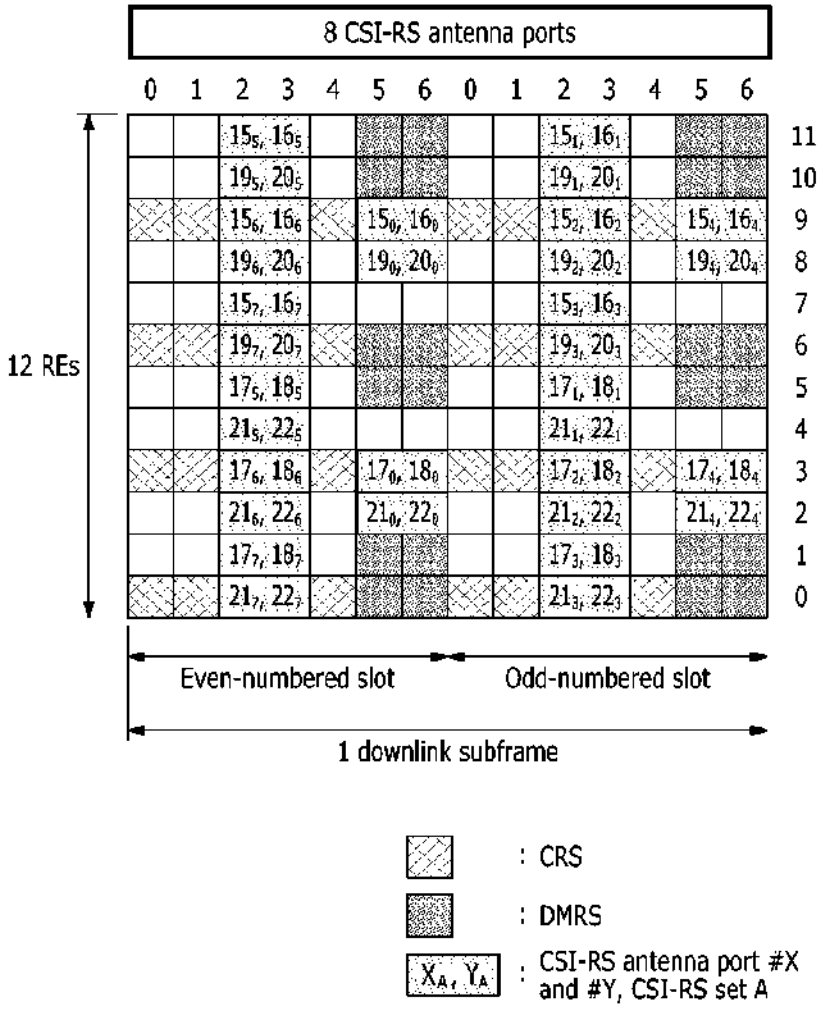

8 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 46

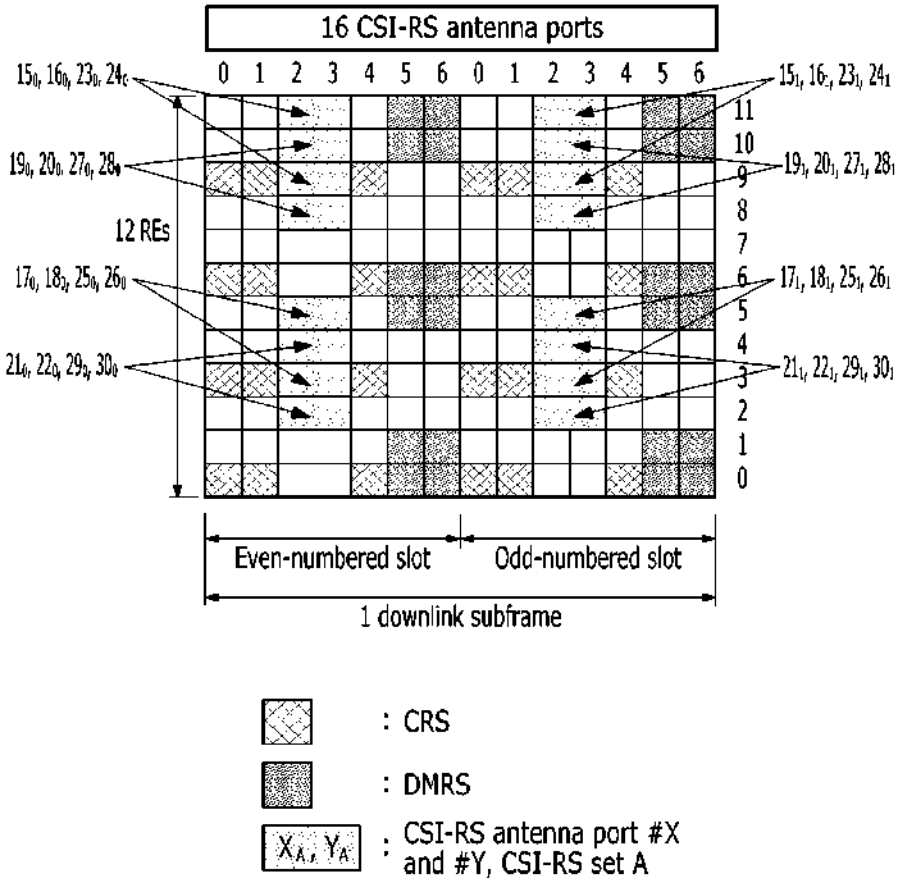

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 47

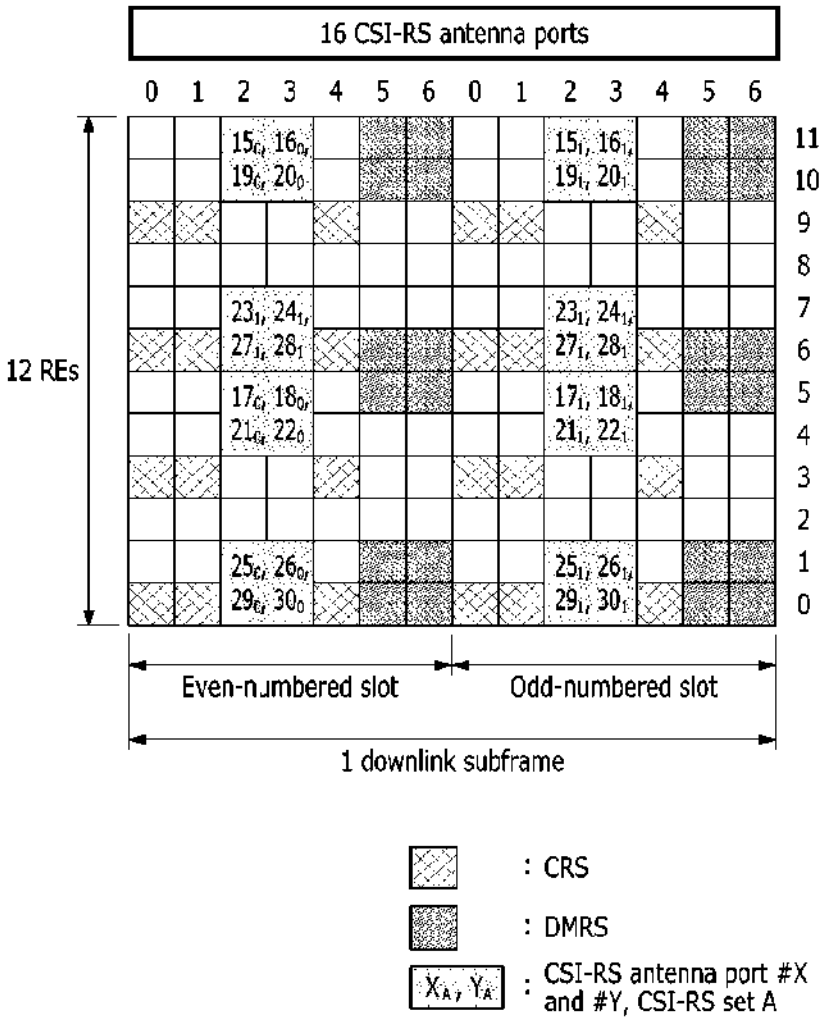

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 48

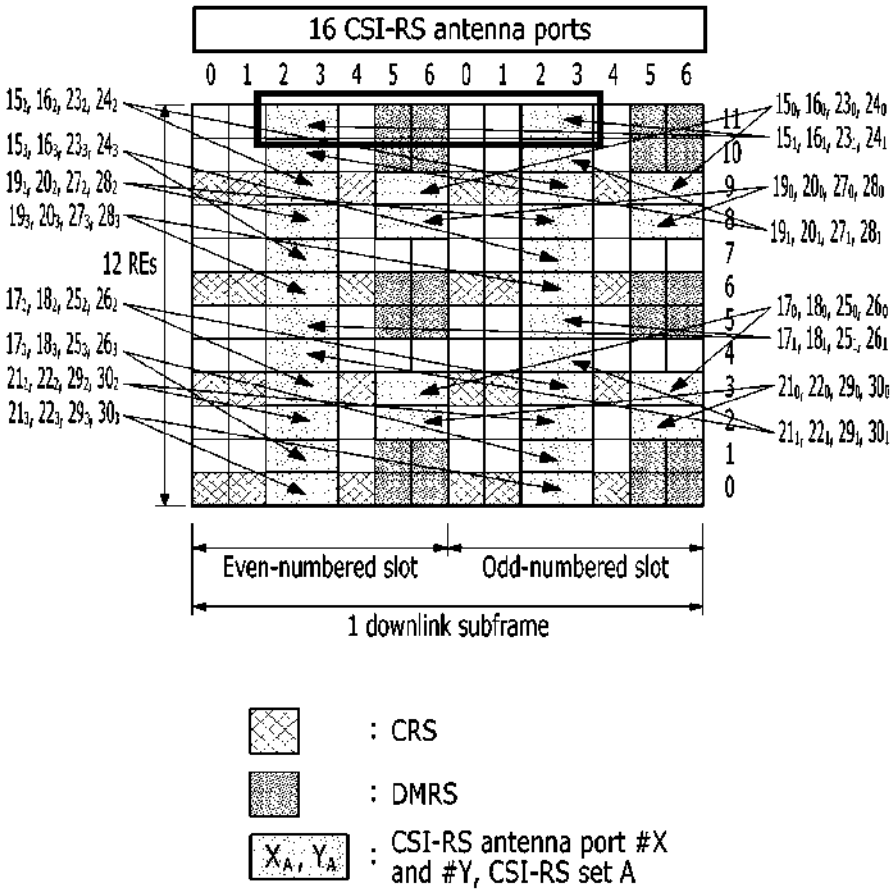

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 49

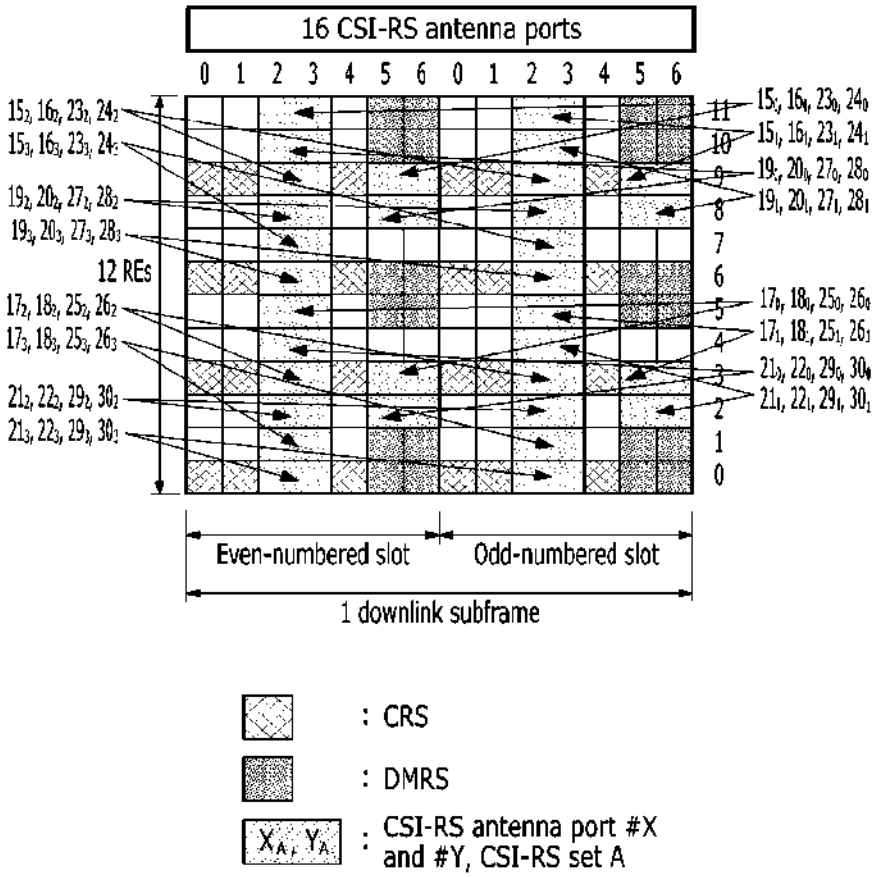

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 50

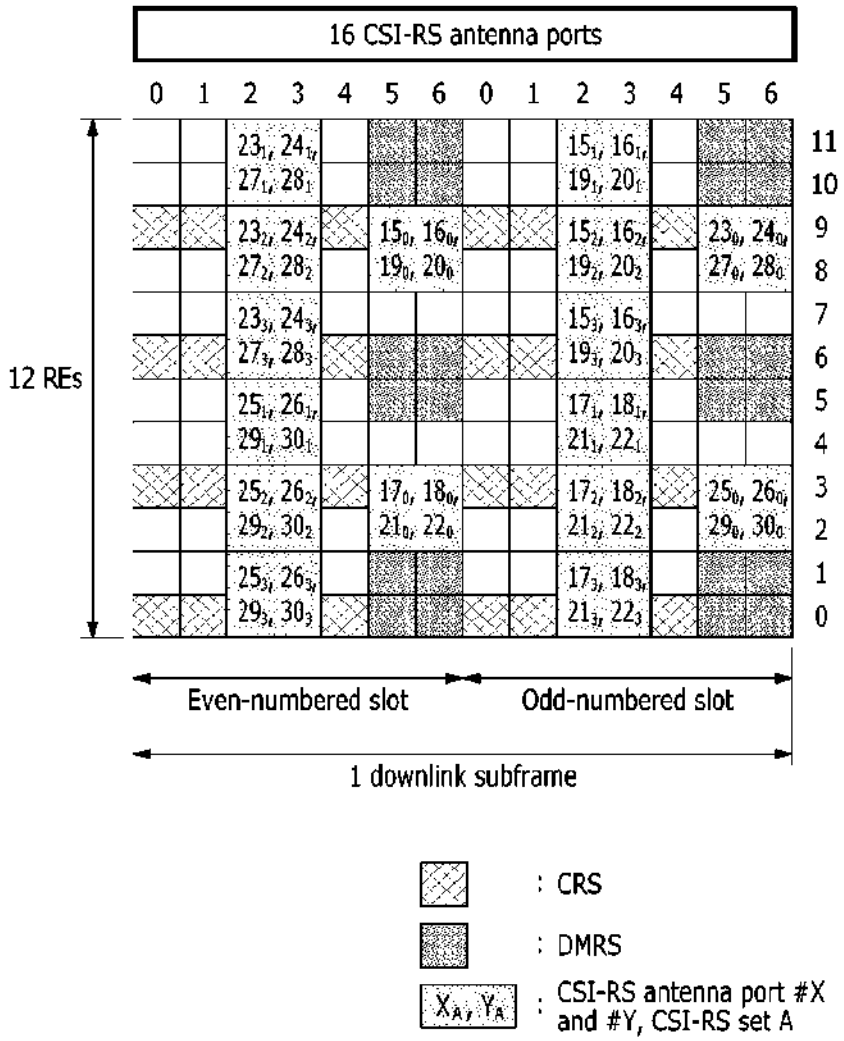

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 51

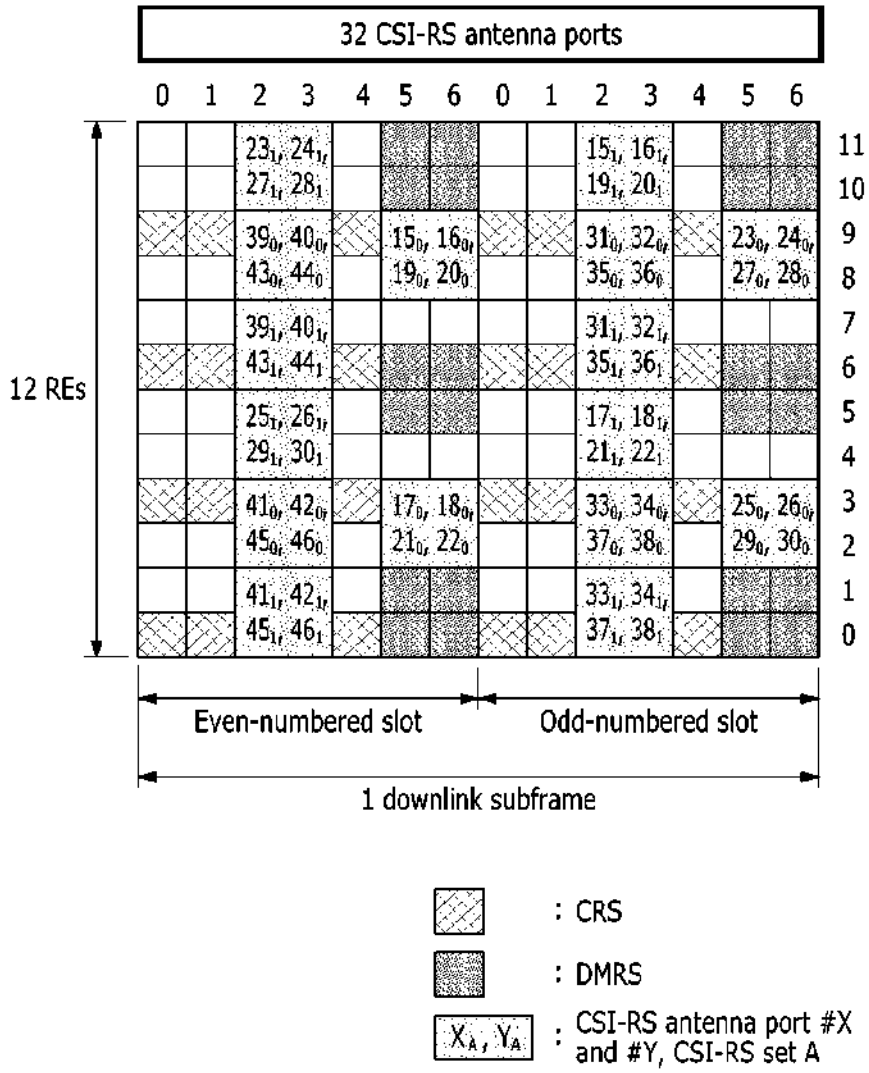

32 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 52

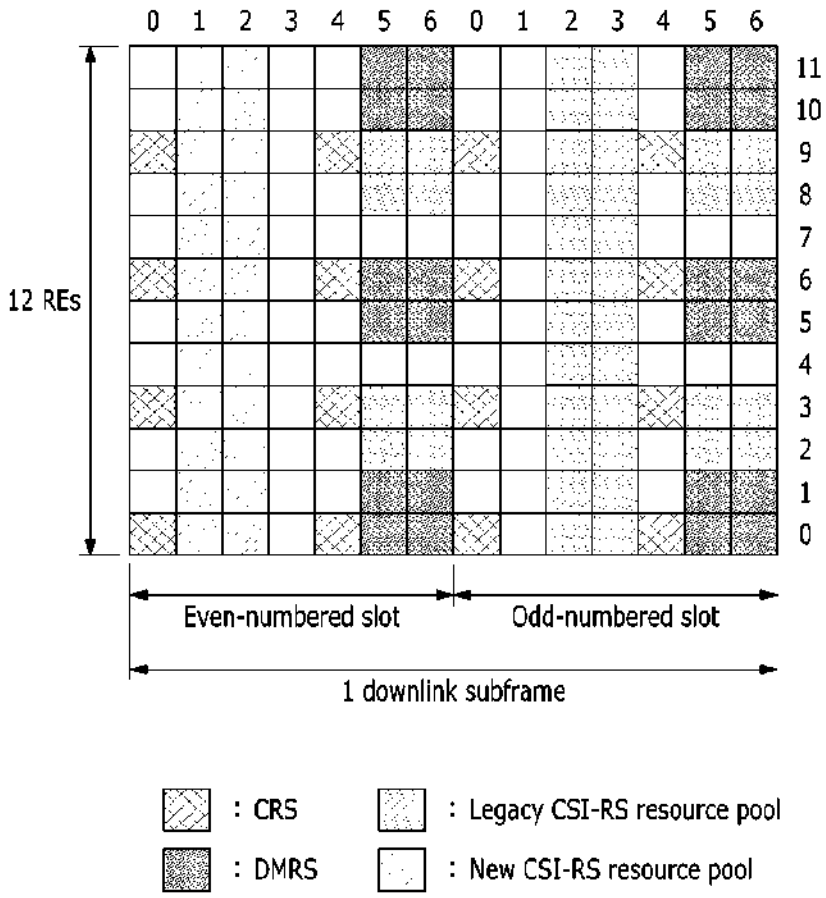

0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Legacy CSI-RS resource pool
: DMRS
: New CSI-RS resource pool

FIG. 53

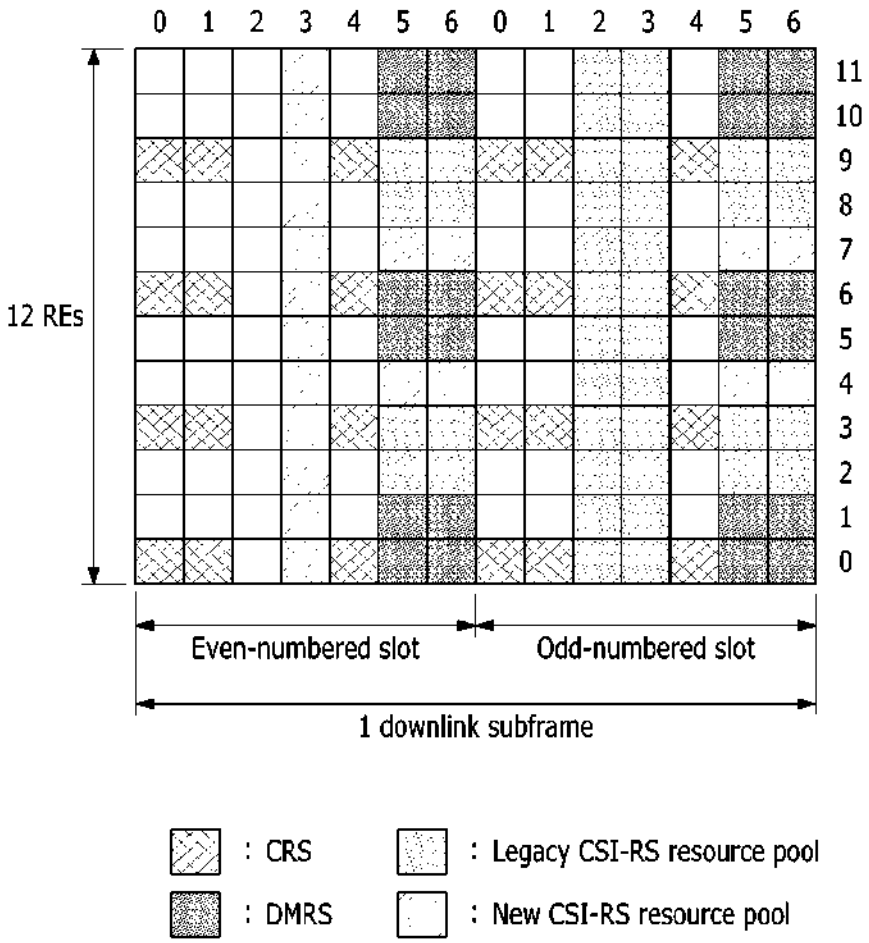

0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Legacy CSI-RS resource pool
: DMRS
: New CSI-RS resource pool

FIG. 54

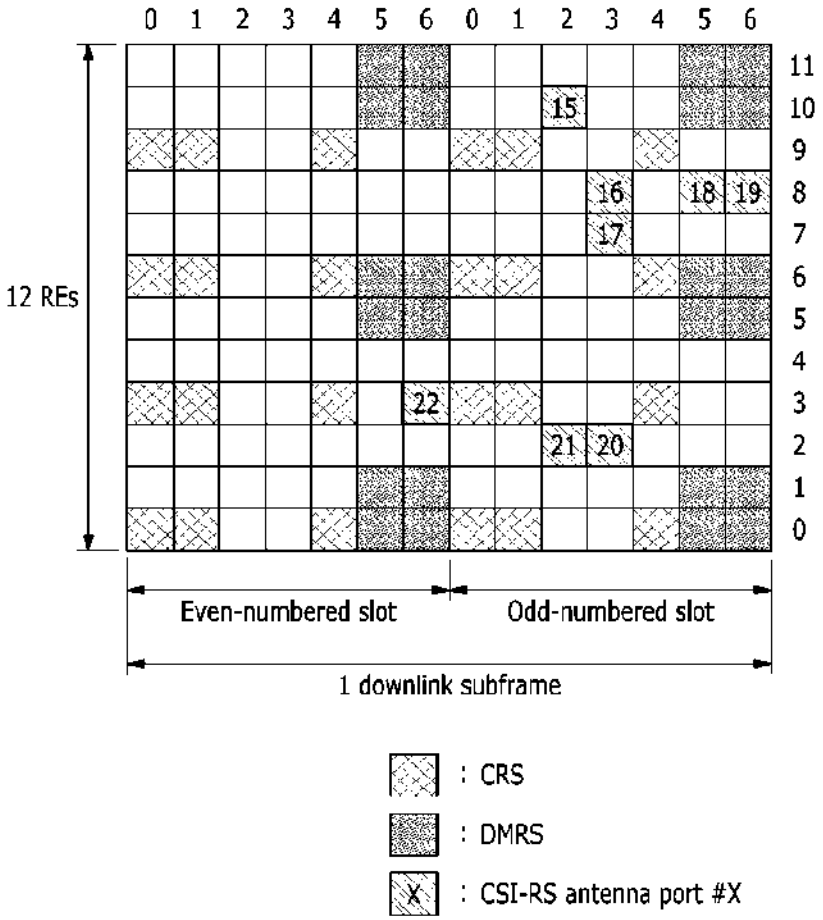

0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
15
16
17
18
19
22
21
20
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X : CSI-RS antenna port #X

FIG. 55

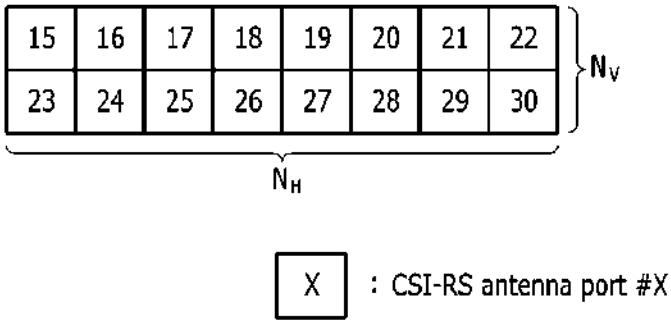

15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
N_V
N_H
X
: CSI-RS antenna port #X

FIG. 56

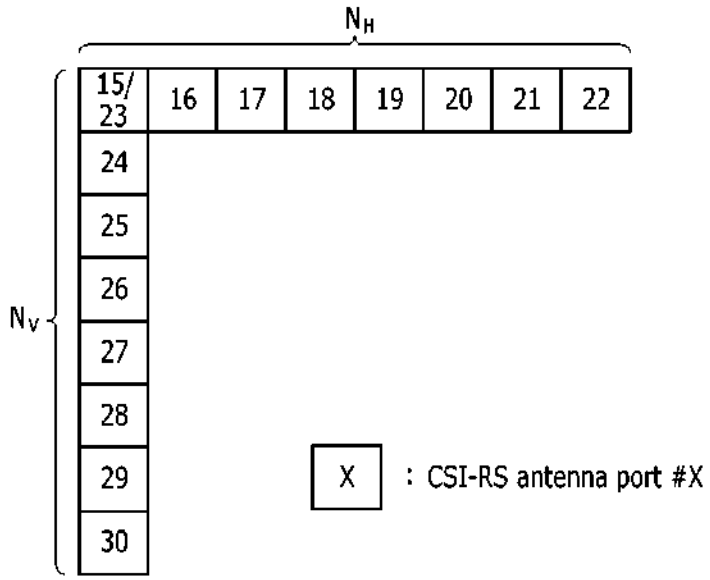

N_H
N_V
15/23
16
17
18
19
20
21
22
24
25
26
27
28
29
30
X
: CSI-RS antenna port #X

FIG. 57A

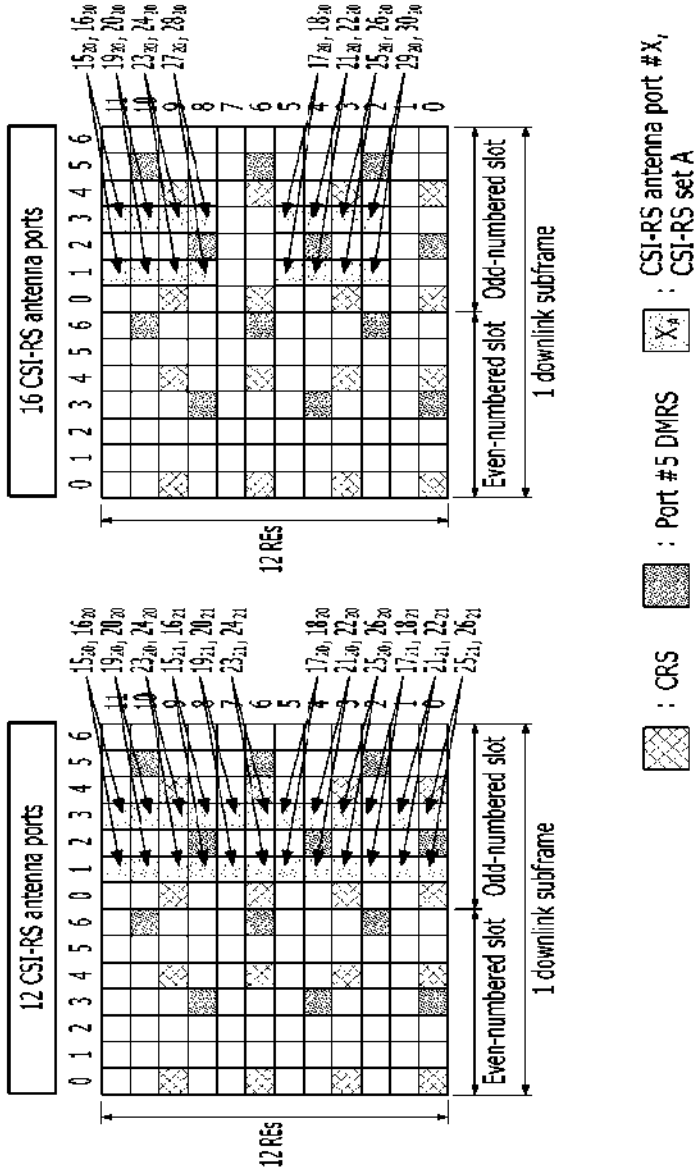

16 CSI-RS antenna ports
12 CSI-RS antenna ports
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Port #5 DMRS
: CSI-RS antenna port #X
: CSI-RS set A

FIG. 57B

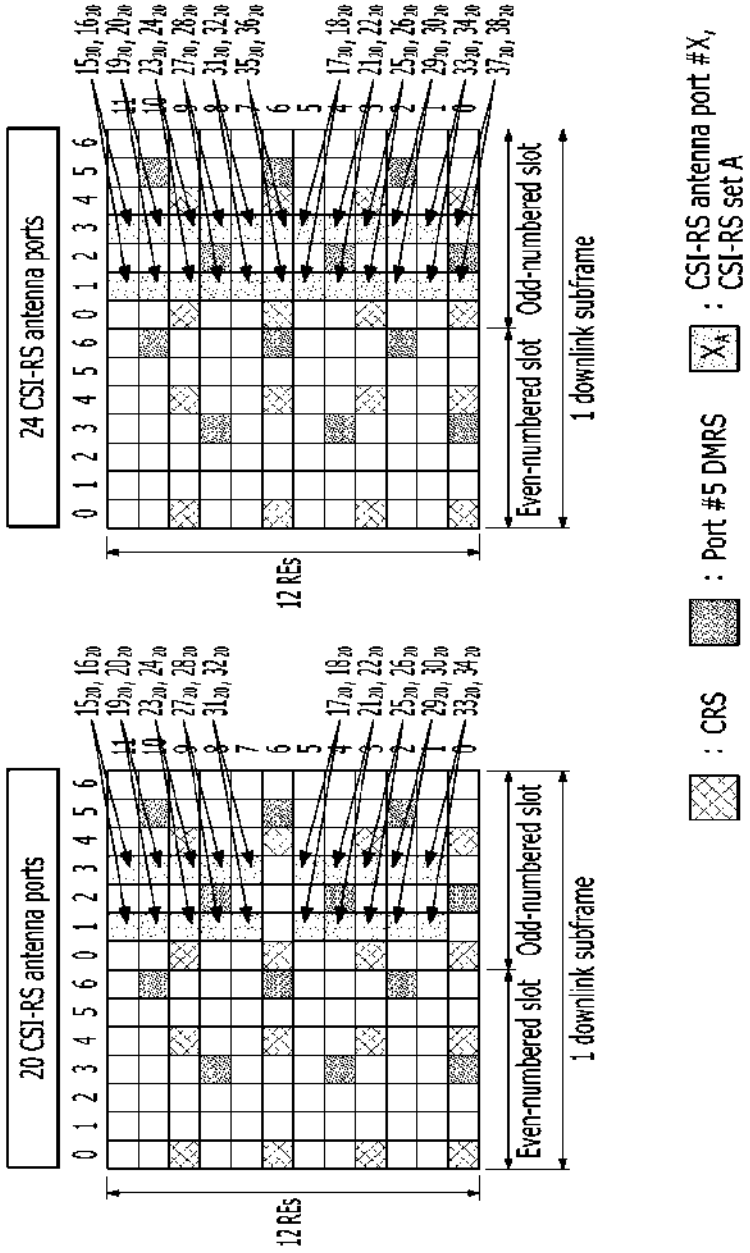

20 CSI-RS antenna ports
24 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
Even-numbered slot
Odd-numbered slot
1 downlink subframe
12 REs
: CRS
: Port #5 DMRS
: CSI-RS antenna port #X, CSI-RS set A

FIG. 58

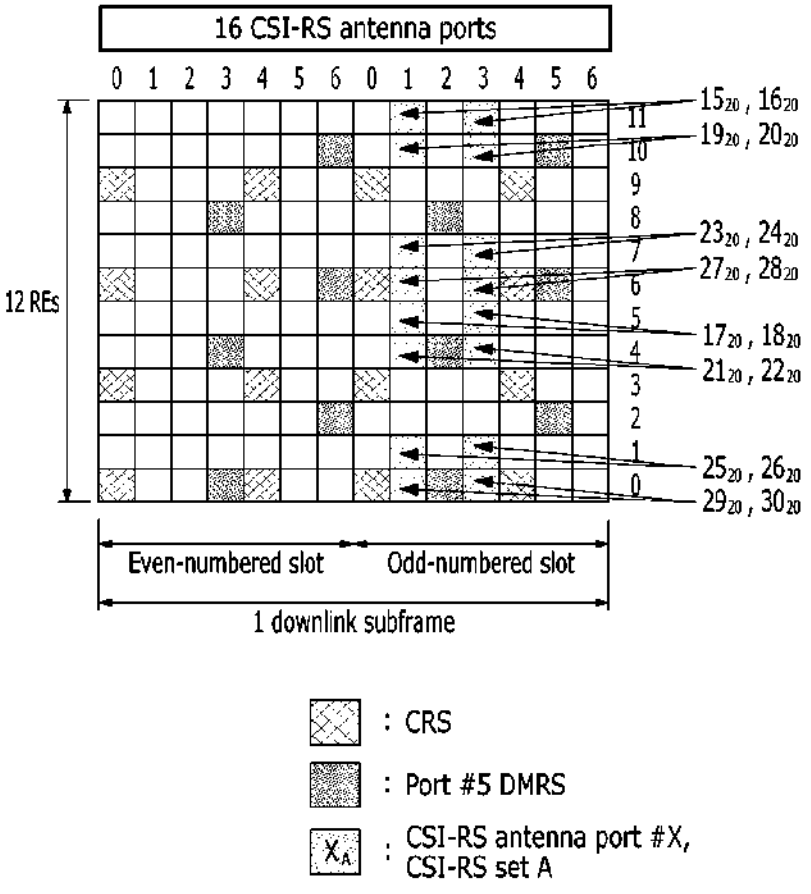

16 CSI-RS antenna ports
0 1 2 3 4 5 6 0 1 2 3 4 5 6
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
15_{20}, 16_{20}
19_{20}, 20_{20}
23_{20}, 24_{20}
27_{20}, 28_{20}
17_{20}, 18_{20}
21_{20}, 22_{20}
25_{20}, 26_{20}
29_{20}, 30_{20}
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Port #5 DMRS
X_A : CSI-RS antenna port #X, CSI-RS set A

FIG. 59

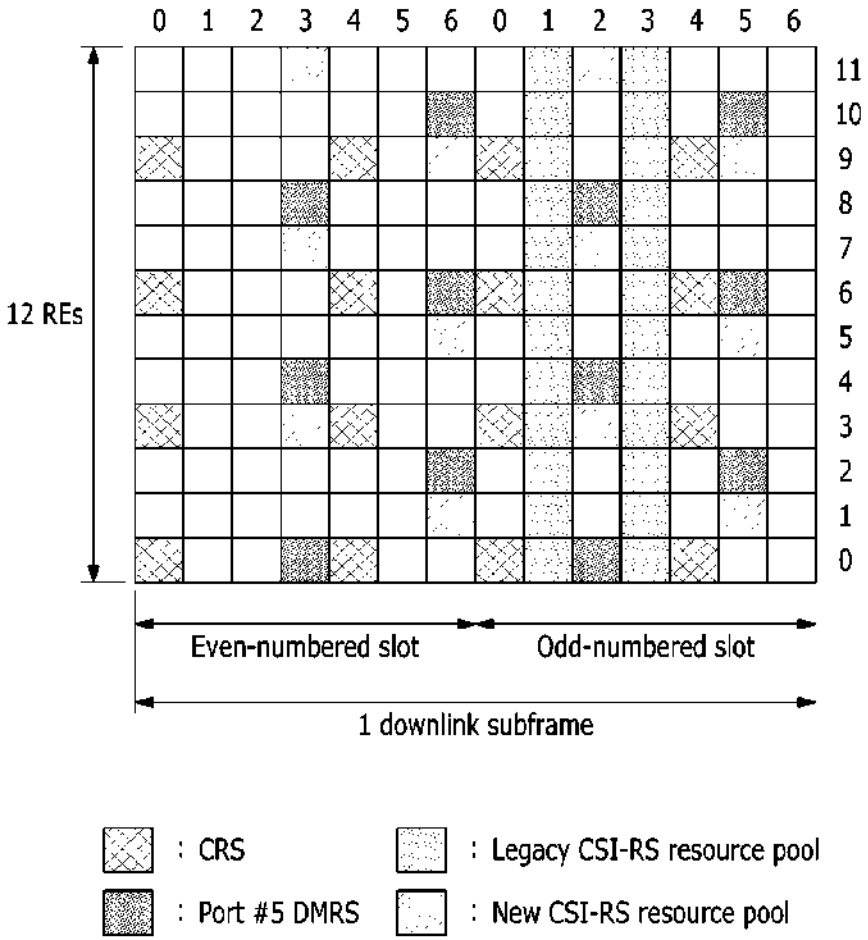

0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Legacy CSI-RS resource pool
: Port #5 DMRS
: New CSI-RS resource pool

FIG. 60

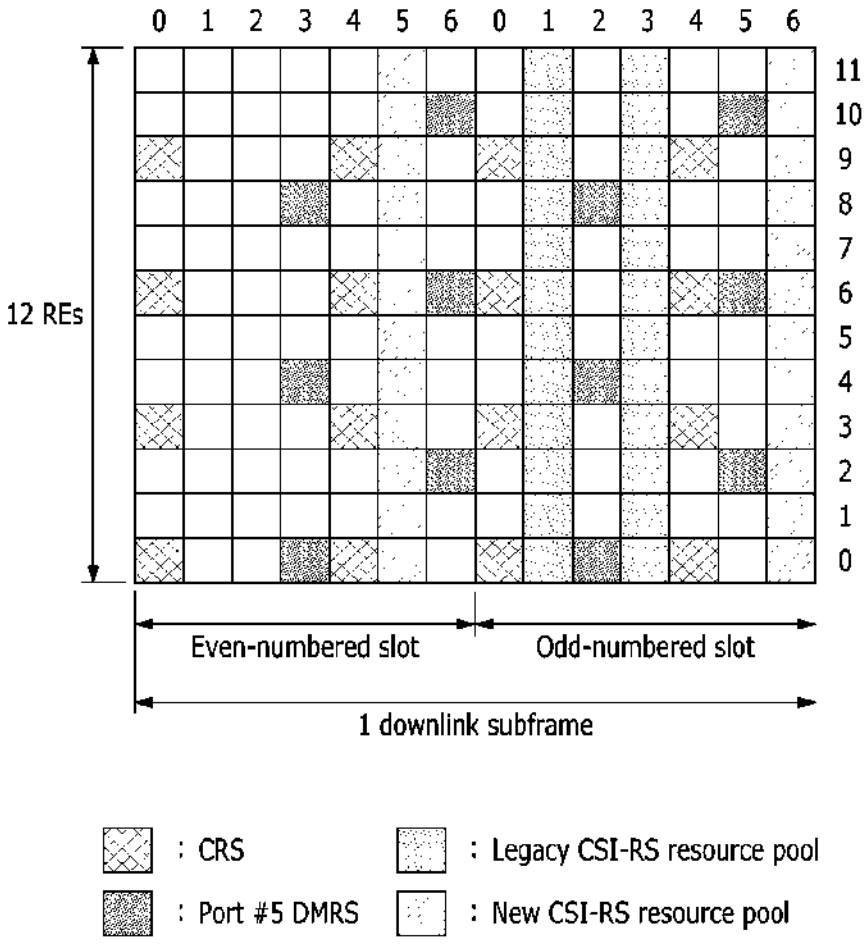

0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Legacy CSI-RS resource pool
: Port #5 DMRS
: New CSI-RS resource pool

FIG. 61

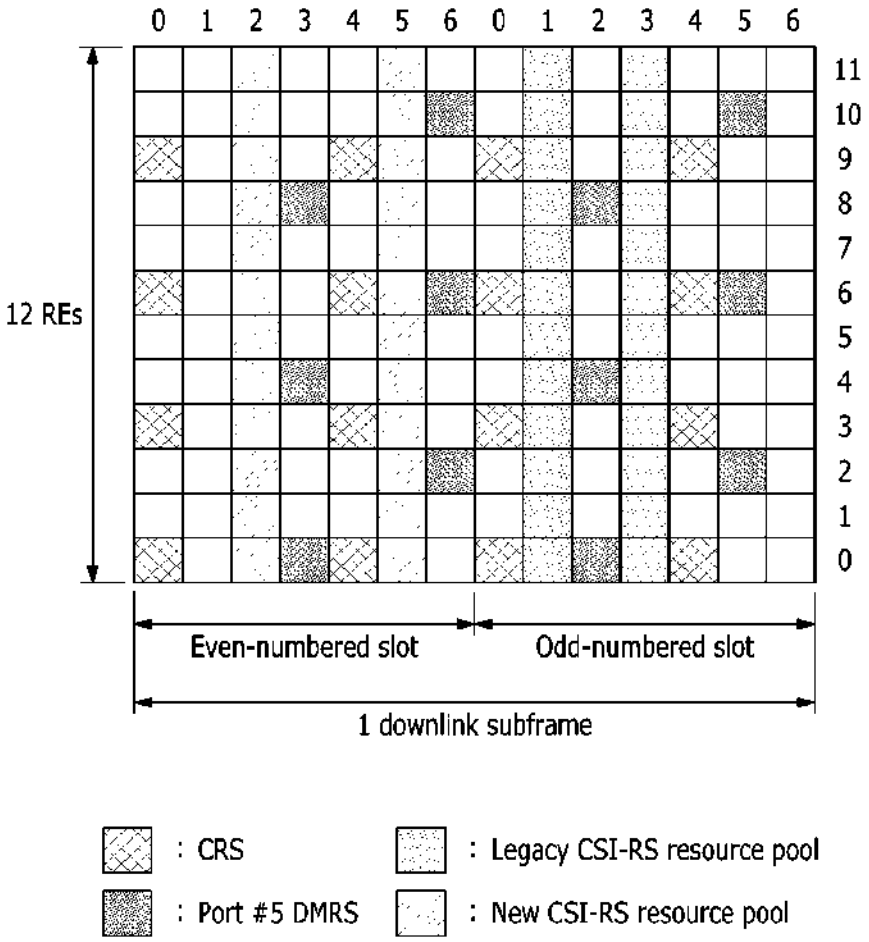

0 1 2 3 4 5 6 0 1 2 3 4 5 6
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Legacy CSI-RS resource pool
: Port #5 DMRS
: New CSI-RS resource pool

FIG. 62

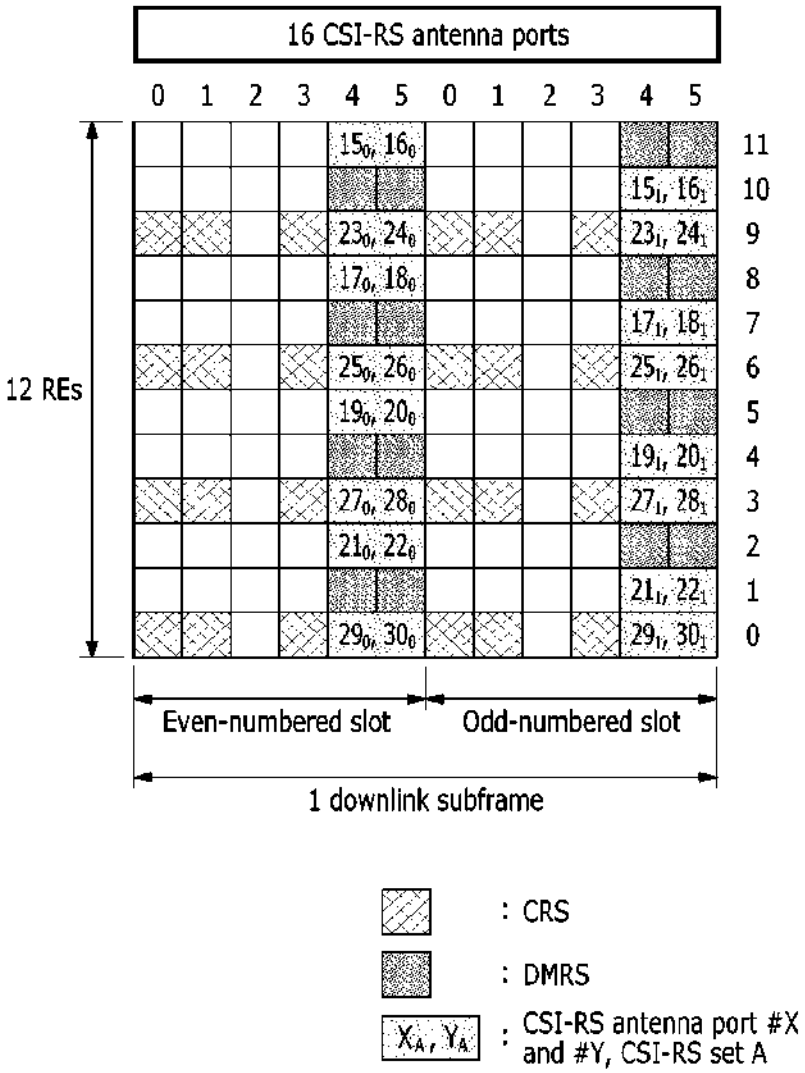

16 CSI-RS antenna ports
0 1 2 3 4 5 0 1 2 3 4 5
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 63

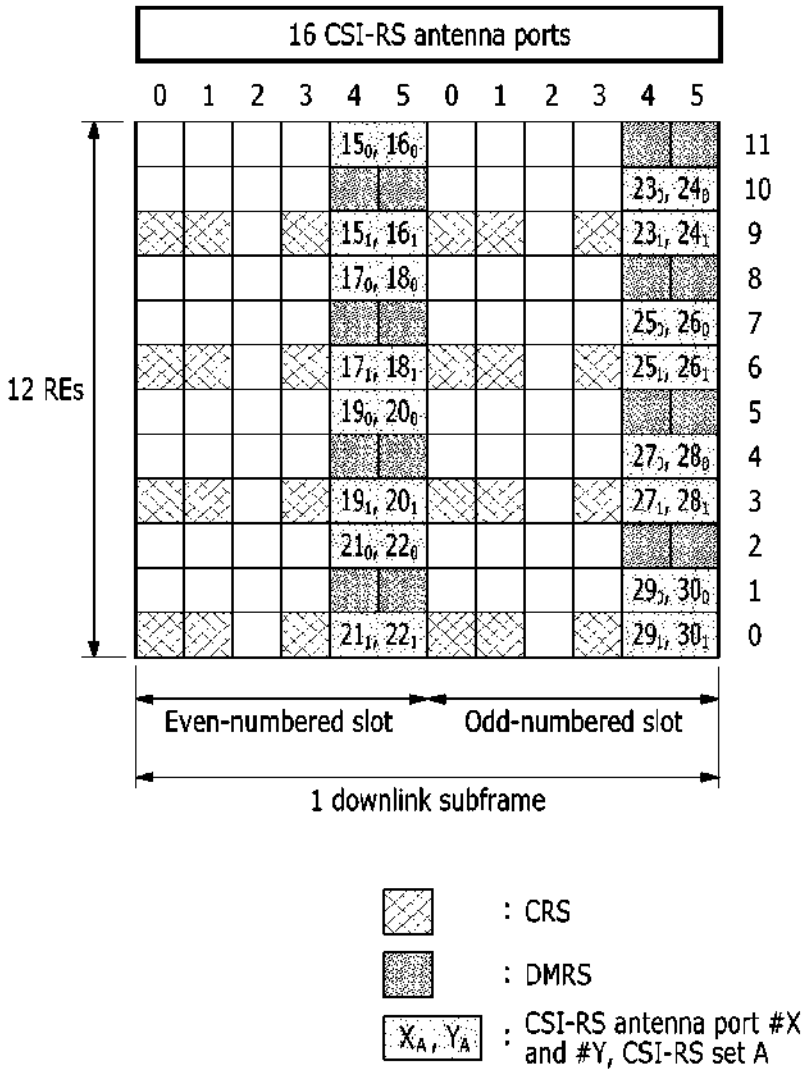

16 CSI-RS antenna ports
0 1 2 3 4 5 0 1 2 3 4 5
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 64

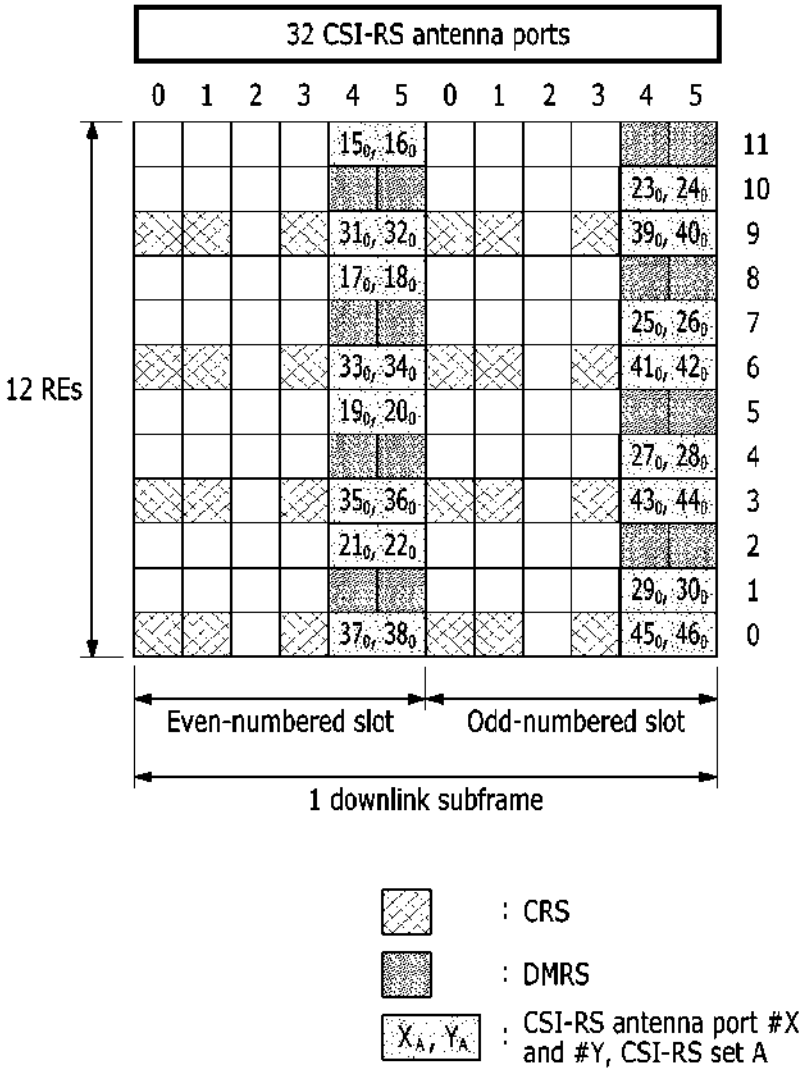

32 CSI-RS antenna ports
0 1 2 3 4 5 0 1 2 3 4 5
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 65

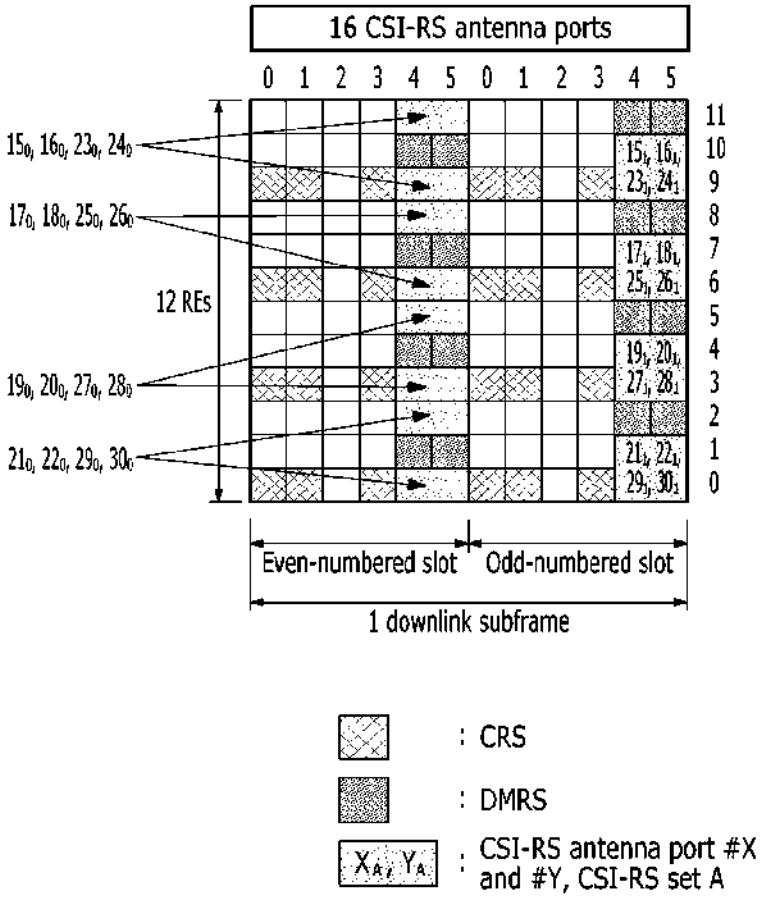

16 CSI-RS antenna ports
0 1 2 3 4 5 0 1 2 3 4 5
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 66

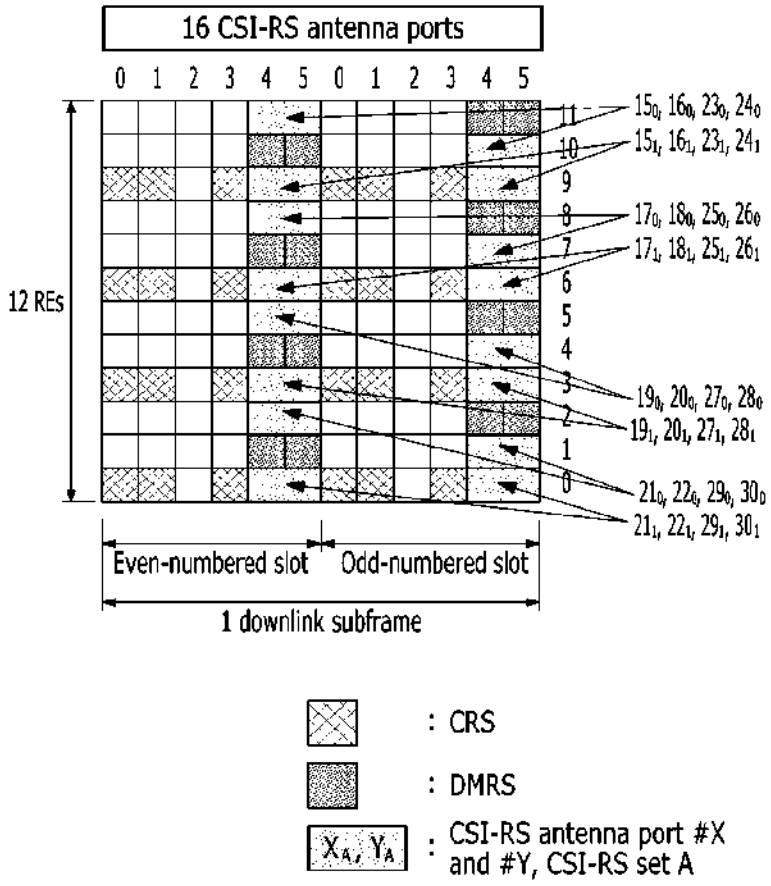

16 CSI-RS antenna ports
0 1 2 3 4 5 0 1 2 3 4 5
12 REs
11
10
9
8
7
6
5
4
3
2
1
0
$15_0, 16_0, 23_0, 24_0$
$15_1, 16_1, 23_1, 24_1$
$17_0, 18_0, 25_0, 26_0$
$17_1, 18_1, 25_1, 26_1$
$19_0, 20_0, 27_0, 28_0$
$19_1, 20_1, 27_1, 28_1$
$21_0, 22_0, 29_0, 30_0$
$21_1, 22_1, 29_1, 30_1$
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
X_A, Y_A : CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 67

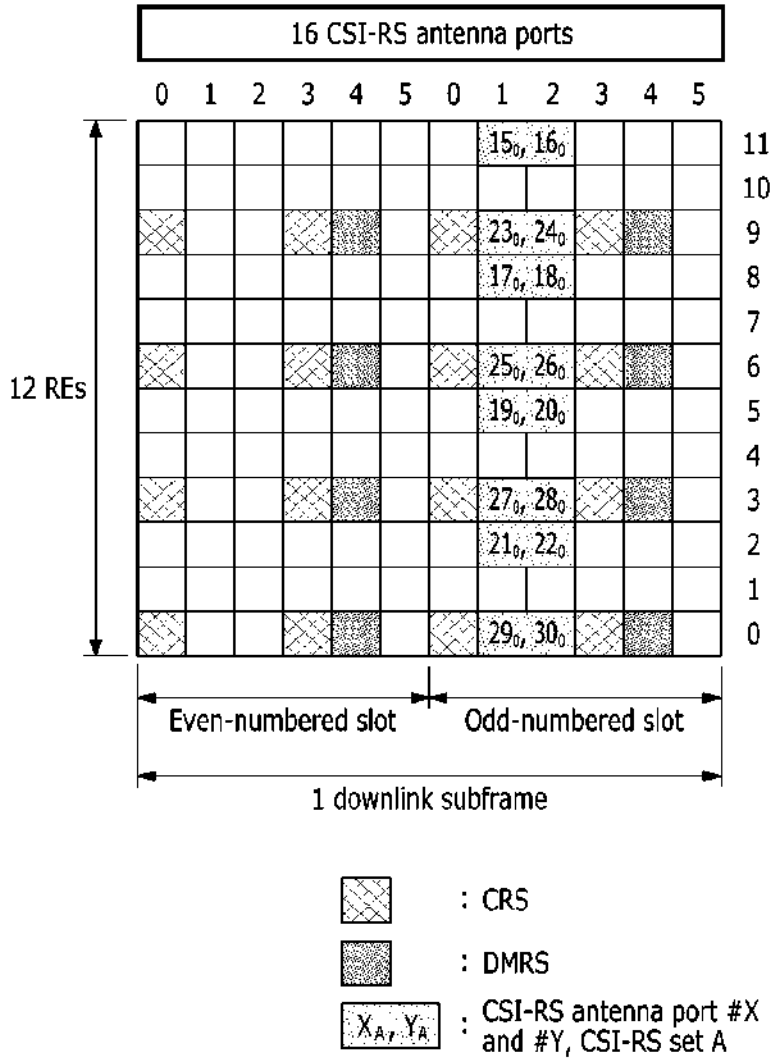

16 CSI-RS antenna ports
0 1 2 3 4 5 0 1 2 3 4 5
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: DMRS
: CSI-RS antenna port #X and #Y, CSI-RS set A

FIG. 68

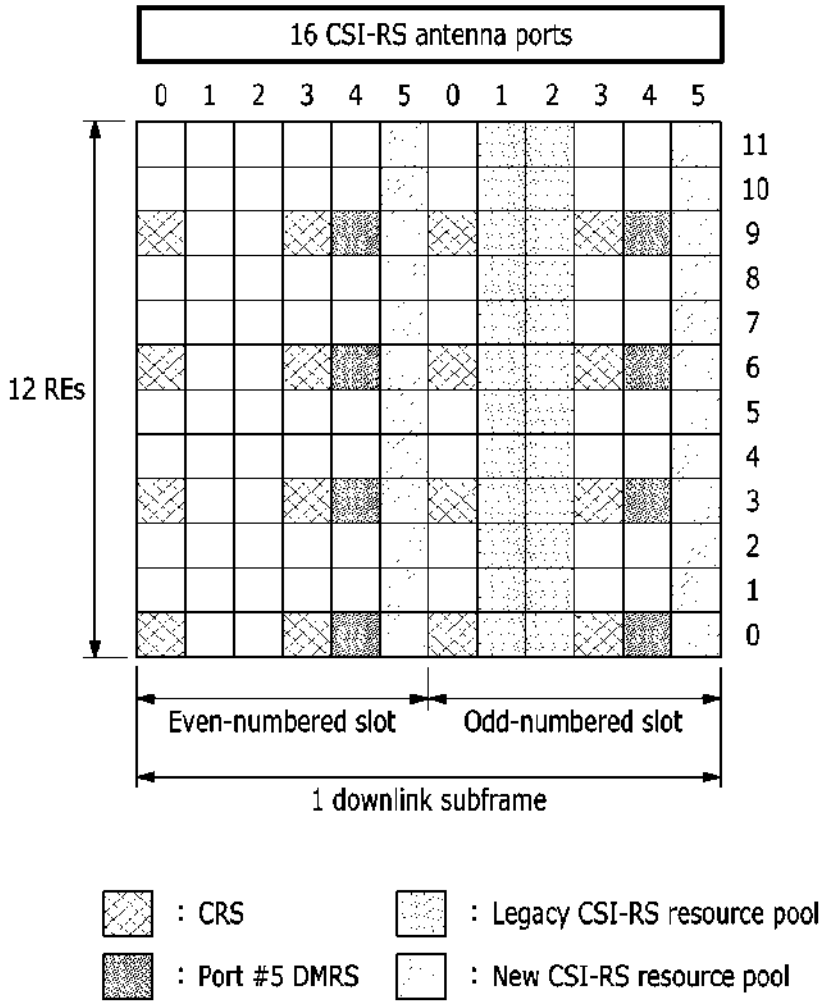

16 CSI-RS antenna ports
0 1 2 3 4 5 0 1 2 3 4 5
11
10
9
8
7
6
5
4
3
2
1
0
12 REs
Even-numbered slot
Odd-numbered slot
1 downlink subframe
: CRS
: Legacy CSI-RS resource pool
: Port #5 DMRS
: New CSI-RS resource pool

FIG. 69

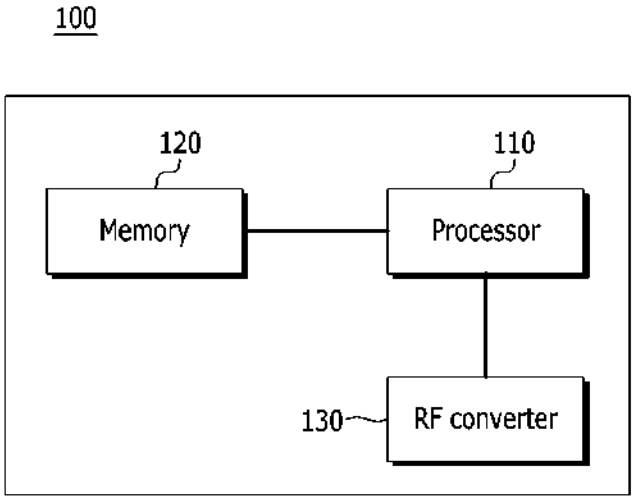


FIG. 70

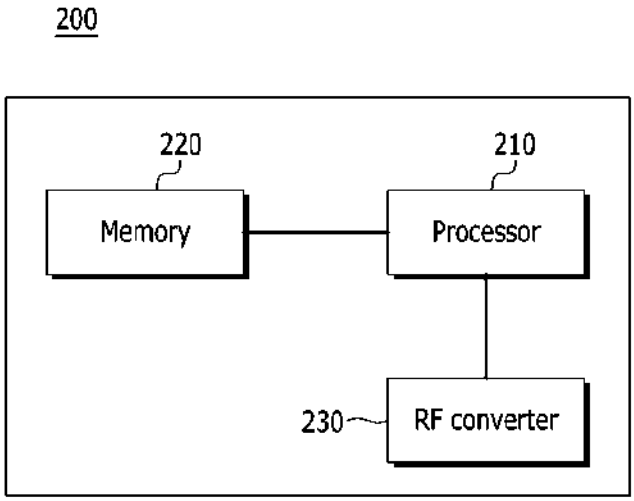
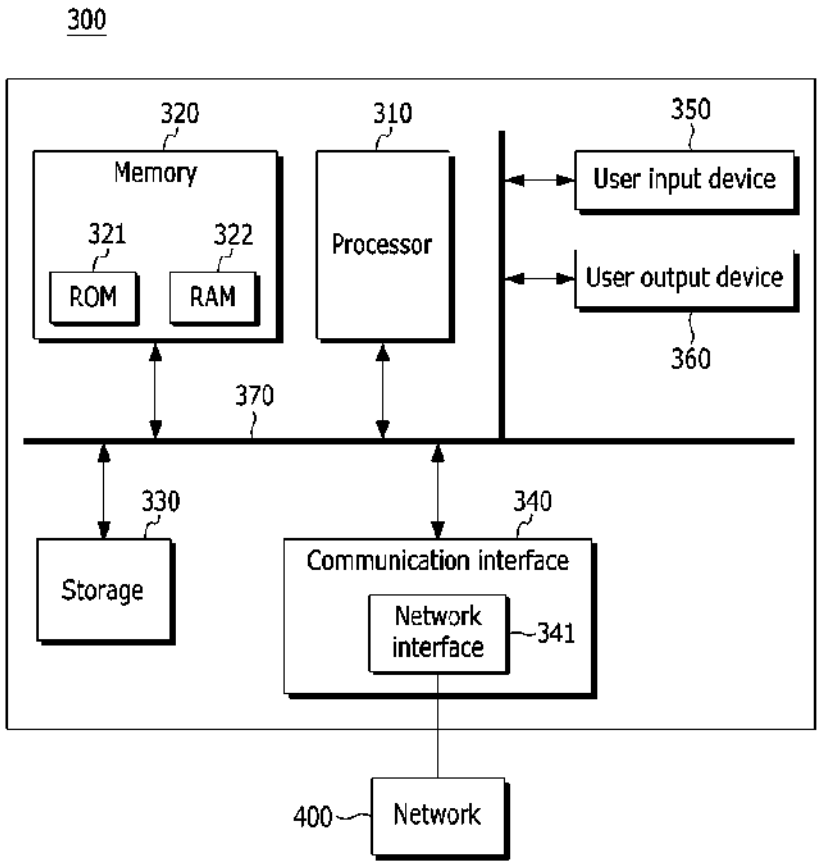


FIG. 71


300
320
Memory
321
ROM
322
RAM
310
Processor
350
User input device
User output device
360
370
330
Storage
340
Communication interface
Network interface
341
400
Network

METHOD AND APPARATUS FOR TRANSMITTING CHANNEL STATE INFORMATION REFERENCE SIGNAL

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2014-0129602, 10-2014-0135332, 10-2014-0142891, 10-2014-0151572, 10-2015-0016245, 10-2015-0060866, 10-2015-0075214, and 10-2015-0114943 filed in the Korean Intellectual Property Office on Sep. 26, 2014, Oct. 7, 2014, Oct. 21, 2014, Nov. 5, 2014, Feb. 2, 2015, Apr. 29, 2015, May 28, 2015, and Aug. 13, 2015, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] (a) Field of the Invention

[0003] The present invention relates to a method and apparatus for transmitting a channel state information reference signal in a wireless communication system.

[0004] (b) Description of the Related Art

[0005] A multiple-input multiple-output (MIMO) method in a wireless communication system is a transmission/reception method using a plurality of transmission antennas and a plurality of reception antennas. A plurality of radio channel paths are generated between transmission and reception antennas in a MIMO system. A transmission/reception stage can increase a data transmission capacity or can improve transfer quality by separating or merging the plurality of radio channel paths. A MIMO scheme includes a spatial multiplexing scheme and a spatial diversity scheme. A downlink MIMO scheme introduced in a long term evolution (LTE) system includes a transmit diversity method, a cyclic delay diversity (CDD) method, a beamforming method, and a spatial multiplexing method. Furthermore, a multi-user MIMO (MU-MIMO) scheme for simultaneously transmitting data to a plurality of terminals in the same resources is supported.

[0006] An antenna port in the LTE standard is a logical antenna unit implemented by the weighted sum of one or a plurality of physical antenna elements, and is chiefly defined in a transmission stage. An antenna port is also a basic unit in which a reference signal (RS) is transmitted. Accordingly, a terminal estimates a channel with respect to each antenna port rather than a physical antenna element, and performs a channel state information (CSI) measurement and report based on the estimated channel. Different antenna port numbers are assigned to a cell-specific RS (CSR), a user equipment-specific RS (URS), and a CSI-RS, that is, LTE downlink reference signals. An object of the URS is to decode a physical downlink shared channel (PDSCH) by a terminal, and the URS is also called a demodulation RS (DMRS). Antenna port numbers for a CRS may be 0 to 3, antenna port numbers for a URS may be 7 to 14, and antenna port numbers for a CSI-RS may be 15 to 22. Mapping between antenna ports and a physical antenna element(s) is called antenna virtualization. A terminal is basically unable to be aware of which virtualization has been applied to each antenna port.

[0007] A CSI-RS is a downlink RS transmitted by a base station so that a terminal may obtain a CSI, and has been introduced in LTE Release 10. In existing Release 8/9 systems, a CRS has been used in order to obtain the CSI of a terminal. In the Release 10 system, simultaneous transmission according to a maximum of 8 downlink layers has been introduced, and thus a new RS for estimating a channel having lower density than an existing CRS has been required to be introduced. A CSI-RS may be set to have an interval of 6 resource elements (RE) or 12 REs in a frequency axis and to have a cycle of 5, 10, 20, 40, or 80 ms in a time axis. CSI-RS configuration information is transmitted through user equipment-specific RRC signaling. The number of CSI-RS antenna ports which may be set for a terminal is 1, 2, 4, or 8. A total number of REs occupied by CSI-RS transmission for the number of CSI-RS antenna ports 1, 2, 4, or 8 within a single physical resource block (PRB) pair is 2, 2, 4, or 8. That is, if the number of CSI-RS antenna ports is 1, a total number of REs occupied by CSI-RS transmission is 2; if the number of CSI-RS antenna ports is 2, a total number of REs occupied by CSI-RS transmission is 2; if the number of CSI-RS antenna ports is 4, a total number of REs occupied by CSI-RS transmission is 4; and if the number of CSI-RS antenna ports is 8, a total number of REs occupied by CSI-RS transmission is 8.

SUMMARY OF THE INVENTION

[0008] The present invention has been made in an effort to provide a method and apparatus for configuring, by a base station, a plurality of RS antenna ports in a terminal in order to estimate a channel in a MIMO wireless communication system and providing an RS for estimating a channel.

[0009] Furthermore, the present invention provides a method and apparatus for extending a CSI-RS resource configuration for a terminal if the number of CSI-RS antenna ports is greater than 8 (e.g., 12, 16, 24, 32, or 64).

[0010] Furthermore, the present invention provides a method and apparatus for additionally defining a CSI-RS RE set if the number of CSI-RS antenna ports is 1, 2, 4, or 8.

[0011] In accordance with an exemplary embodiment of the present invention, a method of transmitting a channel state information reference signal (CSI-RS) by a base station is provided. The method of transmitting the CSI-RS includes including a plurality of first resource elements (REs) corresponding to at least two of a second orthogonal frequency division multiplexing (OFDM) symbol, a third OFDM symbol, and a fourth OFDM symbol of a first time slot in a first CSI-RS resource pool configured in a first subframe including the first time slot and a second time slot subsequent to the first time slot, and transmitting the CSI-RS using at least one of REs included in the first CSI-RS resource pool.

[0012] The method of transmitting a CSI-RS may further include: setting information about an OFDM symbol which belongs to the OFDM symbols of the first time slot and at which the transmission of a physical downlink shared channel (PDSCH) is started in a first parameter for a first set to which the first subframe belongs; setting information about an OFDM symbol which belongs to the OFDM symbols of a third time slot of the third time slot and a fourth time slot subsequent to the third time slot included in a second subframe and at which the transmission of a PDSCH is started in a second parameter for a second set to which the second subframe belongs; and transmitting the first parameter and the second parameter to a terminal.

[0013] The first subframe may be configured so that the CSI-RS is transmitted through at least one of the first REs.

[0014] The method of transmitting the CSI-RS may further include transmitting a bitmap of 19 bits for configuring the first REs as resources for a zero power (ZP) CSI-RS to a terminal.

[0015] Including the first REs in the first CSI-RS resource pool may include including 24 first REs corresponding to the third OFDM symbol and fourth OFDM symbol of the first time slot in the first CSI-RS resource pool.

[0016] Transmitting the CSI-RS may include mapping CSI-RS antenna ports greater of than 8 to the REs included in the first CSI-RS resource pool.

[0017] Mapping the CSI-RS antenna ports may include mapping 16 CSI-RS antenna ports to 16 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool, and multiplexing the 16 CSI-RS antenna ports using frequency division multiplexing (FDM) and code division multiplexing (CDM).

[0018] Mapping the CSI-RS antenna ports may include mapping 16 CSI-RS antenna ports to 16 REs of the 24 first REs and multiplexing the 16 CSI-RS antenna ports using FDM and CDM.

[0019] Mapping the CSI-RS antenna ports may include mapping 16 CSI-RS antenna ports to 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the first time slot and which are included in the first CSI-RS resource pool and 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool and multiplexing the 16 CSI-RS antenna ports using time division multiplexing (TDM) and CDM.

[0020] Mapping the CSI-RS antenna ports may include mapping 8 CSI-RS antenna ports of the 16 CSI-RS antenna ports to 8 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool, mapping the remaining 8 CSI-RS antenna ports of the 16 CSI-RS antenna ports to 8 REs of the 24 first REs, and multiplexing the 16 CSI-RS antenna ports using TDM and CDM.

[0021] Mapping the CSI-RS antenna ports may include mapping 32 CSI-RS antenna ports to 8 REs which correspond to the sixth OFDM symbol and the seventh OFDM symbol of the first time slot and which are included in the first CSI-RS resource pool, 8 REs which correspond to the sixth OFDM symbol and the seventh OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool, 8 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool, and 8 REs of the 24 first REs, and multiplexing the 32 CSI-RS antenna ports using FDM, TDM, and CDM.

[0022] Mapping the CSI-RS antenna ports may include mapping 32 CSI-RS antenna ports to 16 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool and 16 REs of the 24 first Res, and multiplexing the 32 CSI-RS antenna ports using FDM, TDM, and CDM.

[0023] Furthermore, in accordance with another exemplary embodiment of the present invention, a method of transmitting a channel state information reference signal (CSI-RS) by a base station is provided. The method of transmitting the CSI-RS includes setting the number of CSI-RS antenna ports for transmitting the CSI-RS to a value greater than 8, mapping the CSI-RS antenna ports to resource elements (RE) included in the CSI-RS resource pool of a subframe, and multiplexing the CSI-RS antenna ports using frequency division multiplexing (FDM) and code division multiplexing (CDM).

[0024] The subframe may include a first time slot and a second time slot subsequent to the first time slot.

[0025] Setting the number of CSI-RS antenna ports may include setting the number of CSI-RS antenna ports to one of 12, 16, 20, and 24.

[0026] Mapping the CSI-RS antenna ports may include mapping the set number of CSI-RS antenna ports to REs which belong to 24 first REs corresponding to the third orthogonal frequency division multiplexing (OFDM) symbol and the fourth OFDM symbol of the second time slot and included in the CSI-RS resource pool and which are equal to the number of CSI-RS antenna ports.

[0027] Mapping the set number of CSI-RS antenna ports may include mapping the 16 CSI-RS antenna ports to two REs which belong to the 24 first REs and which correspond to the twelfth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the eleventh subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the tenth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the ninth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the sixth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the fifth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the fourth subcarrier of the subframe, and two REs which belong to the 24 first REs and which correspond to the third subcarrier of the subframe when the number of CSI-RS antenna ports is 16.

[0028] Mapping the set number of CSI-RS antenna ports may include mapping the 16 CSI-RS antenna ports to two REs which belong to the 24 first REs and which correspond to the twelfth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the eleventh subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to an eighth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the seventh subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the sixth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the fifth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to the second subcarrier of the subframe, and two REs which belong to the 24 first REs and which correspond to the first subcarrier of the subframe when the number of CSI-RS antenna ports is 16.

[0029] Furthermore, in accordance with yet another exemplary embodiment of the present invention, a method of transmitting a channel state information reference signal (CSI-RS) by a base station is provided. The method of transmitting the CSI-RS may include setting the number of first CSI-RS antenna ports for transmitting the CSI-RS to a value greater than 8, mapping the CSI-RS antenna ports to resource elements (RE) included in the CSI-RS resource pool of a subframe, and multiplexing the first CSI-RS antenna ports using time division multiplexing (TDM) and code division multiplexing (CDM).

[0030] The subframe may include a first time slot and a second time slot subsequent to the first time slot.

[0031] The method of transmitting the CSI-RS may further include configuring a first energy per resource element (EPRE) for a demodulation reference signal (DMRS) in an

orthogonal frequency division multiplexing (OFDM) symbol which belongs to the OFDM symbols of the subframe and at which the CSI-RS is transmitted, configuring a second EPRE for a DMRS in an OFDM symbol which belongs to the OFDM symbols of the subframe and at which the CSI-RS is not transmitted, and transmitting a ratio of the first EPRE and the second EPRE to a terminal.

[0032] Setting the number of first CSI-RS antenna ports may include setting the number of first CSI-RS antenna ports to 16.

[0033] Mapping the first CSI-RS antenna ports may include mapping 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the CSI-RS resource pool, and mapping the remaining 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs which correspond to the sixth OFDM symbol and the seventh OFDM symbol of the second time slot and which are included in the CSI-RS resource pool.

[0034] Setting the number of first CSI-RS antenna ports may include setting the number of first CSI-RS antenna ports to 16.

[0035] Mapping the first CSI-RS antenna ports may include mapping 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs which correspond to the sixth OFDM symbol and the seventh OFDM symbol of the first time slot and which are included in the CSI-RS resource pool, and mapping the remaining 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the CSI-RS resource pool.

[0036] The method of transmitting a CSI-RS may further include setting the number of second CSI-RS antenna ports for transmitting the CSI-RS to a value equal to the number of first CSI-RS antenna ports, mapping the second CSI-RS antenna ports to the REs included in the CSI-RS resource pool, and multiplexing the second CSI-RS antenna ports using frequency division multiplexing (FDM) and CDM.

[0037] Multiplexing the first CSI-RS antenna ports may include multiplexing some of the first CSI-RS antenna ports using TDM and CDM, and multiplexing the remainder of the first CSI-RS antenna ports using frequency division multiplexing (FDM) and CDM.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] FIG. **1** is a diagram showing the mapping of a CSI-RS RE set if the number of CSI-RS ports is 2.

[0039] FIG. **2** is a diagram showing the mapping of a CSI-RS RE set if the number of CSI-RS ports is **4**.

[0040] FIG. **3** is a diagram showing the mapping of a CSI-RS RE set if the number of CSI-RS ports is 8.

[0041] FIG. **4** is a diagram showing the conceptual diagram of three-dimensional beamforming using a two-dimensional active antenna array.

[0042] FIGS. **5**A and **5**B are diagrams showing an embodiment of a resource configuration for 12, 16, 20, or 24 CSI-RS antenna ports according to Method M110.

[0043] FIG. **6** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M110.

[0044] FIG. **7** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M110.

[0045] FIG. **8** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M111.

[0046] FIG. **9** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M111.

[0047] FIG. **10** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M120.

[0048] FIG. **11** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M120.

[0049] FIG. **12** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130.

[0050] FIG. **13** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130.

[0051] FIG. **14** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130.

[0052] FIG. **15** is a diagram showing another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130.

[0053] FIG. **16** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130.

[0054] FIG. **17** is a diagram showing further yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130.

[0055] FIG. **18** is a diagram showing still yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130.

[0056] FIG. **19** is a diagram showing still yet another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130.

[0057] FIG. **20** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130.

[0058] FIG. **21** is a diagram showing yet another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130.

[0059] FIGS. **22**A and **22**B are diagrams showing exemplary embodiments in which length-4 OCC has been applied to REs.

[0060] FIG. **23** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M141.

[0061] FIG. **24** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M141.

[0062] FIG. **25** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M142.

[0063] FIG. **26** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M143.

[0064] FIG. **27** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M144.

[0065] FIG. **28** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M144.

[0066] FIG. **29** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M145.

[0067] FIG. **30** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M146.

[0068] FIG. **31** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M147.

[0069] FIG. **32** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M147.

[0070] FIG. **33** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M148.

[0071] FIG. **34** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M148.

[0072] FIG. **35** is a diagram showing an extended CSI-RS resource pool according to Method M210.

[0073] FIGS. **36**A and **36**B are diagrams showing an embodiment of a resource configuration for 12, 16, 20, or 24 CSI-RS antenna ports according to Method M211.

[0074] FIG. **37** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M212.

[0075] FIG. **38** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M212.

[0076] FIG. **39** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M213.

[0077] FIG. **40** is a diagram showing another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M213.

[0078] FIG. **41** is a diagram showing an embodiment of a resource configuration for 64 CSI-RS antenna ports according to Method M213.

[0079] FIG. **42** is a diagram showing another embodiment of a resource configuration for 64 CSI-RS antenna ports according to Method M213.

[0080] FIG. **43** is a diagram showing an embodiment of a resource configuration for 2 CSI-RS antenna ports according to Method M210.

[0081] FIG. **44** is a diagram showing an embodiment of a resource configuration for 4 CSI-RS antenna ports according to Method M210.

[0082] FIG. **45** is a diagram showing an embodiment of a resource configuration for 8 CSI-RS antenna ports according to Method M210.

[0083] FIG. **46** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M214.

[0084] FIG. **47** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M214.

[0085] FIG. **48** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M214.

[0086] FIG. **49** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M214.

[0087] FIG. **50** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M214.

[0088] FIG. **51** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M214.

[0089] FIG. **52** is a diagram showing a CSI-RS resource pool extended by Method M220.

[0090] FIG. **53** is a diagram showing a CSI-RS resource pool extended by Method M240.

[0091] FIG. **54** is a diagram showing an embodiment of a resource configuration for 8 CSI-RS antenna ports according to Method M310.

[0092] FIG. **55** is a diagram showing an exemplary embodiment of a two-dimensional rectangular array configuration for 16 CSI-RS antenna ports.

[0093] FIG. **56** is a diagram showing an exemplary embodiment of a two-dimensional cross array configuration for 16 CSI-RS antenna ports.

[0094] FIGS. **57**A and **57**B are diagrams showing an embodiment of a resource configuration for 12, 16, 20, or 24 CSI-RS antenna ports according to Method M510.

[0095] FIG. **58** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M510.

[0096] FIG. **59** is a diagram showing a CSI-RS resource pool extended by Method M521.

[0097] FIG. **60** is a diagram showing a CSI-RS resource pool extended by Method M522.

[0098] FIG. **61** is a diagram showing a CSI-RS resource pool extended by Method M523.

[0099] FIG. **62** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended cyclic prefix (CP) is configured.

[0100] FIG. **63** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0101] FIG. **64** is a diagram showing another embodiment of a resource configuration for 32 CSI-RS antenna ports if an extended CP is set.

[0102] FIG. **65** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0103] FIG. **66** is a diagram showing further yet another embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0104] FIG. **67** is a diagram showing still another embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0105] FIG. **68** is a diagram showing an extended CSI-RS resource pool if an extended CP is set.

[0106] FIG. **69** is a diagram showing the configuration of a base station in accordance with an exemplary embodiment of the present invention.

[0107] FIG. **70** is a diagram showing the configuration of a terminal in accordance with an exemplary embodiment of the present invention.

[0108] FIG. **71** is a diagram showing a computer system in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0109] In the following detailed description, only certain exemplary embodiments of the present invention have been shown and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

[0110] In the entire specification, a terminal may refer to a mobile terminal (MT), a mobile station (MS), an advanced mobile station (AMS), a high reliability mobile station (HR-MS), a subscriber station (SS), a portable subscriber station (PSS), an access terminal (AT), or user equipment (UE), and may include some or all of the functions of the MS, MT, AMS, HR-MS, SS, PSS, AT, and UE.

[0111] Furthermore, a base station (BS) may refer to an advanced base station (ABS), a high reliability base station (HR-BS), a nodeB, an evolved node B (eNodeB), an access point (AP), a radio access station (RAS), a base transceiver station (BTS), a mobile multihop relay (MMR)-BS, a relay station functioning as a base station, a high reliability relay station functioning as a base station, a small base station, and a macro base station, and may include some or all of the functions of the ABS, HR-BS, nodeB, eNodeB, AP, RAS, BTS, and MMR-BS, relay station, high reliability relay station, small base station, and macro base station.

[0112] 1. Mapping of CSI-RS RE if the Number of CSI-RS Antenna Ports is 1, 2, 4 or 8

[0113] The mapping of an RE in which a CSI-RS is transmitted complies with a pattern configured by each antenna port number and may be configured in a configured CSI-RS resource pool. A CSI-RS resource configuration (hereinafter referred to as a "CSI-RS configuration") has been defined for each normal cyclic prefix (CP) and extended CP. Furthermore, a CSI-RS configuration is divided into a CSI-RS configuration which may be configured in both frequency division duplex (FDD) and time division duplex (TDD), and a CSI-RS configuration which may be configured only in TDD. For example, a CSI-RS configuration in the case of a normal CP complies with Table 1 below.

TABLE 1

	CSI-RS configuration	Number of CSI reference signals configured: 1 or 2 (k',l')	1 or 2 n_s mod 2	4 (k',l')	4 n_s mod 2	8 (k',l')	8 n_s mod 2
Frame structure type 1 and 2	0	9 and 5	0	9 and 5	0	9 and 5	0
	1	11,2	1	11,2	1	11,2	1
	2	9 and 2	2	9 and 2	2	9 and 2	1
	3	7 and 2	1	7 and 2	1	7 and 2	1
	4	9 and 5	1	9 and 5	1	9 and 5	1
	5	8 and 5	0	8 and 5	0		
	6	10,2	1	10,2	1		
	7	8 and 2	1	8 and 2	1		
	8	6 and 2	1	6 and 2	1		
	9	8 and 5	1	8 and 5	1		
	10	3 and 5	0				
	11	2 and 5	0				
	12	5 and 2	1				
	13	4 and 2	1				
	14	3 and 2	1				
	15	2 and 2	1				
	16	1 and 2	1				
	17	0 and 2	1				
	18	3 and 5	1				
	19	2 and 5	1				
Frame structure type 2 only	20	11,1	1	11,1	1	11,1	1
	21	9 and 1	1	9 and 1	1	9 and 1	1
	22	7 and 1	1	7 and 1	1	7 and 1	1
	23	10,1	1	10,1	1		
	24	8 and 1	1	8 and 1	1		
	25	6 and 1	1	6 and 1	1		
	26	5 and 1	1				
	27	4 and 1	1				
	28	3 and 1	1				
	29	2 and 1	1				
	30	1 and 1	1				
	31	0 and 1	1				

[0114] In Table 1, CSI-RS configuration Nos. 0-19 may be applied to FDD and TDD in common, and CSI-RS configuration Nos. 20-31 may be only applied to TDD. In the case of TDD, there is a possibility that the DMRS of the antenna port No. 5 may be transmitted for a terminal configured as transmission mode (TM) 7. Accordingly, in order to avoid resource overlap with the antenna port No. 5 DMRS, CSI-RS configuration Nos. 20-31 have been additionally defined. In Table 1, an index pair (k', l') indicated by each CSI-RS configuration means an RE that is the reference point of a CSI-RS RE set, and it has been previously defined in a standard regarding that how a CSI-RS RE set is determined based on (k', l') within a single PRB pair.

[0115] FIGS. 1 to 3 illustrate the mapping of RE sets from a CSI-RS configuration No. 0 to a maximum CSI-RS configuration No. 19 if a normal CP is applied and the number of CSI-RS antenna ports is 2, 4, or 8. In this specification, a "CSI-RS set A" indicated in the drawings means a CSI-RS configuration No. A. X, Y denotes CSI-RS antenna port number. X_A, Y_A denotes CSI-RS antenna port Nos. X and Y in the CSI-RS configuration No. A.

[0116] FIG. 1 is a diagram showing the mapping of a CSI-RS RE set if the number of CSI-RS ports is 2, FIG. 2 is a diagram showing the mapping of a CSI-RS RE set if the number of CSI-RS ports is 4, and FIG. 3 is a diagram showing the mapping of a CSI-RS RE set if the number of CSI-RS ports is 8. A single downlink subframe shown in FIGS. 1 to 3 includes two time slots. Specifically, if a normal CP is set, a single subframe includes an even-numbered time slot (hereinafter referred to as a "first time slot") and an odd-numbered time slot (hereinafter referred to as a "second time slot") subsequent to an even-numbered time slot. The first time slot or the second time slot includes 7 orthogonal frequency division multiplexing (OFDM) symbols No. 0-No. 6 in a time axis and 12 subcarriers No. 0-No. 11 in a frequency axis. That is, 84=7×12 REs are present in the first time slot or the second time slot. A single subframe corresponds to a single PRB pair. Some of 84 REs may be configured as REs for CRS transmission, some of the 84 REs may be configured as REs for DMRS transmission, and some of the 84 REs may be config-

ured as REs for CSI-RS transmission. For example, in FIG. 1, the CSI-RS antenna port Nos. 15 and 16 of a CSI-RS configuration No. 0 are mapped (or configured in) to two REs that correspond to the sixth OFDM symbol (i.e., the OFDM symbol No. 5) and seventh OFDM symbol (i.e., the OFDM symbol No. 6) of a first time slot and that correspond to a tenth subcarrier (i.e., a subcarrier No. 9). That is, two CSI-RS antenna ports (Nos. 15 and 16) for each of the CSI-RS configuration Nos. 0-19 are mapped to two REs. Hereinafter, an RE that corresponds to a subcarrier No. i and an OFDM symbol No. j is called an RE (i, j).

[0117] For another example, in FIG. 2, the CSI-RS antenna port Nos. 15 and 16 of a CSI-RS configuration No. 1 are mapped to the RE (11, 2) and RE (11, 3) of a second time slot. The CSI-RS antenna port Nos. 17 and 18 of a CSI-RS configuration No. 1 are mapped to the RE (5, 2) and RE (5, 3) of the second time slot. That is, the four CSI-RS antenna ports Nos. 15 to 18 of each of CSI-RS configuration Nos. 0-9 are mapped to 4 REs.

[0118] For yet another example, in FIG. 3, the CSI-RS antenna port Nos. 15 and 16 of a CSI-RS configuration No. 0 are mapped to the RE (9, 5) and RE (9, 6) of a first time slot; the CSI-RS antenna port Nos. 17 and 18 of the CSI-RS configuration No. 0 are mapped to the RE (3, 5) and RE (3, 6) of the first time slot; the CSI-RS antenna port Nos. 19 and 20 for the CSI-RS configuration No. 0 are mapped to the RE (8, 5) and RE (8, 6) of the first time slot; and the CSI-RS antenna port Nos. 21 and 22 for the CSI-RS configuration No. 0 are mapped to the RE (2, 5) and RE (2, 6) of the first time slot. That is, 8 CSI-RS antenna port Nos. 15 to 22 for each of the CSI-RS configuration Nos. 0-4 are mapped to 8 REs.

[0119] Code division multiplexing (CDM) is applied to CSI-RS antenna ports (e.g., CSI-RS antenna port Nos. 15 and 16) transmitted through the same RE as an inter-antenna port multiplexing method. For example, in FIG. 1, the CSI-RS antenna port Nos. 15 and 16 are transmitted (i.e., CSI-RSs are transmitted) through the RE (9, 5) of the first time slot, and the CSI-RS antenna port Nos. 15 and 16 are transmitted through the RE (9, 6) of the first time slot. In this case, in order to differentiate the CSI-RS antenna port Nos. 15 and 16 transmitted through the same RE, CDM is applied between the CSI-RS antenna port Nos. 15 and 16.

[0120] Frequency division multiplexing (FDM) is applied between CSI-RS antenna ports (e.g., the CSI-RS antenna port Nos. 15 and 17) transmitted through different REs as an inter-antenna port multiplexing method. For example, in FIG. 2, the CSI-RS antenna port No. 15 is transmitted through the RE (9, 5) and RE (9, 6) of the first time slot, and the CSI-RS antenna port No. 17 is transmitted through the RE (3, 5) and RE (3, 6) of the first time slot. In this case, in order to differentiate the CSI-RS antenna port Nos. 15 and 17 transmitted through different REs, FDM is applied between the CSI-RS antenna port Nos. 15 and 17.

[0121] 2. Method of Extending CSI-RS Configuration and Method of Defining Added CSI-RS RE Set

[0122] FIG. 4 is a schematic view showing three-dimensional beamforming of a full dimension (FD)-MIMO system using a two-dimensional active antenna array.

[0123] In an FD-MIMO (or three-dimensional MIMO) system, in order for a base station to perform three-dimensional beamforming, a terminal needs to perform measurements and a report on a CSI in a vertical axis in addition to a CSI in an existing horizontal axis. However, since a maximum number of CSI-RS antenna ports which may be configured in a single terminal is 8 in an existing LTE standard, the terminal may not estimate the entire channel space using only the maximum number of 8 CSI-RS ports if the size of a two-dimensional antenna array is large. Furthermore, since the number of radio frequency (RF) chains is increased in an FD-MIMO system, there may be a problem in that transmission efficiency is deteriorated if an existing CSI-RS pattern is identically applied.

[0124] Hereinafter, a method of extending a CSI-RS configuration for a terminal to a case where the number of antenna ports is 16, 32, or 64 is chiefly described. Furthermore, in some methods, a method of extending a CSI-RS configuration to a case where the number of antenna ports is 12 or 24 is described. Furthermore, in some methods, a method of additionally defining a CSI-RS RE set for a case where the number of CSI-RS antenna ports is 1, 2, 4, or 8 is described. Methods to be described below belong to one or a plurality of the following 4 cases.

- **[0125]** If a CP is a normal CP, a CSI-RS configuration applicable to both FDD and TDD
- **[0126]** If a CP is a normal CP, a CSI-RS configuration applicable to only TDD
- **[0127]** If a CP is an extended CP, a CSI-RS configuration applicable to both FDD and TDD
- **[0128]** If a CP is an extended CP, a CSI-RS configuration applicable to only TDD

[0129] Methods in accordance with exemplary embodiments of the present invention may have different advantages according to an antenna virtualization method. In this case, antenna virtualization means mapping between an antenna port and a physical antenna element(s). In a digital signal processing-based communication system, antenna virtualization may include antenna port virtualization and transceiver unit (TXRU) virtualization. In this case, the TXRU means the unit of an RF device capable of independently controlling the phase and amplitude of an input signal, and it is commonly called an RF chain. Antenna port virtualization means mapping between an antenna port and a TXRU(s), and TXRU virtualization means mapping between a TXRU and a physical antenna element(s). A terminal is basically unable to be aware of virtualization applied to each antenna port. Assuming that the entire transmission power of a base station is 1 for convenience sake, maximum output power of the power amplifier of each transmitter unit (TXU) may be implemented by 1/M (in this case, M the number of base stations).

[0130] If a CSI-RS antenna port is configured in a two-dimensional manner, CSI-RS antenna port virtualization may be divided into horizontal axis virtualization and vertical axis virtualization. In horizontal axis CSI-RS antenna port virtualization, in general, one-to-one mapping may be applied, that is, mapping may be applied in such a manner that each CSI-RS antenna port is connected to a single TXU. In contrast, in vertical axis CSI-RS antenna port virtualization, one-to-one mapping may be applied, and mapping may be applied in a full connection form in which each CSI-RS antenna port is connected to all the TXUs in a vertical axis. In this specification, unless specially described, it is assumed that one-to-one mapping is applied to vertical axis virtualization of a CSI-RS antenna port.

[0131] In this specification, CSI-RS antenna port numbers are sequentially numbered from No. 15 because they have been defined as Nos. 15-22 in a current LTE standard, but this is only for an index for differentiating a plurality of CSI-RS

antenna ports and does not have a special meaning. That is, CSI-RS antenna port Nos. may be defined as any numbers in addition to the rule.

[0132] A terminal performs channel estimation on each port with respect to CSI-RS antenna ports configured using a method of configuring CSI-RS resources in accordance with an exemplary embodiment of the present invention described in this specification. A terminal may use channel information about each CSI-RS antenna port, obtained through channel estimation, to perform at least CSI measurement and report.

[0133] 2.1. CSI-RS Configuration Applicable to Both FDD and TDD if a Normal CP is Set

[0134] First, a method of extending CSI-RS configuration Nos. 0-19 which is applied to an FDD frame structure and a TDD frame structure in common if a normal CP is set is described below. In this case, as illustrated in FIGS. **1** to **3**, a total number of REs which may be configured as CSI-RS transmission resources within a single PRB pair is 40. A set of REs which may be configured as CSI-RS transmission resources within a single PRB pair is hereinafter called a CSI-RS resource pool. A CSI-RS configuration method used without changing a CSI-RS resource pool in an existing standard (hereinafter referred to as "Method M100") is first described, and a method of extending the CSI-RS resource pool (hereinafter referred to as "Method M200") is subsequently described.

[0135] In Method M100, a method of extending a CSI-RS pattern in a frequency axis using FDM (hereinafter referred to as "Method M110") is described.

[0136] Method M110 is a method of extending a CSI-RS RE set in the frequency axis on the same OFDM symbol, but orthogonal cover code (OCC) having a length of 2 is identically applied as in an existing method. FIGS. **5**A, **5**B, **6**, and **7** are exemplary embodiments of Method M110.

[0137] FIG. **5**A is a diagram showing an exemplary embodiment of a CSI-RS configuration for 12 or 16 CSI-RS antenna ports according to Method M110, and **5**B is a diagram showing an exemplary embodiment of a CSI-RS configuration for 20 or 24 CSI-RS antenna ports according to Method M110. FIG. **6** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M110. FIG. **7** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M110.

[0138] In the CSI-RS configuration methods illustrated in FIGS. **5**A and **5**B, whenever the number of antenna ports is increased every four antenna ports, a rule in which an RE set is extended in the frequency axis is the same. In all the exemplary embodiments of FIGS. **5**A, **5**B, **6**, and **7**, a nested structure with an existing CSI-RS antenna port pattern has been applied by taking coexistence with an existing terminal into consideration. That is, a newly defined CSI-RS antenna port pattern partially includes an existing 1, 2, 4, or 8 CSI-RS antenna port pattern. In other words, a CSI-RS antenna port pattern newly defined for a CSI-RS configuration No. A partially includes an existing CSI-RS antenna port pattern for a CSI-RS configuration No. B (No. B may be the same as or different from No. A) and includes an additional RE, thereby establishing a nested structure. For example, a CSI-RS antenna port pattern (i.e., 12, 16, 20, or 24 CSI-RS antenna ports) for a CSI-RS configuration No. 0 illustrated in FIGS. **5**A and **5**B includes an existing CSI-RS antenna port pattern (i.e., 8 CSI-RS antenna ports) for a CSI-RS configuration No. 1. That is, if a CSI-RS antenna port pattern for the CSI-RS configuration No. A partially includes a CSI-RS antenna port pattern for the CSI-RS configuration No. B, although the CSI-RS configuration Nos. A and B have different CSI-RS configuration numbers, a nested structure is established between the CSI-RS antenna port pattern for the CSI-RS configuration No. A and the CSI-RS antenna port pattern for the CSI-RS configuration No. B.

[0139] Likewise, a nested structure is also partially established between the patterns of 12 or 24 CSI-RS antenna ports illustrated in FIGS. **5**A and **5**B. Method M110 has a drawback in that 32 or 64 CSI-RS antenna port patterns are unable to be defined within a single subframe, and a drawback in that only one of 16 CSI-RS antenna ports (Nos. 15 to 30) for a corresponding CSI-RS RE set (e.g., the CSI-RS configuration No. 0) may be defined if the number of CSI-RS antenna ports is 16, 20, or 24 as illustrated in FIGS. **5**A to **7**. In the methods of FIGS. **5**A and **5**B, if the number of CSI-RS antenna ports is 12, two CSI-RS RE sets (e.g., 12 CSI-RS antenna ports (Nos. 15 to 26) for the CSI-RS configuration No. 0 and 12 CSI-RS antenna ports (Nos. 15 to 26) for the CSI-RS configuration No. 1) may be defined within a single subframe.

[0140] If 12, 16, 20, or 24 CSI-RS antenna ports are configured according to Method M110, assuming that one-to-one mapping is applied to antenna port virtualization, there is an advantage in that full transmission power can be applied to each antenna port. Accordingly, a terminal can obtain the same CSI-RS channel estimation performance as that of a case where existing 1, 2, 4, or 8 CSI-RS antenna ports have been configured. If one-to-one mapping is applied to antenna port virtualization in Method M110 and full transmission power is applied to each CSI-RS antenna port, however, CSI-RS power boost is increased compared to an existing method. In this case, the CSI-RS power boost means that transmission power of RE in which a CSI-RS is transmitted by each TXU becomes greater than transmission power of an RE in which a DMRS or PDSCH is transmitted. CSI-RS power boost exceeding a limit may cause performance degradation attributable to RF impairments. If 16 CSI-RS antenna ports are configured according to Method M110, CSI-RS power boost of 9 dB may be required. To this end, a method of increasing a maximum setting value of a ratio (defined as Pc in the LTE standard) of a CSI-RS EPRE to 18 dB to a PDSCH energy per resource element (EPRE), that is, a parameter set in a terminal by a base station, may be taken into consideration. Alternatively, in methods to be described below, a method of increasing a maximum setting value of Pc to 21 dB if CSI-RS power boost of 12 dB is required may be taken into consideration.

[0141] In an exemplary embodiment on the right side of FIG. **5**A and exemplary embodiments of FIGS. **5**B to **7**, the index (or number) of a CSI-RS configuration has been illustrated as being No. 0, but the index of a CSI-RS configuration does not need to be No. 0. For example, a method of setting the index of a CSI-RS configuration as No. 1 in the exemplary embodiment on the right side of FIG. **5**A and the exemplary embodiment of FIG. **5**B and setting the index of a CSI-RS configuration as No. 2 in the exemplary embodiment of FIG. **7** so that the index of a CSI-RS configuration is the same as that of an RE set for the existing 1, 2, 4, or 8 CSI-RS antenna port may be taken into consideration.

[0142] A method of extending a CSI-RS pattern in the frequency axis using a plurality of PRB pairs that are contiguous in the frequency axis and using FDM (hereinafter referred to as "Method M111") is described below.

[0143] Method M111 has a principle similar to that of Method M110, but is different from Method M110 in that an existing CSI-RS resource pool is not used without a change, but a CSI-RS resource pool is extended using a plurality of PRB pairs.

[0144] FIG. **8** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M111. Specifically, FIG. **8** is a diagram showing an example in which the size of a CSI-RS resource pool has been doubled by binding two PRB pairs into one. That is, a total number of REs which may be configured as CSI-RS transmission resources is 80 (=40×2). In Method M110, only one pattern of 16 CSI-RS antenna ports may be defined within a single subframe. In contrast, in Method M111, if two PRB pairs are combined as illustrated in FIG. **8**, a maximum number of 5 patterns of 16 CSI-RS antenna ports may be defined. That is, in Method M111, 16 CSI-RS antenna ports (Nos. 15 to 30) for a CSI-RS configuration No. 0, 16 CSI-RS antenna ports (Nos. 15 to 30) for a CSI-RS configuration No. 1, 16 CSI-RS antenna ports (Nos. 15 to 30) for a CSI-RS configuration No. 2, 16 CSI-RS antenna ports (Nos. 15 to 30) for a CSI-RS configuration No. 3, and 16 CSI-RS antenna ports (Nos. 15 to 30) for a CSI-RS configuration No. 4 may be configured. However, Method M111 has a problem in that channel estimation performance may be degraded because the number of REs allocated to each CSI-RS antenna port is reduced by half in the frequency axis.

[0145] FIG. **9** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M111. Specifically, FIG. **9** shows an example in which a CSI-RS configuration for 32 CSI-RS antenna ports has been defined by combining two PRB pairs. FIG. **9** illustrates that a CSI-RS RE set within a single PRB pair has been configured in the same manner as the exemplary embodiment on the right side of FIG. **5**B. The exemplary embodiment of FIG. **9** has the same characteristics and advantages as the exemplary embodiment of FIG. **8**. However, the number of CSI-RS antenna ports is 32 in the exemplary embodiment of FIG. **9**, which has been increased by four times compared to the existing number of CSI-RS antenna ports of 8. Accordingly, CSI-RS power boost increased by four times compared to the existing number of CSI-RS antenna ports of 8 may be required. In this case, a method of increasing a maximum setting value of Pc to 21 dB may be taken into consideration.

[0146] In Method M100, a method of increasing a CSI-RS pattern using time division multiplexing (TDM) in a time axis (hereinafter referred to as "M120") is described below.

[0147] Method M120 is a method of differentiating an existing antenna port and a newly defined antenna port using different time resources. Method M120 is a multiplexing method between CSI-RS antenna ports, and it uses TDM.

[0148] FIG. **10** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M120. FIG. **11** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M120.

[0149] As illustrated in FIG. **11**, in Method M120, unlike in Method M110, if the number of CSI-RS antenna ports is 16, two CSI-RS RE sets may be defined within a single subframe. For example, in Method M120, 16 CSI-RS antenna ports Nos. 15-30 for a CSI-RS configuration No. 0 and 16 CSI-RS antenna ports Nos. 15-30 for a CSI-RS configuration No. 1 may be defined within a single subframe.

[0150] Furthermore, in the exemplary embodiment illustrated in FIG. **11**, the 16 patterns of CSI-RS antenna ports for the CSI-RS configuration Nos. 0 and 1 partially include the existing pattern of CSI-RS antenna ports (1, 2, 4, or 8) for CSI-RS configuration Nos. 0 and 1. A nested structure is established between the CSI-RS antenna port pattern illustrated in FIG. **10** and the existing CSI-RS antenna port pattern (1, 2, 4, or 8 CSI-RS antenna ports).

[0151] Furthermore, in the exemplary embodiment illustrated in FIG. **10**, a time axis interval between an RE set of CSI-RS antenna port Nos. 15-22 and an RE set of CSI-RS antenna port Nos. 23-30 is one OFDM symbol, and the two RE sets have the same frequency axis location. As described above, the exemplary embodiment illustrated in FIG. **10** has an advantage in that the CSI measurement accuracy of a terminal can be increased by minimizing a difference between points of time at which CSI-RS antenna ports are transmitted.

[0152] In contrast, in Method M120, full transmission power for each antenna port may not be guaranteed if one-to-one mapping is applied to CSI-RS antenna port virtualization. Specifically, an example in which transmission power is equally distributed to all TXUs may be taken into consideration because a CSI-RS antenna port is virtualized with a TXU in a one-to-one mapping form, but beamforming or precoding having constant modulus amplitude is applied to a DMRS or PDSCH transmitted in the same OFDM symbol as an OFDM symbol in which a corresponding CSI-RS is transmitted. In this case, in accordance with Method M120, remaining power is generated in a TXU to which a CSI-RS antenna port is not mapped because transmission power of an RE occupied by a CSI-RS antenna port cannot be equally distributed to each power amplifier of a TXU. In this case, in order for a TXU to which a CSI-RS antenna port has been mapped to not apply damage to transmission power of a DMRS and PDSCH, transmission power of a corresponding CSI-RS antenna port is reduced. As illustrated in FIG. **10** or **11**, if the number of CSI-RS antenna ports is extended by two times compared to the existing number 8 of CSI-RS antenna ports according to the TDM method, CSI-RS transmission power is reduced by half. This may cause the degradation of channel estimation performance because it reduces CSI-RS reception power of a terminal by half. If the number of CSI-RS antenna ports is extended by four times (32 CSI-RS antenna ports) compared to the existing number 8 of CSI-RS antenna ports according to the TDM method, CSI-RS transmission power is reduced to ¼ on the assumption of the same antenna port virtualization.

[0153] As a method for solving a problem in that CSI-RS transmission power is reduced in Method M120, a method of applying beamforming or precoding not having constant modulus amplitude to the DMRS and PDSCH of an OFDM symbol in which a CSI-RS is transmitted may be taken into consideration. However, such a method is problematic in that DMRS channel estimation performance or PDSCH demodulation performance may be degraded because different beamforming or precoding may be applied to OFDM symbols within a single subframe. A method of unequally allocating PDSCH transmission power of an OFDM symbol in which a CSI-RS is transmitted and an OFDM symbol in which a CSI-RS is not transmitted within a single subframe may be taken into consideration as another method.

[0154] A method (hereinafter referred to as "Method M121") of signaling to a terminal, by a base station, a ratio of

the EPRE of the DMRS or PDSCH of an OFDM symbol in which a CSI-RS is transmitted (hereinafter referred to as a "first EPRE") and the EPRE of the DMRS or PDSCH of an OFDM symbol in which a CSI-RS is not transmitted (hereinafter referred to as a "second EPRE") is described below.

[0155] For convenience of description, a ratio of EPREs in which the first EPRE is taken as a denominator and the second EPRE is taken as a numerator in Method M121 is called P_D. The value P_D may be sufficient when the value is smaller than 1 if it has an object to increase CSI-RS transmission power. For example, in the exemplary embodiments of FIGS. **10** and 11, the value P_D may be set to ½. If the value P_D is ½, it means that DMRS or PDSCH transmission power of an OFDM symbol in which a CSI-RS is transmitted is reduced by half. A base station may increase CSI-RS transmission power twice using the value P_D. Method M121 has an advantage in that it can compensate for a loss in terms of CSI-RS transmission power, but may be disadvantageous in terms of the entire transmission power utilization because it increases the remaining power of a TXU to which a CSI-RS antenna port is not mapped.

[0156] A method in which a CSI-RS pattern according to Method M110 and a CSI-RS pattern according to Method M120 coexist within a single subframe (hereinafter referred to as "Method M130") is described below.

[0157] FIGS. **12** to **15** are exemplary embodiments of Method M130. FIG. **12** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130. FIG. **13** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130. FIG. **14** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130. FIG. **15** is a diagram showing another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130.

[0158] A characteristic of the exemplary embodiments according to Method M130 is that a nested structure is established between CSI-RS patterns for a different number of antenna ports with respect to the same CSI-RS configuration. For example, a pattern (CSI-RS antenna port Nos. 15-46) for a CSI-RS configuration No. 0 illustrated in FIG. **13** partially includes a pattern (CSI-RS antenna port Nos. 15-30) for a CSI-RS configuration No. 0 illustrated in FIG. **12**. The pattern for the CSI-RS configuration No. **0** illustrated in FIG. **12** partially includes an existing pattern (1, 2, 4, or 8 CSI-RS antenna ports) for the CSI-RS configuration No. 0. Accordingly, for the CSI-RS configuration of Table 1 extended up to 16 and 32 CSI-RS antenna ports, extended parts are illustrated in Table 2 below.

TABLE 2

An exemplary embodiment of a CSI-RS configuration extended according to Method M130

		Number of CSI reference signals configured			
	CSI-RS	16		32	
	configuration	(k', l')	n_s mod 2	(k', l')	n_s mod 2
Frame structure types 1 and 2	0	9 and 5	0	9 and 5	0
	1	11, 2	1		

[0159] In accordance with the characteristic, if a base station tries to change the number of CSI-RS antenna ports configured in a terminal, an unnecessary change of a CSI-RS configuration index may be omitted. The exemplary embodiments illustrated in FIGS. **12** to **15** are only some of various exemplary embodiments to which the principle of Method M130 may be applied.

[0160] A method of designing an RE set so that a difference between points of time at which CSI-RS antenna ports are transmitted is minimized may be applied to Method M130. FIGS. **16** to **19** are exemplary embodiments of such a method. FIG. **16** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130. FIG. **17** is a diagram showing yet another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130. FIG. **18** is a diagram showing still yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130. FIG. **19** is a diagram showing still yet another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130.

[0161] In the exemplary embodiments illustrated in FIGS. **16** to **19**, a maximum interval between REs forming a single CSI-RS pattern in a time axis is 4 OFDM symbols. In this case, CSI measurement accuracy of a terminal can be improved that much because the maximum interval is smaller by 1 than that of the exemplary embodiments illustrated in FIGS. **12** to **15**. In contrast, the exemplary embodiments illustrated in FIGS. **16** to **19** do not have a nested structure within the same CSI-RS configuration index, that is, the characteristic of the exemplary embodiments illustrated in FIGS. **12** to **15**. In particular, in the exemplary embodiment illustrated in FIG. **18**, an additional characteristic is that the TDM-based CSI-RS pattern illustrated in FIG. **10** is included.

[0162] In accordance with the exemplary embodiments of FIGS. **12** to **19**, the number of CSI-RS configurations or CSI-RS RE sets which may be configured in a single subframe is 2 if the number of CSI-RS antenna ports is 16 and 1 if the number of CSI-RS antenna ports is 32. A method of allowing a resource overlap between CSI-RS RE sets and also configuring a larger number of CSI-RS configurations or CSI-RS RE sets within a single subframe may be applied to Method M130. FIGS. **20** and **21** are exemplary embodiments of such a method. FIG. **20** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M130. Specifically, FIG. **20** illustrates that 4 different CSI-RS configuration Nos. 0-3 have been defined if the number of CSI-RS antenna ports is 16. For example, CSI-RS antenna port Nos. 23 and 24 for a CSI-RS configuration No. 0 and CSI-RS antenna port Nos. 15 and 16 for a CSI-RS configuration No. 1 may be mapped to the RE (11, 2) and RE (11, 3) of a second time slot.

[0163] FIG. **21** is a diagram showing yet another embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M130. Specifically, FIG. **21** illustrates that two different CSI-RS configuration Nos. 0 and 1 have been defined if the number of CSI-RS antenna ports is 32. For example, CSI-RS antenna port Nos. 27 and 28 for a CSI-RS configuration No. 0 and CSI-RS antenna port Nos. 19 and 20 for a CSI-RS configuration No. 1 may be mapped to the RE (10, 2) and RE (10, 3) of a second time slot.

[0164] CDM using OCC having a length of 2 is applied to the methods described so far for each CSI-RS antenna port

part sharing the same RE. A method of extending a CSI-RS pattern using CDM based on OCC having a longer length is described below.

[0165] A method of extending a CSI-RS pattern using CDM (hereinafter referred to as "Method M140") is described.

[0166] Method M140 is a method of multiplexing antenna ports using OCC having a longer length than an existing length-2 Walsh code while using an existing CSI-RS resource pool in the same manner. In this case, a method of extending a CSI-RS pattern includes a method of extending a CSI-RS pattern in a time axis and a method of extending a CSI-RS pattern in a frequency axis. In Method M140, a case where the length of OCC is 4 may be basically taken into consideration. If CSI-RS power boost according to the application of FDM is problematic, OCC having a length of 8 may be taken into consideration.

[0167] Length-4 Walsh code ([1 1 1 1], [1 −1 1 −1], [1 1 −1 −1], [1 −1 −1 1]) may be taken into consideration as length-4 OCC. Furthermore, length-8 Walsh code ([1 1 1 1 1 1 1 1], [1 −1 1 −1 1 −1 1 −1], [1 1 −1 −1 1 1 −1 −1], [1 −1 −1 1 1 −1 −1 1], [1 1 1 1 −1 −1 −1 −1], [1 −1 1 −1 −1 1 −1 1], [1 1 −1 −1 −1 −1 1 1], [1 −1 −1 1 −1 1 1 −1]) may be taken into consideration as length-8 OCC. In accordance with Method M140, although one-to-one mapping is used as antenna port virtualization, the CSI-RS transmission power reduction problem of Method M110 or the CSI-RS power boost problem of Method M120 is not generated. In contrast, if channel responses between REs to which OCC has been applied are different, orthogonality between codes may not be guaranteed. Accordingly, channel estimation performance of a terminal may be degraded.

[0168] A method of extending a CSI-RS pattern in a frequency axis using length-4 Walsh code (hereinafter referred to as "Method M141") is described below.

[0169] FIGS. **22**A and **22**B are diagrams showing exemplary embodiments in which length-4 OCC has been applied to REs.

[0170] Method M141 is a method of applying the length-4 Walsh code to CSI-RS REs disposed in a quadrangle form in a time-frequency axis as illustrated in FIGS. **22**A and **22**B. In this case, all 4 REs to which OCC has been applied are contiguous (FIG. **22**A) or are placed at relatively close locations (FIG. **22**B), thereby being capable of minimizing the degradation of channel estimation performance compared to the existing length-2 OCC.

[0171] FIG. **23** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M141. For example, CSI-RS antenna port Nos. 15, 16 and 23, 24 for a CSI-RS configuration No. **0** are mapped to the RE (11, 2), RE (11, 3), RE (9, 2), and RE (9, 3) of a second time slot. That is, the CSI-RS antenna port Nos. 15, 16 and 23, 24 for the CSI-RS configuration No. **0** share four REs. CDM using length-4 OCC is applied to the CSI-RS antenna port Nos. 15, 16 and 23, 24 for the CSI-RS configuration No. **0**.

[0172] FIG. **24** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M141. For example, CSI-RS antenna port Nos. 15, 16 and 19, 20 for the CSI-RS configuration No. 0 are mapped to the RE (10, 2), RE (10, 3), RE (11, 2), and RE (11, 3) of the second time slot. That is, the CSI-RS antenna port Nos. 15, 16 and 19, 20 for the CSI-RS configuration No. 0 share 4 REs. CDM using length-4 OCC is applied to the CSI-RS antenna port Nos. 15, 16 and 19, 20 for the CSI-RS configuration No. 0.

[0173] A method of extending a CSI-RS pattern in a time axis using the length-4 Walsh code (hereinafter referred to as "Method M142") is described below.

[0174] Method M142 is a method of extending existing time-axis length-2 CDM by twice in a time axis. FIG. **25** is an exemplary embodiment of Method M142. Specifically, FIG. **25** is a diagram showing an exemplary embodiment of a CSI-RS configuration for 16 CSI-RS antenna ports according to Method M142. For example, CSI-RS antenna port Nos. 15, 16 and 23, 24 for a CSI-RS configuration No. 0 are mapped to the RE (9, 5) and RE (9, 6) of a first time slot and the RE (9, 2) and RE (9, 3) of a second time slot. That is, the CSI-RS antenna port Nos. 15, 16 and 23, 24 for the CSI-RS configuration No. 0 share 4 REs. CDM using length-4 OCC is applied to the CSI-RS antenna port Nos. 15, 16 and 23, 24 for the CSI-RS configuration No. 0. For another example, the CSI-RS antenna port Nos. 15, 16 and 23, 24 for the CSI-RS configuration No. 1 are mapped to the RE (11, 2), RE (11, 3), RE (9, 5), and RE (9, 6) of the second time slot. That is, the CSI-RS antenna port Nos. 15, 16 and 23, 24 for the CSI-RS configuration No. 1 share 4 REs, and CDM using length-4 OCC is applied to the CSI-RS antenna port Nos. 15, 16 and 23, 24 for the CSI-RS configuration No. 1.

[0175] A method of extending a CSI-RS pattern in a time axis using TDM and replacing some of existing FDM with CDM using the length-4 Walsh code (hereinafter referred to as "Method M143") is described below.

[0176] Method M143 is a method of extending a CSI-RS pattern in a time axis according to Method M120 and simultaneously applying length-4 CDM in a time and frequency axis according to Method M143. In accordance with Method M143, CDM is newly applied to some CSI-RS antenna ports differentiated by FDM. FIG. **26** is an exemplary embodiment of Method M143. Specifically, FIG. **26** is a diagram showing an exemplary embodiment of a CSI-RS configuration for 16 CSI-RS antenna ports according to Method M143. For example, in an existing CSI-RS pattern (e.g., the exemplary embodiment of FIG. **3**) for 8 CSI-RS antenna ports, FDM has been applied between CSI-RS antenna port Nos. 15 and 16 and CSI-RS antenna port Nos. 19 and 20. In contrast, in the exemplary embodiment of FIG. **26**, CDM is applied to multiplexing between the CSI-RS antenna port Nos. 15, 16 and 19, 20.

[0177] In the exemplary embodiments illustrated in FIGS. **23** to **26**, OCC applied to each CSI-RS antenna port is listed in Table 3 and Table 4 below. Specifically, the exemplary embodiments of FIGS. **23** and **25** comply with Table 3, and the exemplary embodiments of FIGS. **24** and **26** comply with Table 4.

TABLE 3

Exemplary embodiment of mapping between length-4 OCC and CSI-RS antenna port

OCC	CSI-RS antenna port
[1 1 1 1]	{15, 17, 19, 21}
[1 −1 1 −1]	{16, 18, 20, 22}
[1 1 −1 −1]	{23, 25, 27, 29}
[1 −1 −1 1]	{24, 26, 28, 30}

TABLE 4

Another exemplary embodiment of mapping between length-4 OCC and CSI-RS antenna port

OCC	CSI-RS antenna port
[1 1 1 1]	{15, 17, 23, 25}
[1 −1 1 −1]	{16, 18, 24, 26}
[1 1 −1 −1]	{19, 21, 27, 29}
[1 −1 −1 1]	{20, 22, 28, 30}

[0178] A method in which a CSI-RS pattern according to Method M141 and a CSI-RS pattern according to Method M143 coexist in a single subframe (hereinafter referred to as "Method M144") is described below.

[0179] FIGS. **27** and **28** are exemplary embodiments of Method M144. Specifically, FIG. **27** is a diagram showing an exemplary embodiment of a CSI-RS configuration for 16 CSI-RS antenna ports according to Method M144, and FIG. **28** is a diagram showing an exemplary embodiment of a CSI-RS configuration for 32 CSI-RS antenna ports according to Method M144.

[0180] FIG. **27** illustrates an example in which a CSI-RS pattern according to Method M143 has been applied to a CSI-RS configuration No. **0** and a CSI-RS pattern according to Method M141 has been applied to a CSI-RS configuration No. 1.

[0181] FIG. **28** illustrates an example in which a CSI-RS pattern in which all of TDM, FDM, and CDM have been combined has been applied to a CSI-RS configuration No. **0**. For example, CDM is applied between CSI-RS antenna port Nos. 15, 16 and 19, 20, TDM is applied between CSI-RS antenna port Nos. 15, 16 and 19, 20 and CSI-RS antenna port Nos. 23, 24 and 27, 28, and FDM is applied between CSI-RS antenna port Nos. 31, 32 and 35, 36 and CSI-RS antenna port Nos. 23, 24 and 27, 28.

[0182] In the exemplary embodiment illustrated in FIGS. **27** and **28**, OCC applied to each CSI-RS antenna port is listed in Table 5 below.

TABLE 5

Yet another exemplary embodiment of mapping between length-4 OCC and CSI-RS antenna port

OCC	CSI-RS antenna port
[1 1 1 1]	{15, 17, 23, 25, 31, 33, 39, 41}
[1 −1 1 −1]	{16, 18, 24, 26, 32, 34, 40, 42}
[1 1 −1 −1]	{19, 21, 27, 29, 35, 37, 43, 45}
[1 −1 −1 1]	{20, 22, 28, 30, 36, 38, 44, 46}

[0183] If some of CSI-RS resources configured by Method M140 and detailed methods Methods M141-M144 of Method M140 are to be shared by legacy terminals, CSI-RS reception performance of the legacy terminals may be influenced because the legacy terminals do not have the ability to differentiate the length-4 Walsh code. For example, it is assumed that a base station has configured the CSI-RS pattern illustrated in FIG. **23** in a new terminal according to Method M141 and configured 8 CSI-RS antenna ports and a CSI-RS configuration No. 1 in a legacy terminal. In this case, the legacy terminal expects that it will receive CSI-RS antenna port Nos. 15 and 16 in the RE (11, 2) and RE (11, 3) of a second time slot, but actually receives the CSI-RS antenna port Nos. 15 and 16 to which CSI-RS antenna port Nos. 15, 16 and 23, 24 have been added. As a result, the legacy terminal is unable to distinguish the CSI-RS antenna port Nos. 15 and 16 from the received 4 CSI-RS antenna ports. The legacy terminal receives a channel response added to the CSI-RS antenna port Nos. 15 and 23 instead of the channel response of the CSI-RS antenna port No. 15 corresponding to Walsh code[1 1], and receives a channel response added to the CSI-RS antenna port Nos. 16 and 24 instead of the channel response of the CSI-RS antenna port No. 16 corresponding to Walsh code[1 −1]. Likewise, as in the CSI-RS antenna port Nos. 19 and 20, the legacy terminal receives the channel response sum of the CSI-RS antenna port No. 19 and the CSI-RS antenna port No. 27 in the place of the CSI-RS antenna port No. 19, and receives the channel response sum of the CSI-RS antenna port No. 20 and the CSI-RS antenna No. 28 in the place of the CSI-RS antenna port No. 20. That is, the legacy terminal measures a valid channel response to which the two CSI-RS antenna port pairs have been added and reports the measurement to the base station. In this case, the base station is aware that CSI reported by the legacy terminal is about a valid channel response and thus may perform scheduling by taking into consideration the fact. As a result, in accordance with Method M140 or the detailed methods of Methods M140, although a nested structure is fully satisfied as in Method M110 and Method M130, the base station may transmit a CSI-RS using common resources for the new terminal and the legacy terminal.

[0184] A method of extending a CSI-RS pattern in a frequency axis using the length-8 Walsh code (hereinafter referred to as "Method 145") is described below.

[0185] FIG. **29** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M145. For example, CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for a CSI-RS configuration No. 0 are mapped to the RE (11, 2), RE (11, 3), RE (10, 2), RE (10, 3), RE (9, 2), RE (9, 3), RE (8, 2), and RE (8, 3) of a second time slot. That is, the CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for the CSI-RS configuration No. 0 share 8 REs, and CDM using length-8 OCC is applied to the CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for the CSI-RS configuration No. **0**.

[0186] In the exemplary embodiment illustrated in FIG. **29**, a maximum interval between REs to which the length-8 Walsh code is applied in a frequency axis is two OFDM symbols. In the case of an existing CSI-RS pattern for 8 CSI-RS antenna ports, 4 different CSI-RS antenna ports are multiplexed through FDM. In contrast, in the exemplary embodiment of FIG. **29**, 2 different CSI-RS antenna ports are multiplexed through FDM, and the remaining CSI-RS antenna ports are multiplexed through CDM. Accordingly, a maximum of 3 dB of CSI-RS power boost may be required.

[0187] A method of extending a CSI-RS pattern using the length-8 Walsh code in a time axis and frequency axis (hereinafter referred to as "Method M146") is described below.

[0188] FIG. **30** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M146.

[0189] Method M146 is a method of extending existing length-2 CDM in a time axis and frequency axis every two times and applying length-8 CDM to 8 REs. For example, CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for a CSI-RS configuration No. 0 are mapped to the RE (9, 5), RE (9, 6), RE (8, 5), and RE (8, 6) of a first time slot and the RE (9, 2), RE (9, 3), RE (8, 2), and RE (8, 3) of a second time slot. That is, the CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for the CSI-RS configuration No. 0 share 8 REs, and length-8 CDM is applied to the CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for the CSI-RS configuration No. 0.

[0190] In accordance with the exemplary embodiment illustrated in FIG. **30**, as in the exemplary embodiment illustrated in FIG. **29**, maximum CSI-RS power boost is reduced from existing 6 dB to 3 dB.

[0191] In the exemplary embodiments of FIGS. **29** and **30**, OCC applied to each CSI-RS antenna port complies with Table 6 below.

TABLE 6

Exemplary embodiment of mapping between length-8 OCC and CSI-RS antenna ports

OCC	CSI-RS antenna port
[1 1 1 1 1 1 1 1]	{15, 17}
[1 −1 1 −1 1 −1 1 −1]	{16, 18}
[1 1 −1 −1 1 1 −1 −1]	{19, 21}
[1 −1 −1 1 1 −1 −1 1]	{20, 22}
[1 1 1 1 −1 −1 −1 −1]	{23, 25}
[1 −1 1 −1 −1 1 −1 1]	{24, 26}
[1 1 −1 −1 −1 −1 1 1]	{27, 29}
[1 −1 −1 1 −1 1 1 −1]	{28, 30}

[0192] A method of extending a CSI-RS pattern using TDM or FDM and replacing existing FDM with CDM using the length-8 Walsh code (hereinafter referred to as "Method M147") is described below.

[0193] Method M147 is a method of extending a CSI-RS pattern in a frequency axis or time axis according to Method M110 or Method M120, and also applying length-8 CDM in the time axis and frequency axis according to Method M145. FIGS. **31** and **32** are exemplary embodiments of Method M147.

[0194] FIG. **31** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M147. For example, CSI-RS antenna port Nos. 15-22 of 16 CSI-RS antenna ports for a CSI-RS configuration No. 0 are mapped to the RE (9, 5), RE (9, 6), RE (8, 5), RE (8, 6), RE (3, 5), RE (3, 6), RE (2, 5), and RE (2, 6) of a first time slot. That is, the CSI-RS antenna port Nos. 15-22 for the CSI-RS configuration No. 0 share 8 REs, and length-8 CDM is applied to the CSI-RS antenna port Nos. 15-22 for the CSI-RS configuration No. **0**.

[0195] FIG. **32** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M147. For example, CSI-RS antenna port Nos. 15-22 of 32 CSI-RS antenna ports for a CSI-RS configuration No. 0 are mapped to the RE (9, 5), RE (9, 6), RE (8, 5), RE (8, 6), RE (3, 5), RE (3, 6), RE (2, 5), and RE (2, 6) of a first time slot. That is, the CSI-RS antenna port Nos. 15-22 for the CSI-RS configuration No. 0 share 8 REs, and length-8 CDM is applied to the CSI-RS antenna port Nos. 15-22 for the CSI-RS configuration No. **0**.

[0196] In the exemplary embodiments of FIGS. **31** and **32**, OCC applied to each CSI-RS antenna port may comply with Table 7 below.

TABLE 7

Another exemplary embodiment of mapping between length-8 OCC and CSI-RS antenna ports

OCC	CSI-RS antenna port
[1 1 1 1 1 1 1 1]	{15, 23, 31, 39}
[1 −1 1 −1 1 −1 1 −1]	{16, 24, 32, 40}

TABLE 7-continued

Another exemplary embodiment of mapping between length-8 OCC and CSI-RS antenna ports

OCC	CSI-RS antenna port
[1 1 −1 −1 1 1 −1 −1]	{19, 27, 35, 43}
[1 −1 −1 1 1 −1 −1 1]	{20, 28, 36, 44}
[1 1 1 1 −1 −1 −1 −1]	{17, 25, 33, 41}
[1 −1 1 −1 −1 1 −1 1]	{18, 26, 34, 42}
[1 1 −1 −1 −1 −1 1 1]	{21, 29, 37, 45}
[1 −1 −1 1 −1 1 1 −1]	{22, 30, 38, 46}

[0197] A method in which a CSI-RS pattern according to Method M145 and a CSI-RS pattern according to Method M147 coexist in a single subframe (hereinafter referred to as "Method M148") is described below.

[0198] FIGS. **33** and **34** are exemplary embodiments of Method M148.

[0199] FIG. **33** is a diagram showing an embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M148. Specifically, FIG. **33** shows an example in which a CSI-RS pattern according to Method M145 has been applied to a CSI-RS configuration No. 0 and a CSI-RS pattern according to Method M147 has been applied to a CSI-RS configuration No. 1. For example, CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 of 16 CSI-RS antenna ports for a CSI-RS configuration No. 0 are mapped to the RE (9, 5), RE (9, 6), RE (8, 5), and RE (8, 6) of a first time slot and the RE (9, 2), RE (9, 3), RE (8, 2), and RE (8, 3) of a second time slot. That is, the CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for the CSI-RS configuration No. 0 share 8 REs, and length-8 CDM is applied to the CSI-RS antenna port Nos. 15, 16, 19, 20, 23, 24, 27, and 28 for the CSI-RS configuration No. **0**. For another example, CSI-RS antenna port Nos. 15-22 of 16 CSI-RS antenna ports for a CSI-RS configuration No. 1 are mapped to the RE (11, 2), RE (11, 3), RE (10, 2), RE (10, 3), RE (5, 2), RE (5, 3), RE (4, 2), and RE (4, 3) of the second time slot. That is, the CSI-RS antenna port Nos. 15-22 for the CSI-RS configuration No. 1 share 8 REs, and length-8 CDM is applied to the CSI-RS antenna port Nos. 15-22 for the CSI-RS configuration No. 1.

[0200] FIG. **34** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M148. Specifically, in the exemplary embodiment of FIG. **34**, both the principles of Method M145 and Method M147 are applied to a CSI-RS pattern for a CSI-RS configuration No. 0.

[0201] In the exemplary embodiments of FIGS. **33** and **34**, OCC applied to each CSI-RS antenna port may comply with Table 7 above.

[0202] The exemplary embodiments of FIGS. **22** to **34** are some examples to which the principles of Method M140 and the detailed methods Methods M141-M148 of Method M140 have been applied. Method M140 and the detailed methods Methods M141-M148 of Method M140 may be implemented in various forms in addition to the exemplary embodiments.

[0203] In an FD-MIMO system, in order to support the transmission of a very large number of CSI-RS antenna ports or to avoid inter-cell CSI-RS interference, a method Method M200 of extending a CSI-RS resource pool within a single PRB pair may be required. A method of extending a CSI-RS resource pool and a method of configuring CSI-RS resources corresponding to the method are described below.

[0204] A method of adding REs, corresponding to the OFDM symbol Nos. 2 and 3 of a first time slot, to a CSI-RS resource pool (hereinafter referred to as "Method M210") is described below.

[0205] FIG. **35** is a diagram showing an extended CSI-RS resource pool according to Method M210.

[0206] Since a total number of REs corresponding to the OFDM symbol Nos. 2 and 3 of a first time slot is 24, a CSI-RS resource pool includes a total of 64 (=40+24) REs as illustrated in FIG. **35** in accordance with Method M210. Accordingly, more various CSI-RS and zero-power (ZP) CSI-RS resource configurations are possible within a single subframe whose resource region has been further widened, and a CSI-RS configuration for 64 CSI-RS antenna ports is possible within a single subframe. The method of configuring CSI-RS resources according to Method M210 may use the principles of the detailed methods Method M110, Method M111, Method M120, Method M121, Method M130, and Methods M140-M148 of Method M100 in the same or similar manner.

[0207] If a CSI-RS resource pool is extended according to Method M210, a legacy terminal is unable to recognize a newly added resource pool (i.e., REs corresponding to the OFDM symbol Nos. 2 and 3 of a first time slot) as CSI-RS resources. Accordingly, if a CSI-RS is transmitted in the newly added resource pool, the legacy terminal is unable to perform PDSCH rate matching on the corresponding resources. In this case, a method of bearing some degree of performance degradation in a legacy terminal or a method of scheduling the transmission of a downlink PDSCH to a legacy terminal only in a subframe in which a CSI-RS is not transmitted in a newly added resource pool may be taken into consideration.

[0208] A method of extending a CSI-RS pattern using FDM in a CSI-RS resource pool extended according to Method M210 (hereinafter referred to as "Method M211") is described below.

[0209] FIGS. **36**A and **36**B are exemplary embodiments of Method M211. Specifically, FIG. **36**A is a diagram showing an exemplary embodiment of a CSI-RS configuration for 12 or 16 CSI-RS antenna ports according to Method M211, and **36**B is a diagram showing an exemplary embodiment of a CSI-RS configuration for 20 or 24 CSI-RS antenna ports according to Method M211.

[0210] In the exemplary embodiments of FIGS. **36**A and **36**B, CSI-RS patterns defined in the OFDM symbol Nos. 2 and 3 of the second time slot in the exemplary embodiments of FIGS. **5**A and **5**B are likewise applied to the OFDM symbol Nos. 2 and 3 of a first time slot. For example, in an exemplary embodiment on the right side of FIG. **36**A, CSI-RS antenna port Nos. 15-30 for a CSI-RS configuration No. 0 have been defined in the OFDM symbol Nos. 2 and 3 of a second time slot. CSI-RS antenna port Nos. 15-30 for a CSI-RS configuration No. 1 have been defined in the OFDM symbol Nos. 2 and 3 of a first time slot in the same pattern as that of the CSI-RS configuration No. 0.

[0211] Accordingly, in the exemplary embodiments of FIGS. **36**A and **36**B, CSI-RS RE sets that are two times those in the exemplary embodiments of FIGS. **5**A and **5**B may be configured in a single subframe. The CSI-RS pattern illustrated in FIG. **5** has been applied to the exemplary embodiments of FIGS. **36**A and **36**B, but this is only an example. In the CSI-RS resource configuration according to Method M211, other CSI-RS patterns to which the principle of Method M110 has been applied may be used.

[0212] A method of extending a CSI-RS pattern using TDM in a CSI-RS resource pool extended according to Method M210 (hereinafter referred to as "Method M212") is described below.

[0213] FIGS. **37** and **38** are exemplary embodiments of Method M210. Specifically, FIGS. **37** and **38** are diagrams showing exemplary embodiments of a CSI-RS configuration for 16 CSI-RS antenna ports according to Method M212.

[0214] In Method M212, as in Method M211, CSI-RS RE sets that are twice that in the case where an existing CSI-RS resource pool is used may be configured in a single subframe.

[0215] In the exemplary embodiment illustrated in FIG. **37**, 4 CSI-RS configuration Nos. 0-3 have the same RE set.

[0216] In the exemplary embodiment illustrated in FIG. **38**, an RE set applied to the CSI-RS configuration Nos. 0 and 1 and the CSI-RS configuration Nos. 2 and 3 are different.

[0217] Furthermore, the exemplary embodiments illustrated in FIGS. **37** and **38** partially include an existing CSI-RS pattern for 1, 2, 4, or 8 CSI-RS antenna ports with respect to the same CSI-RS configuration index.

[0218] A method of extending a CSI-RS pattern using both FDM and TDM in a CSI-RS resource pool extended according to Method M210 (hereinafter referred to as "Method M213") is described below.

[0219] FIGS. **39** to **42** are exemplary embodiments of Method M213. FIGS. **39** and **40** are diagrams showing exemplary embodiments of a CSI-RS configuration for 32 CSI-RS antenna ports according to Method M213. FIGS. **41** and **42** are diagrams showing exemplary embodiments of a CSI-RS configuration for 64 CSI-RS antenna ports according to Method M213.

[0220] Specifically, a CSI-RS pattern illustrated in FIG. **39** satisfies a nested structure with the CSI-RS pattern illustrated in FIG. **37**. For example, a CSI-RS pattern (CSI-RS antenna port Nos. 15-46) for a CSI-RS configuration No. 0 illustrated in FIG. **39** partially includes the CSI-RS pattern (CSI-RS antenna port Nos. 15-30) for the CSI-RS configuration No. 0 illustrated in FIG. **37**.

[0221] A CSI-RS pattern illustrated in FIG. **40** satisfies a nested structure with the CSI-RS pattern illustrated in FIG. **38**. For example, a CSI-RS pattern (CSI-RS antenna port Nos. 15-46) for a CSI-RS configuration No. 0 illustrated in FIG. **40** partially includes the CSI-RS pattern (CSI-RS antenna port Nos. 15-30) for the CSI-RS configuration No. 0 illustrated in FIG. **38**.

[0222] A CSI-RS pattern illustrated in FIG. **41** satisfies a nested structure with the CSI-RS pattern illustrated in FIG. **39**. For example, a CSI-RS pattern (CSI-RS antenna port Nos. 15-78) for a CSI-RS configuration No. 0 illustrated in FIG. **41** partially includes the CSI-RS pattern (CSI-RS antenna port Nos. 15-46) for the CSI-RS configuration No. 0 illustrated in FIG. **39**.

[0223] A CSI-RS pattern illustrated in FIG. **42** satisfies a nested structure with the CSI-RS pattern illustrated in FIG. **40**. For example, a CSI-RS pattern (CSI-RS antenna port Nos. 15-78) for a CSI-RS configuration No. 0 illustrated in FIG. **42** partially includes the CSI-RS pattern (CSI-RS antenna port Nos. 15-46) for the CSI-RS configuration No. 0 illustrated in FIG. **40**.

[0224] If the number of CSI-RS antenna ports is 32 or 64, the extension of a CSI-RS pattern using TDM may further worsen a problem in which CSI-RS transmission power is reduced. In particular, if one-to-one mapping is used as an antenna port virtualization method, a method of satisfying

full-power utilization may not be present in the exemplary embodiments of FIGS. **41** and **42**. Furthermore, there may be a problem in that cell coverage is reduced because DMRS and PDSCH transmission power versus CSI-RS transmission power is too low.

[0225] If the CSI-RS configuration of Table 1 is extended up to 16, 32, or 64 CSI-RS antenna ports according to Method M212 and Method M213, extended parts are as listed in Table 8 below.

TABLE 8

Exemplary embodiment of CSI-RS configuration extended according to Method M212 and Method M213

	CSI-RS	16		32		64	
	configuration	(k',l')	n_s mod 2	(k',l')	n_s mod 2	(k',l')	n_s mod 2
Frame structure types 1 and 2	0	9 and 5	0	9 and 5	0	9 and 5	0
	1	11,2	1	11,2	1		
	2	9 and 2	1				
	3	7 and 2	1				

[0226] Method M210 may also be used to extend an RE set for 1, 2, 4, or 8 CSI-RS antenna ports in addition to a resource configuration for 12, 16, 20, 24, 32, or 64 CSI-RS antenna ports. That is, a method of configuring resources for 1, 2, 4, or 8 CSI-RS antenna ports using REs corresponding to the OFDM symbol Nos. 2 and 3 of a first time slot may be taken into consideration. FIGS. **43** to **45** are exemplary embodiments of such a method.

[0227] FIG. **43** is a diagram showing an embodiment of a resource configuration for 2 CSI-RS antenna ports according to Method M210. Specifically, FIG. **43** shows an example in which the CSI-RS pattern (CSI-RS antenna port Nos. 15 and 16) for the CSI-RS configuration Nos. 0-19 illustrated in FIG. **1** has been identically defined and a CSI-RS pattern (CSI-RS antenna port Nos. 15 and 16) for CSI-RS configuration Nos. 20-31 have been additionally defined in the OFDM symbol Nos. 2 and 3 of a first time slot.

[0228] FIG. **44** is a diagram showing an embodiment of a resource configuration for 4 CSI-RS antenna ports according to Method M210. Specifically, FIG. **44** shows an example in which the CSI-RS pattern (CSI-RS antenna port Nos. 15-18) for the CSI-RS configuration Nos. 0-9 illustrated in FIG. **2** has been identically defined and a CSI-RS pattern (CSI-RS antenna port Nos. 15-18) for CSI-RS configuration Nos. 10-15 has been additionally defined in the OFDM symbol Nos. 2 and 3 of a first time slot.

[0229] FIG. **45** is a diagram showing an embodiment of a resource configuration for 8 CSI-RS antenna ports according to Method M210. Specifically, FIG. **45** shows an example in which the CSI-RS pattern (the CSI-RS antenna port Nos. 15-22) for the CSI-RS configuration Nos. 0-4 illustrated in FIG. **3** has been identically defined and a CSI-RS pattern (CSI-RS antenna port Nos. 15-22) for CSI-RS configuration Nos. 5-7 has been additionally defined in the OFDM symbol Nos. 2 and 3 of a first time slot.

[0230] The exemplary embodiments illustrated in FIGS. **43** to **45** have a characteristic in that a nested structure is established between 1, 2, 4, or 8 CSI-RS antenna ports newly defined in the OFDM symbol Nos. 2 and 3 of the first time slot. RE mapping for a single CSI-RS antenna port is the same as that for two CSI-RS antenna ports. In this case, in RE mapping for a single CSI-RS antenna port, the CSI-RS antenna port Nos. 15 and 16 do not coexist, but only the CSI-RS antenna port No. 15 is present.

[0231] Furthermore, the 1, 2, 4, or 8 CSI-RS antenna ports illustrated in FIGS. **43** to **45** have a characteristic in that a nested structure is also established with the 16, 32, or 64 CSI-RS antenna ports illustrated in FIGS. **37** to **42**. Nos. 20-31, that is, the CSI-RS configuration indices of an RE set newly added in FIG. **43**, are numbers used for convenience sake and are different from 20-31, that is, CSI-RS configuration indices dedicated to TDD of Table 1.

[0232] A method of extending a CSI-RS pattern using CDM in a CSI-RS resource pool extended according to Method M210 (hereinafter referred to as "Method M214") is described below.

[0233] The various principles of Method M141 to Method M148 may be applied to Method M214 identically or similarly. Some representative exemplary embodiments of various exemplary embodiments of Method M214 are described below.

[0234] FIGS. **46** and **47** are exemplary embodiments of Method M214. FIGS. **46** and **47** are diagrams showing exemplary embodiments of a CSI-RS configuration for 16 CSI-RS antenna ports according to Method M214. Specifically, a method of extending a CSI-RS pattern in a frequency axis using the length-4 Walsh code is applied to the exemplary embodiments of FIGS. **46** and **47**. In the exemplary embodiments of FIGS. **46** and **47**, the method of extending a CSI-RS pattern uses the same principle as Method M141. In the exemplary embodiments of FIGS. **46** and **47**, OCC applied to each CSI-RS antenna port may comply with Table 4.

[0235] FIGS. **48** and **49** are diagrams showing another exemplary embodiments of a CSI-RS configuration for 16 CSI-RS antenna ports according to Method M214. Specifically, a method of extending a CSI-RS pattern in a time axis using the length-4 Walsh code is applied to the exemplary embodiments of FIGS. **48** and **49**. In the exemplary embodiments of FIGS. **48** and **49**, the method of extending a CSI-RS pattern uses the same principle as Method M142. Likewise, in the exemplary embodiments of FIGS. **48** and **49**, OCC applied to each CSI-RS antenna port may comply with Table 3.

[0236] FIG. **50** is a diagram showing yet another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M214. Specifically, a method of extending a CSI-RS pattern in a time axis using TDM and replacing some of existing FDM with CDM using the length-4 Walsh code is applied to FIG. **50**. That is, in the exemplary embodiment of FIG. **50**, the method of extending a CSI-RS uses the same principle as Method M143. In the exemplary embodiment of FIG. **50**, likewise, OCC applied to each CSI-RS antenna port may comply with Table 4.

[0237] FIG. **51** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports according to Method M214. Specifically, a method in which an extended pattern based on CDM and an extended pattern based on both CDM and TDM in a frequency axis coexist in a single subframe is applied to FIG. **51**. That is, in the exemplary embodiment of FIG. **51**, the method of extending a CSI-RS uses the same principle as Method M144. For example, CDM and TDM are applied to a CSI-RS pattern (CSI-RS antenna port Nos. 15-46) for a CSI-RS configuration No. 0, and CDM is applied to a CSI-RS pattern (CSI-RS antenna port Nos. 15-46) for a CSI-RS configuration No. 1. A

method of adding the REs of the OFDM symbol Nos. 1 and 2 of a first time slot to a CSI-RS resource pool (hereinafter referred to as "Method M220") is described below.

[0238] FIG. **52** is a diagram showing a CSI-RS resource pool extended by Method M220.

[0239] If 1 or 2 CRS antenna ports transmitted by a base station are configured, a method of adding 24 REs corresponding to the OFDM symbol Nos. 1 and 2 of a first time slot to a CSI-RS resource pool (Method M220) as illustrated in FIG. **52** may be taken into consideration.

[0240] The principles of Method M210 or the detailed methods Method M211 to Method M214 of Method M210 may be applied to a detailed method for a CSI-RS resource configuration using a resource pool newly added by Method M220 (i.e., the 24 REs corresponding to the OFDM symbol Nos. 1 and 2 of the first time slot). That is, in Method M210 or the detailed methods Method M211 to Method M214 of Method M210, the principle applied to the OFDM symbol Nos. 2 and 3 of the first time slot may be identically applied to the OFDM symbol Nos. 1 and 2 of the first time slot.

[0241] A method of supporting all of CSI-RS resource configuration methods to which length-2 CDM is applied (hereinafter referred to as a "length-2 CDM resource configuration method") and CSI-RS resource configuration methods to which length-4 or length-8 CDM (hereinafter referred to as a "length-4 CDM resource configuration method") is applied, from among the methods described so far, and configuring one of a length-2 CDM resource configuration method and a length-4 CDM resource configuration method in a terminal through high layer signaling may be taken into consideration.

[0242] In accordance with a current standard, a physical downlink control channel (PDCCH) region may be configured in the OFDM symbol Nos. 0 to 2 of a first time slot in a system whose bandwidth exceeds 10 resource blocks (RB) and may be configured in the OFDM symbol Nos. 0 to 3 of a first time slot in a system whose bandwidth is 10 RBs or less. Accordingly, if Method M210 or Method M220 is used, a CSI-RS resource configuration (or a ZP CSI-RS resource configuration) and a PDCCH region should not be overlapped. This may be solved by setting the value of a control format indicator (CFI) to 1 or 2 in a subframe in which a base station transmits a CSI-RS or ZP CSI-RS according to Method M210 or Method M220 and transmitting the CFI value through a physical control format indicator channel (PCFICH). If a base station has sent an erroneous CFI value or a terminal has received an erroneous CFI value due to a PCFICH decoding error, there is still a possibility that a terminal for which a CSI-RS has been configured in the OFDM symbol No. 1 or 2 of a first time slot may recognize that a PDCCH region and CSI-RS resources are overlapped in the corresponding subframe.

[0243] In this case, a method in which the terminal considers that the reception of the PCFICH is erroneous, does not perform PDCCH decoding in the corresponding subframe, and normally performs CSI-RS-based CSI measurement, may be taken into consideration. That is, for example, if Method M210 is used, the terminal may not expect that a CFI value is 3 or more if a system bandwidth exceeds 10 RBs and a CFI value is 2 or more if a system bandwidth is 10 RBs or less in a subframe in which a ZP CSI-RS or non-ZP (NZP) CSI-RS has been configured in the OFDM symbol Nos. 2 and 3 of the first time slot. Alternatively, since there is a high probability that an actual CFI value is 1 or 2, the terminal may normally perform CSI-RS-based CSI measurement, may assume that a CFI value is 1 or 2, and may attempt PDCCH decoding. In this case, a corresponding operation may be defined in a standard with respect to the PDCCH decoding of the terminal, or the terminal may perform blind decoding as a terminal implementation issue.

[0244] In order to be aware of PDSCH RE mapping information or perform PDSCH rate matching in receiving a PDSCH, a terminal needs to be aware of the location of an OFDM symbol (hereinafter referred to as a "PDSCH starting symbol") at which PDSCH transmission is started. In accordance with a current LTE standard, a PDSCH starting symbol may be defined by a serving cell in which a PDSCH has been scheduled and the CFI value of a subframe or may be indicated by RRC signaling. Specifically, cases indicated by RRC signaling are as follows. If a terminal has been configured to monitor an enhanced PDCCH (EPDCCH) in a subframe in which a PDSCH is received, a PDSCH starting symbol is indicated by "epdcch-StartSymbol-r11" if a PDSCH is based on an EPDCCH in the same serving cell or if the PDSCH is based on a semi-persistent scheduling (SPS) PDSCH. Alternatively, if a PDSCH is subject to cross-carrier scheduling by another serving cell, a PDSCH starting symbol is determined (or indicated) by "pdsch-Start-r10."

[0245] Furthermore, if a PDSCH is indicated by downlink control information (DCI) format 2D (if transmission mode is 10), a PDSCH starting symbol is indicated by "pdsch-Start-r11" defined in a parameter set indicated by a "PDSCH RE Mapping and Quasi-Co-Location."

[0246] In general, the listed RRC parameters (e.g., epdcch-StartSymbol-r11, pdsch-Start-r10, and pdsch-Start-r11) need to be set based on a maximum value of a CFI to be transmitted by a base station. For example, a case where a base station sets a CFI value for a subframe configured so that a CSI-RS is transmitted in a resource pool (24 REs corresponding to the OFDM symbol Nos. 2 and 3 of a first time slot) extended by Method M210 to 2 and sets a CFI value for a subframe configured so that a CSI-RS is not transmitted in a resource pool extended by Method M210 to 3 is assumed. In this case, if a terminal is able to perform PDSCH rate matching while avoiding collision with a PDCCH region in all subframes, the value of an RRC parameter (e.g., epdcch-StartSymbol-r11, pdsch-Start-r10, or pdsch-Start-r11) needs to be set to 3 or more. For example, if the value of an RRC parameter (e.g., epdcch-StartSymbol-r11, pdsch-Start-r10, or pdsch-Start-r11) is 3, a PDSCH starting symbol is configured in a terminal as the OFDM symbol No. 3 of a first time slot. Accordingly, the terminal is unable to use the OFDM symbol No. 2 of the first time slot in PDSCH RE mapping in a subframe configured so that a CSI-RS is transmitted in a resource pool extended by Method M210. This reduces resource use efficiency.

[0247] There is a need for a method in a case where a PDSCH starting symbol is indicated by RRC signaling with respect to a new terminal to which Method M210 or Method M220 is applied when taking such a problem into consideration.

[0248] A method (hereinafter referred to as "Method M230") of determining a set of subframes configured so that a CSI-RS is transmitted in a resource pool extended by Method M210 or Method M220 (hereinafter referred to as a "first subframe") and a set of subframes not configured so that a CSI-RS is transmitted in a resource pool extended by Method M210 or Method M220 (hereinafter referred to as a "second subframe") and configuring a PDSCH starting sym-

bol in a terminal using a different RRC parameter for each of a set of first subframes (hereinafter referred to as a "first set") and a set of second subframes (hereinafter referred to as a "second set") is described below.

[0249] If a base station configures a PDSCH starting symbol in a terminal using different RRC parameters for a first set and a second set, the terminal may differentiate the first set and the second set using one of Method M231, Method M232, and Method M233.

[0250] Specifically, Method M231 is a method of notifying, by a base station, a terminal of subframes forming a first set and subframes forming a second set through signaling. Method M232 is a method of notifying, by a base station, a terminal of subframes forming at least one of a first set and a second set. In Method M232, a terminal considers that subframes signaled by a base station are included in one of a first set and a second set and subframes not signaled by the base station are included in the other of the first set and the second set.

[0251] In accordance with Method M231 and Method M232, signaling overhead is increased, but two different RRC parameters may also be used for other purposes in addition to the aforementioned use.

[0252] In accordance with Method M230, a base station transmits an RRC parameter for configuring the PDSCH starting symbol of a first set and an RRC parameter for configuring the PDSCH starting symbol of a second set to a terminal. In accordance with Method M230, a base station can configure a PDSCH starting symbol for a first set in a terminal using a separate RRC parameter for the first set. Accordingly, the base station can transmit a PDSCH from an OFDM symbol right next to a PDCCH region without wasting resources even in the first set. Method M230 may be independently applied to RRC parameters (e.g., epdcch-StartSymbol-r11, pdsch-Start-r10, and pdsch-Start-r11). A terminal performs PDSCH RE mapping on each of a first set and a second set based on an RRC parameter for the first set and an RRC parameter for the second set.

[0253] In relation to Method M230, as the method of determining, by a terminal, a first set and a second set, a terminal may use Method M233 in addition to the method according to additional RRC signaling. Specifically, Method M233 is a method of determining a first set and a second set based on a CSI-RS resource configuration configured in a terminal.

[0254] If Method M210 or Method M220 is used, there may be a problem in that PDCCH transmission resources are insufficient. In particular, such a phenomenon may become a greater problem in a system having a small bandwidth (e.g., a system having a bandwidth of 10 RBs or less).

[0255] A method of adding REs to a CSI-RS resource pool while maintaining the first three OFDM symbols (the OFDM symbol Nos. 0-2 of a first time slot) in order to secure a PDCCH region (hereinafter referred to as "Method M240") is described below.

[0256] FIG. **53** is a diagram showing a CSI-RS resource pool extended by Method M240.

[0257] In Method M240, a CSI-RS configuration for 1, 2, 4, 8, 12, 16, 20, 24, or 32 CSI-RS antenna ports may be defined using the principles of the methods described so far identically or similarly.

[0258] If a normal CP is set, the number of REs which may be additionally used to transmit a CSI-RS other than the first three OFDM symbols (the OFDM symbol Nos. 0-2 of the first time slot) is 20 as illustrated in FIG. **53**. In accordance with Method M240, although all of the newly added 20 REs are used, it is impossible to configure resources for 64 CSI-RS antenna ports within a single subframe.

[0259] REs added to a CSI-RS resource pool according to Method M210, Method M220, or Method M240 need to be used for a ZP CSI-RS resource configuration in addition to an NZP CSI-RS resource configuration. There is a need for a method of configuring, by a base station, a resource pool, added according to Method M210, Method M220, or Method M240, in a terminal as a ZP CSI-RS resource. As one of such methods, a method of increasing the bitmap length of a ZP CSI-RS resource configuration list now set to 16 bits (i.e., the length of a bitmap for ZP CSI-RS predetermined signaling) may be taken into consideration. For example, a method of increasing the bitmap length of a ZP CSI-RS resource configuration list to 19 bits may be taken into consideration. More specifically, for the bitmap of the ZP CSI-RS resource configuration list, a new parameter of 19 bits may be defined, and a new parameter for 3 bits may be additionally defined while maintaining a current parameter of 16 bits.

[0260] In all the methods described so far, CDM is basically applied to a CSI-RS pattern except that the number of CSI-RS antenna ports is 1. Accordingly, a single CSI-RS antenna port is transmitted through 2 REs, 4 REs, or 8 REs. If length-2 CDM is used and the number of CSI-RS antenna ports is 2 or more, one RE is used in each CSI-RS antenna port on average because two CSI-RS antenna ports share two REs. If the number of CSI-RS antenna ports is 1, however, resource use efficiency may be degraded.

[0261] A method of transmitting one CSI-RS antenna port through only one RE without using CDM may be taken into consideration.

[0262] As a method of multiplexing CSI-RS antenna ports, a method of allowing a single CSI-RS antenna port to occupy a single RE except CDM (hereinafter referred to as "Method M300") is described below.

[0263] In accordance with Method M300, if the number of CSI-RS antenna ports is 1, unnecessary CSI-RS transmission overhead is not generated. Specifically, Method M300 may be divided into Method M310 and Method M320 depending on the range of an RE which may be used for a single CSI-RS pattern, that is, a single CSI-RS RE set.

[0264] A method of using all REs within a CSI-RS resource pool for a single CSI-RS resource configuration (hereinafter referred to as "Method M310") is described below.

[0265] FIG. **54** is one of exemplary embodiments of Method M310. FIG. **54** is a diagram showing an embodiment of a resource configuration for 8 CSI-RS antenna ports according to Method M310. For example, a CSI-RS antenna port No. 15 is mapped to the RE (10, 2) of a second time slot, and a CSI-RS antenna port No. 16 is mapped to the RE (8, 3) of the second time slot. That is, one CSI-RS antenna port is transmitted through only one RE.

[0266] In accordance with Method M310, CSI-RS resources may be configured using a specific RE set in the entire region of an existing CSI-RS resource pool (40 REs) or in the entire region of a CSI-RS resource pool extended by Method M210, Method M220, or Method M240.

[0267] A method of dividing a CSI-RS resource pool into a plurality of sections and using the REs of one of the plurality of sections for a single CSI-RS resource configuration (hereinafter referred to as "Method M320") is described below. For example, it is assumed that a CSI-RS resource pool is divided into 5 sections and a CSI-RS pattern for four CSI-RS antenna

ports is configured. A base station may select one of the 5 sections and configure CSI-RS antenna port Nos. 15-18 in the four of a plurality of REs included in the selected section. In accordance with Method M320, as in Method M310, one CSI-RS antenna port is transmitted through only one RE.

[0268] In Method M310 or Method M320, the existing CSI-RS resource pool (40 REs), a CSI-RS resource pool extended by Method M210, a CSI-RS resource pool extended by Method M220, a CSI-RS resource pool extended by Method M240, a CSI-RS resource pool extended using a plurality of subframes, a CSI-RS resource pool extended using a plurality of PRB pairs adjacent in a frequency axis, or a specific CSI-RS resource pool may be used.

[0269] Method M300 or the detailed methods Method M310 and Method M320 of Method M300 may use full transmission power in transmitting each CSI-RS antenna port using a specific antenna virtualization method. Specifically, such an antenna port virtualization method may use a method implemented by linearly combining CSI-RS antenna ports in each of which weight values having constant modulus amplitude have been applied to all TXUs.

[0270] A terminal may need to recognize CSI-RS antenna ports, configured through the aforementioned methods, as a two-dimensional array. For example, if 16 CSI-RS antenna ports (e.g., CSI-RS antenna port Nos. 15-30) have been configured in a terminal, an antenna port array may be a one-dimensional array having a length of 16 only in a horizontal axis or may be a two-dimensional rectangular array having a length of 2 in a vertical axis and having a length of 8 in a horizontal axis. Accordingly, a method of signaling, by a base station, information about the two-dimensional array of CSI-RS antenna ports to a terminal may be taken into consideration.

[0271] A method (hereinafter referred to as "Method M400") of notifying, by a base station, a terminal of the number of CSI-RS antenna ports in a horizontal axis (hereinafter referred to as "NH") and the number of CSI-RS antenna ports in a vertical axis (hereinafter referred to as "NV") is described below.

[0272] In Method M400, if a terminal is already aware of a total number of CSI-RS antenna ports configured in the terminal, a base station may notify the terminal of only NH or NV.

[0273] The array structure of CSI-RS antenna ports assumed by a terminal through the signaling of Method M400 includes a structure according to Method M410 and a structure according to Method M420.

[0274] Method M410 is a method of assuming, by a terminal, CSI-RS antenna ports to be a two-dimensional rectangular array, that is, NV×NH. FIG. **55** is an exemplary embodiment of Method M410.

[0275] FIG. **55** is a diagram showing an exemplary embodiment of a two-dimensional rectangular array configuration for 16 CSI-RS antenna ports. Specifically, FIG. **55** illustrates an example in which 16 CSI-RS antenna ports (e.g., CSI-RS antenna port Nos. 15-30) are configured in a terminal, NV=2, and NH=8. A method of mapping CSI-RS antenna port numbers on a two-dimensional array is as follows. A method of previously defining the mapping rule of CSI-RS antenna port numbers according to a rule, first mapping CSI-RS antenna port numbers in a horizontal axis, and then mapping CSI-RS antenna port numbers in a vertical axis as illustrated in FIG. **55** may be taken into consideration. Alternatively, a method of mapping CSI-RS antenna port numbers in order opposite order of the above method may be taken into consideration.

[0276] In Method M410, a base station may set NV and NH so that the product of NV and NH becomes a total number of CSI-RS antenna ports configured in a terminal.

[0277] Method M420 is a method of assuming, by a terminal, CSI-RS antenna ports to be a cross array whose length in a vertical axis is NV and whose length in a horizontal axis is NH. FIG. **56** is an exemplary embodiment of Method M420.

[0278] FIG. **56** is a diagram showing an exemplary embodiment of a two-dimensional cross array configuration for 16 CSI-RS antenna ports. Specifically, FIG. **56** shows an example in which 16 CSI-RS antenna ports (e.g., CSI-RS antenna port Nos. 15-30) are configured in a terminal, NV=8, and NH=8.

[0279] In Method M420, a base station may configure NV and NH so that the sum of NV and NH becomes a total number of CSI-RS antenna ports configured in a terminal.

[0280] In Method M420, the location where a CSI-RS antenna port in a vertical axis overlaps with a CSI-RS antenna port in a horizontal axis or corresponding antenna port numbers (i.e., the CSI-RS antenna port Nos. 15 and 23 in FIG. **56**) may be fixed, or a base station may variably set the place in a terminal.

[0281] 2.2. CSI-RS Configuration Applicable to Only TDD if a Normal CP is Set

[0282] Likewise, a method of using a CSI-RS resource pool (i.e., 24 REs) defined in an existing standard without a change (hereinafter referred to as "Method M510") and a method of extending a CSI-RS resource pool (hereinafter referred to as "Method M520") may be taken into consideration. In this specification, "Port #5 DMRS" indicated in the drawings denotes the DMRS of an antenna port No. 5.

[0283] FIGS. **57A**, **57B**, and **58** are exemplary embodiments of Method M510. In the exemplary embodiments of FIGS. **57A**, **57B**, and **58**, a CSI-RS resource pool includes 24 REs corresponding to the OFDM symbol Nos. 1 and 3 of a second time slot.

[0284] FIG. **57A** is a diagram showing an exemplary embodiment of a resource configuration for 12 or 16 CSI-RS antenna ports according to Method M510, and FIG. **57B** is a diagram showing an exemplary embodiment of a resource configuration for 20 or 24 CSI-RS antenna ports according to Method M510. For example, CSI-RS antenna port Nos. 15 and 16 for a CSI-RS configuration No. 20 are mapped to the RE (11, 1) and RE (11, 3) of a second time slot. Length-2 CDM is applied between the CSI-RS antenna port Nos. 15 and 16 for the CSI-RS configuration No. 20. CSI-RS antenna port Nos. 19 and 20 for the CSI-RS configuration No. 20 are mapped to the RE (10, 1) and RE (10, 3) of the second time slot. Length-2 CDM is applied between the CSI-RS antenna port Nos. 19 and 20 for the CSI-RS configuration No. 20. FDM is applied between the CSI-RS antenna port Nos. 15 and 16 for the CSI-RS configuration No. 20 and the CSI-RS antenna port Nos. 19 and 20 for the CSI-RS configuration No. 20.

[0285] FIG. **58** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports according to Method M510. For example, CSI-RS antenna port Nos. 23 and 24 for a CSI-RS configuration No. 20 are mapped to the RE (7, 1) and RE (7, 3) of a second time slot. Length-2 CDM is applied between the CSI-RS antenna port Nos. 23 and 24 for the CSI-RS configuration No. 20. CSI-RS antenna port Nos. 27 and 28 for the CSI-RS configuration No.

20 is mapped to the RE (6, 1) and RE (6, 3) of the second time slot. Length-2 CDM is applied between the CSI-RS antenna port Nos. 27 and 28 for the CSI-RS configuration No. 20. FDM is applied between the CSI-RS antenna port Nos. 23 and 24 for the CSI-RS configuration No. 20 and the CSI-RS antenna port Nos. 27 and 28 for the CSI-RS configuration No. 20.

[0286] Method M520 is described below.

[0287] If a normal CP is set, the DMRS of an antenna port No. 5 is not mapped to three REs in each of OFDM symbol (e.g., the OFDM symbol Nos. 3 and 6 of a first time slot and the OFDM symbol Nos. 2 and 5 of a second time slot) in which the DMRS of the antenna port No. 5 is transmitted. For example, the DMRS of the antenna port No. 5 is not mapped to the RE (11, 3), RE (7, 3), and RE (3, 3) of the first time slot. That is, the DMRS of the antenna port No. 5 is not mapped to the RE (11, 3), RE (7, 3), RE (3, 3), RE (9, 6), RE (5, 6), and RE (1, 6) of the first time slot and the RE (11, 2), RE (7, 2), RE (3, 2), RE (9, 5), RE (5, 5), and RE (1, 5) of the second time slot. A method of adding such 12 REs to a CSI-RS resource pool (hereinafter referred to as "Method M521") may be taken into consideration. FIG. **59** is an exemplary embodiment of Method M521.

[0288] FIG. **59** is a diagram showing a CSI-RS resource pool extended by Method M521. In accordance with Method M521, a total of 36 (=24+12) REs may be used for a CSI-RS configuration within a single PRB pair. A method of configuring CSI-RS resources according to Method M521 may use the principles of the aforementioned methods identically or similarly, and thus a detailed description thereof is omitted.

[0289] Method M522 and Method M523 may be taken into consideration as other detailed methods of Method M520.

[0290] Method M522 is a method of adding 12 REs, corresponding to the OFDM symbol No. 5 of a first time slot, and 12 REs, corresponding to the OFDM symbol No. 6 of a second time slot, to a CSI-RS resource pool. FIG. **60** is an exemplary embodiment of Method M522. FIG. **60** is a diagram showing a CSI-RS resource pool extended by Method M522.

[0291] Method M523 is a method of adding 24 REs, corresponding to the OFDM symbol Nos. 2 and 5 of a first time slot, to a CSI-RS resource pool. FIG. **61** is an exemplary embodiment of Method M523. FIG. **61** is a diagram showing a CSI-RS resource pool extended by Method M523.

[0292] In Method M522 and Method M523, a total of 48 (=24+24) CSI-RS antenna ports may be configured in a single subframe.

[0293] In Method M523, a CSI-RS resource pool includes the OFDM symbol No. 2 of a first time slot. Accordingly, Method M523 may use Method M230 identically or similarly in order to efficiently use PDSCH transmission resources while avoiding a collision against a PDCCH region. That is, a method of determining a set of subframes (hereinafter referred to as "third subframes") configured so that a CSI-RS is transmitted in a resource pool extended by Method M523 and a set of subframes (hereinafter referred to as "fourth subframes") configured so that a CSI-RS is not transmitted in a resource pool extended by Method M523 and configuring a PDSCH starting symbol in a terminal using two different RRC parameters for a set of third subframes and a set of the fourth subframes may be taken into consideration.

[0294] If a CSI-RS pattern is defined in a resource pool newly added by Method M522 and Method M523, to use length-2 CDM in a frequency axis within the same OFDM symbol instead of existing length-2 CDM in a time axis is more advantageous for channel estimation performance.

[0295] 2.3. CSI-RS Configuration Applicable to Both FDD and TDD if an Extended CP is Set

[0296] If an extended CP is set, a first time slot or a second time slot includes 6 OFDM symbols (Nos. 0 to 5) in a time axis and 12 subcarriers (Nos. 0 to 11) in a frequency axis. That is, if an extended CP is set, the first time slot or the second time slot includes 72=6×12 REs.

[0297] If an extended CP is set, an existing CSI-RS resource pool includes a total of 32 REs. Accordingly, if a CSI-RS resource pool is not extended, a CSI-RS configuration for a total of 32 CSI-RS antenna ports within a single subframe may be defined.

[0298] If an extended CP is set, a CSI-RS resource configuration method (hereinafter referred to as a "first extension CP resource configuration method") applicable to both FDD and TDD may use the principles of the methods of configuring CSI-RS resources for the aforementioned cases where a normal CP is set identically or similarly. Accordingly, a further detailed description thereof is omitted. FIGS. **62** to **66** are exemplary embodiments of the first extension CP resource configuration method.

[0299] FIG. **62** shows an embodiment of a method of extending a CSI-RS pattern in a frequency axis using FDM. Specifically, FIG. **62** is a diagram showing an exemplary embodiment of a CSI-RS configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0300] FIG. **63** shows an embodiment of a method of extending a CSI-RS pattern in a time axis using TDM. Specifically, FIG. **63** is a diagram showing another embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0301] FIG. **64** is a diagram showing an exemplary embodiment of a method of extending a CSI-RS pattern using both FDM and TDM. Specifically, FIG. **64** is a diagram showing an embodiment of a resource configuration for 32 CSI-RS antenna ports if an extended CP is set.

[0302] FIG. **65** is an exemplary embodiment of a method of using the length-4 Walsh code-based CDM and extending a CSI-RS pattern in a frequency axis. Specifically, FIG. **65** is a diagram showing another exemplary embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0303] FIG. **66** shows an exemplary embodiment of a method of using length-4 Walsh code-based CDM and extending a CSI-RS pattern in a time axis. Specifically, FIG. **66** is a diagram showing yet another exemplary embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0304] 2.4. CSI-RS Configuration Applicable to Only TDD if an Extended CP is Set

[0305] If an extended CP is set, a CSI-RS RE set for CSI-RS configuration Nos. 16-27 has been designed to avoid overlap with resources in which the DMRS of an antenna port No. 5 is transmitted as possible. In this case, a CSI-RS resource pool according to an existing standard includes 24 REs.

[0306] As in the aforementioned methods of configuring CSI-RS resources for a normal CP, if an extended CP is set, a method of using an existing CSI-RS resource pool without a change and a method of extending a CSI-RS resource pool may be taken into consideration as a CSI-RS resource configuration method applicable to only TDD (hereinafter referred to as a "second extension CP resource configuration method"). The second extension CP resource configuration method may use the aforementioned methods of configuring CSI-RS resources for a normal CP or the first extension CP

resource configuration method identically or similarly. Accordingly, a detailed description of the second extension CP resource configuration method is omitted. FIGS. **67** and **68** are exemplary embodiments of the second extension CP resource configuration method.

[0307] FIG. **67** shows an exemplary embodiment a method of extending a CSI-RS pattern using FDM using an existing CSI-RS resource pool without a change. Specifically, FIG. **67** is a diagram showing still another embodiment of a resource configuration for 16 CSI-RS antenna ports if an extended CP is set.

[0308] FIG. **68** is a diagram showing one of methods of extending a CSI-RS resource pool. Specifically, FIG. **68** is a diagram showing an extended CSI-RS resource pool if an extended CP is set. The exemplary embodiment of FIG. **68** shows a method of adding 12 REs, corresponding to the OFDM symbol No. 5 of a first time slot, and 12 REs, corresponding to the OFDM symbol No. 5 of a second time slot, to a CSI-RS resource pool. An existing CSI-RS resource pool includes 24 REs corresponding to the OFDM symbol Nos. 1 and 2 of a second time slot.

[0309] If a CSI-RS pattern is defined in the newly added resource pool illustrated in FIG. **68**, to use length-2 CDM in a frequency axis within the same OFDM symbol instead of existing length-2 CDM in a time axis is more advantageous for channel estimation performance.

[0310] 2.5. In the Case of TDD-Special Subframe

[0311] In a TDD cell, a single radio frame includes a downlink subframe, a special subframe, and an uplink frame. The special subframe is present between the downlink subframe and the uplink subframe, and includes a downlink pilot time slot (DwPTS), a guard period (GP), and an uplink pilot time slot (UpPTS). The DwPTS is used in cell search, synchronization, or channel estimation. The GP is an interval for removing interference generated in the uplink of a base station attributable to a difference in the multipath delay of terminals. In the UpPTS interval, a physical random access channel (PRACH) or a sounding reference signal (SRS) may be transmitted. In the DwPTS interval, a downlink PDSCH may also be transmitted. In accordance with a current LTE standard, 10 different special subframes may be configured, and the length or duration of DwPTS, GP, and UpPTS intervals according to each configuration complies with Table 9 below.

TABLE 9

Configuration (lengths of DwPTS, GP, and UpPTS) of TDD-special subframe

	Normal CP in downlink			Extended CP in downlink		
		UpPTS			UpPTS	
Special subframe configuration	DwPTS	Normal CP in uplink	Extended CP in uplink	DwPTS	Normal CP in uplink	Extended CP 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	$13168 \cdot T_s$			—	—	—

[0312] In accordance with a current LTE standard, a CSI-RS is not transmitted in the DwPTS interval of a special subframe. However, in an FD-MIMO system, to transmit a CSI-RS even in a special subframe may assist in distributing CSI-RS transmission overhead into a plurality of subframes. Furthermore, if a base station configures a plurality of CSI-RS resources in a terminal using a plurality of subframes and the terminal aggregates the plurality of CSI-RS resources and performs CSI measurement, a report to include a special subframe in the aggregation of subframes may assist in improving CSI measurement accuracy of the terminal.

[0313] Basically, a CSI-RS resource pool and CSI-RS pattern in a downlink subframe may be applied to the transmission of a CSI-RS in a DwPTS interval without a change. A DwPTS interval may include a minimum of 3 OFDM symbols or a maximum of 12 OFDM symbols according to a special subframe configuration (Nos. 0-9). If a CSI-RS resource pool in a downlink subframe is identically applied to the transmission of a CSI-RS in a DwPTS interval, 32 REs may be used as CSI-RS resource pool if the number of OFDM symbols included in a DwPTS is 11 or more. If the number of OFDM symbols included in a DwPTS is 9 or 10, 8 REs may be used as a CSI-RS resource pool. If the number of OFDM symbols included in a DwPTS is 3 or 6, the transmission of a CSI-RS is impossible.

[0314] A method of extending a CSI-RS resource pool in order to transmit a CSI-RS in a DwPTS interval may be taken into consideration. Specifically, Method M210 or the detailed methods of Method M210 may be used identically or similarly for a case where the DMRS of the antenna port No. 5 is not transmitted. That is, the remaining 56 REs of a total of 64 REs illustrated in FIG. **35** except 8 REs corresponding to the OFDM symbol Nos. 5 and 6 of a second time slot may be used to transmit a CSI-RS in a DwPTS. In this case, if the number of OFDM symbols included in the DwPTS is 11 or more, the 56 REs may be used as a CSI-RS resource pool. If the number of OFDM symbols included in the DwPTS is 9 or 10, 32 REs may be used as a CSI-RS resource pool. If the number of OFDM symbols included in the DwPTS is 6, 24 REs may be used as a CSI-RS resource pool.

[0315] Alternatively, in order to transmit a CSI-RS in a DwPTS interval, Method M220 may be used identically or

similarly. That is, a method of additionally using the OFDM symbol Nos. 1 and 2 of a first time slot may be taken into consideration. In accordance with such a method, although the number of OFDM symbols included in the DwPTS is 3, 24 REs may be used as a CSI-RS resource pool. In accordance with such a method, however, only if the number of CRS antenna ports is 1 or 2, the OFDM symbol Nos. 1 and 2 of the first time slot may be used to transmit a CSI-RS.

[0316] Alternatively, Method M240 may be used identically or similarly for a case where the DMRS of an antenna port No. 5 is not transmitted.

[0317] Alternatively, Method M521, Method M522, or Method M523 may be used identically or similarly for a case where the DMRS of an antenna port No. 5 and a CSI-RS coexist. That is, in the CSI-RS resource pools illustrated in FIGS. **59** to **61**, the remaining resource pool other than 8 REs corresponding to the OFDM symbol Nos. 5 and 6 of the second time slot may be used for the CSI-RS resource configuration of a TDD-special subframe.

[0318] FIG. **69** is a diagram showing the configuration of a base station **100** in accordance with an exemplary embodiment of the present invention.

[0319] Specifically, the base station **100** includes a processor **110**, memory **120**, and an RF converter **130**.

[0320] The processor **110** may be configured to implement the procedures, functions, and methods described in relation to a base station in this specification.

[0321] The memory **120** is connected to the processor **110**, and stores various types of information related to the operation of the processor **110**.

[0322] The RF converter **130** is connected to the processor **110**, and transmits or receives a wireless signal. Furthermore, the base station **100** may have a single antenna or multiple antennas.

[0323] FIG. **70** is a diagram showing the configuration of a terminal **200** in accordance with an exemplary embodiment of the present invention.

[0324] Specifically, the terminal **200** includes a processor **210**, memory **220**, and an RF converter **230**.

[0325] The processor **210** may be configured to implement the procedures, functions, and methods described in relation to a terminal in this specification.

[0326] The memory **220** is connected to the processor **210**, and stores various types of information related to the operation of the processor **210**.

[0327] The RF converter **230** is connected to the processor **210**, and transmits or receives a wireless signal. Furthermore, the terminal **200** may have a single antenna or multiple antennas.

[0328] FIG. **71** is a diagram showing a computer system **300** in accordance with an exemplary embodiment of the present invention.

[0329] An exemplary embodiment of the present invention may be implemented in a computer system (e.g., a computer-readable medium). As illustrated in FIG. **71**, the computer system **300** may include at least one processor **310**, memory **320**, and storage **330**. The computer system **300** may further include a communication interface **340**. The communication interface **340** may include a network interface **341** connected to a network **400**. The computer system **300** may further include a user input device **350** and a user output device **360**. The elements **310**-**360** may communicate with each other through a bus **370**.

[0330] The processor **310** may be a central processing unit (CPU) or semiconductor device for executing processing instructions stored in the memory **320** or storage **330**. The memory **320** and the storage **330** may include a variety of types of volatile or nonvolatile storage media. For example, the memory **320** may include read-only memory **321** and random access memory **322**.

[0331] Accordingly, an exemplary embodiment of the present invention may be implemented as a non-transitory computer-readable medium with a computer-implemented method or computer executable instructions stored therein.

[0332] In an exemplary embodiment of the present invention, if computer-executable instructions are executed by the processor **310**, they may perform a method at least one aspect of the present invention.

[0333] In accordance with an exemplary embodiment of the present invention, a base station can configure a larger number of CSI-RS antenna ports (e.g., 12, 16, 24, 32, or 64) than 8 in a terminal while minimizing channel estimation performance degradation of the terminal by extending a CSI-RS resource configuration.

[0334] Furthermore, in accordance with an exemplary embodiment of the present invention, a CSI-RS RE set for a case where the number of CSI-RS antenna ports is 1, 2, 4, or 8 can be additionally defined.

[0335] While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is.

1. A method of transmitting a channel state information reference signal (CSI-RS) by a base station, comprising:

including a plurality of first resource elements (REs) corresponding to at least two of a second orthogonal frequency division multiplexing (OFDM) symbol, a third OFDM symbol, and a fourth OFDM symbol of a first time slot in a first CSI-RS resource pool configured in a first subframe comprising the first time slot and a second time slot subsequent to the first time slot; and

transmitting the CSI-RS using at least one of REs included in the first CSI-RS resource pool.

2. The method of claim **1**, further comprising:

setting information about an OFDM symbol which belongs to OFDM symbols of the first time slot and at which a transmission of a physical downlink shared control channel (PDSCH) is started in a first parameter for a first set to which the first subframe belongs;

setting information about an OFDM symbol which belongs to OFDM symbols of a third time slot of the third time slot and a fourth time slot subsequent to the third time slot included in a second subframe and at which a transmission of a PDSCH is started in a second parameter for a second set to which the second subframe belongs; and

transmitting the first parameter and the second parameter to a terminal,

wherein the first subframe is configured so that the CSI-RS is transmitted through at least one of the first REs.

3. The method of claim **1**, further comprising transmitting a bitmap of 19 bits for configuring the first REs as resources for a zero power (ZP) CSI-RS to a terminal.

4. The method of claim 1, wherein

including the first REs in the first CSI-RS resource pool comprises including 24 first REs corresponding to the third OFDM symbol and fourth OFDM symbol of the first time slot in the first CSI-RS resource pool, and

transmitting the CSI-RS comprises mapping CSI-RS antenna ports of greater than 8 to the REs included in the first CSI-RS resource pool.

5. The method of claim 4, wherein mapping the CSI-RS antenna ports comprises:

mapping 16 CSI-RS antenna ports to 16 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool; and

multiplexing the 16 CSI-RS antenna ports using frequency division multiplexing (FDM) and code division multiplexing (CDM).

6. The method of claim 4, wherein mapping the CSI-RS antenna ports comprises:

mapping 16 CSI-RS antenna ports to 16 REs of the 24 first REs; and

multiplexing the 16 CSI-RS antenna ports using FDM and CDM.

7. The method of claim 4, wherein mapping the CSI-RS antenna ports comprises:

mapping 16 CSI-RS antenna ports to 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the first time slot and which are included in the first CSI-RS resource pool and 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool; and

multiplexing the 16 CSI-RS antenna ports using time division multiplexing (TDM) and CDM.

8. The method of claim 4, wherein mapping the CSI-RS antenna ports comprises:

mapping 8 CSI-RS antenna ports of the 16 CSI-RS antenna ports to 8 REs of 24 REs which correspond to the third OFDM symbol and the fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool;

mapping remaining 8 CSI-RS antenna ports of the 16 CSI-RS antenna ports to 8 REs of the 24 first REs; and

multiplexing the 16 CSI-RS antenna ports using TDM and CDM.

9. The method of claim 4, wherein mapping the CSI-RS antenna ports comprises:

mapping 32 CSI-RS antenna ports to 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the first time slot and which are included in the first CSI-RS resource pool, 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool, 8 REs of 24 REs which correspond to a third OFDM symbol and a fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool, and 8 REs of the 24 first REs; and

multiplexing the 32 CSI-RS antenna ports using FDM, TDM, and CDM.

10. The method of claim 4, wherein mapping the CSI-RS antenna ports comprises:

mapping 32 CSI-RS antenna ports to 16 REs of 24 REs which correspond to a third OFDM symbol and a fourth OFDM symbol of the second time slot and which are included in the first CSI-RS resource pool and 16 REs of the 24 first REs; and

multiplexing the 32 CSI-RS antenna ports using FDM, TDM, and CDM.

11. A method of transmitting a channel state information reference signal (CSI-RS) by a base station, comprising:

setting a number of CSI-RS antenna ports for transmitting the CSI-RS to a value greater than 8;

mapping the CSI-RS antenna ports to resource elements (RE) included in a CSI-RS resource pool of a subframe; and

multiplexing the CSI-RS antenna ports using frequency division multiplexing (FDM) and code division multiplexing (CDM).

12. The method of claim 11, wherein:

the subframe comprises a first time slot and a second time slot subsequent to the first time slot;

setting the number of CSI-RS antenna ports comprises setting the number of CSI-RS antenna ports to one of 12, 16, 20, and 24; and

mapping the CSI-RS antenna ports comprises mapping the set number of CSI-RS antenna ports to REs which belong to 24 first REs corresponding to a third orthogonal frequency division multiplexing (OFDM) symbol and a fourth OFDM symbol of the second time slot and included in the CSI-RS resource pool and which are equal to the number of CSI-RS antenna ports.

13. The method of claim 12, wherein mapping the set number of CSI-RS antenna ports comprises mapping the 16 CSI-RS antenna ports to two REs which belong to the 24 first REs and which correspond to a twelfth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to an eleventh subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a tenth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a ninth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a sixth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a fifth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a fourth subcarrier of the subframe, and two REs which belong to the 24 first REs and which correspond to a third subcarrier of the subframe when the number of CSI-RS antenna ports is 16.

14. The method of claim 12, wherein mapping the set number of CSI-RS antenna ports comprises mapping the 16 CSI-RS antenna ports to two REs which belong to the 24 first REs and which correspond to a twelfth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to an eleventh subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to an eighth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a seventh subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a sixth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a fifth subcarrier of the subframe, two REs which belong to the 24 first REs and which correspond to a second subcarrier of the subframe, and two REs which belong to the 24 first REs and which correspond to a first subcarrier of the subframe when the number of CSI-RS antenna ports is 16.

15. A method of transmitting a channel state information reference signal (CSI-RS) by a base station, comprising:

setting a number of first CSI-RS antenna ports for transmitting the CSI-RS to a value greater than 8;

mapping the CSI-RS antenna ports to resource elements (RE) included in a CSI-RS resource pool of a subframe; and

multiplexing the first CSI-RS antenna ports using time division multiplexing (TDM) and code division multiplexing (CDM),

wherein the subframe comprises a first time slot and a second time slot subsequent to the first time slot.

16. The method of claim **15**, further comprising:

configuring a first energy per resource element (EPRE) for a demodulation reference signal (DMRS) in an orthogonal frequency division multiplexing (OFDM) symbol which belongs to OFDM symbols of the subframe and at which the CSI-RS is transmitted;

configuring a second EPRE for a DMRS in an OFDM symbol which belongs to the OFDM symbols of the subframe and at which the CSI-RS is not transmitted; and

transmitting a ratio of the first EPRE and the second EPRE to a terminal.

17. The method of claim **15**, wherein

setting the number of first CSI-RS antenna ports comprises setting the number of first CSI-RS antenna ports to 16, and

mapping the first CSI-RS antenna ports comprises:

mapping 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs of 24 REs which correspond to a third OFDM symbol and a fourth OFDM symbol of the second time slot and which are included in the CSI-RS resource pool; and

mapping remaining 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the second time slot and which are included in the CSI-RS resource pool.

18. The method of claim **15**, wherein

setting the number of first CSI-RS antenna ports comprises setting the number of first CSI-RS antenna ports to 16, and

mapping the first CSI-RS antenna ports comprises:

mapping 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs which correspond to a sixth OFDM symbol and a seventh OFDM symbol of the first time slot and which are included in the CSI-RS resource pool; and

mapping remaining 8 antenna ports of the 16 first CSI-RS antenna ports to 8 REs of 24 REs which correspond to a third OFDM symbol and a fourth OFDM symbol of the second time slot and which are included in the CSI-RS resource pool.

19. The method of claim **15**, further comprising:

setting a number of second CSI-RS antenna ports for transmitting the CSI-RS to a value equal to the number of first CSI-RS antenna ports;

mapping the second CSI-RS antenna ports to the REs included in the CSI-RS resource pool; and

multiplexing the second CSI-RS antenna ports using frequency division multiplexing (FDM) and CDM.

20. The method of claim **15**, wherein multiplexing the first CSI-RS antenna ports comprises:

multiplexing some of the first CSI-RS antenna ports using TDM and CDM; and

multiplexing a remainder of the first CSI-RS antenna ports using frequency division multiplexing (FDM) and CDM.

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	20160089-PCT-US-DA1_IDS.pdf	614297 af5d5f92c3771ab5c5d1ae2d8afd1f628d33e31e4	no	5

Warnings:

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2	Non Patent Literature	20160089_PCT_SR.pdf	167537 eb0f1fc4822d6433318ac99ff6dfc871b5dc1e22	no	5
Warnings:					
Information:					
3	Non Patent Literature	20160089_CN_OA1.pdf	943464 8a4a2d7ca73c9a3b53fb6fd9c7962ddd83c83e46	no	16
Warnings:					
Information:					
4	Non Patent Literature	20160089_CN_SEARCH.pdf	348875 cc0946cd68c6dccbb4f540d1c1cc1808c68f0961	no	8
Warnings:					
Information:					
5	Non Patent Literature	20160089_CN_GRANT.pdf	237888 5a588bb7c47d504a01f0051ab6ff5ca138d834ebe	no	3
Warnings:					
Information:					
6	Foreign Reference	CN101567865A.pdf	876532 c05b03377ec9d41fb509d880df4630f1f36f66ac	no	16
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7	Foreign Reference	CN103687010A.pdf	2033803 40694b0d0ac99808f5aaf463d51c25464db0eb59	no	29
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8	Foreign Reference	CN105577318A.pdf	819856 2119666.3e5545.0ae7d45d4f039c01ccb5570cafa5	no	14
Warnings:					
Information:					

9	Foreign Reference	WO2016018100A1.pdf	2907371 a339237a057aea4d73b219faf51d9c35a076d08b	no	59
Warnings:					
Information:					
10	Other Reference-Patent/App/Search documents	US20110223876A1.PDF	718608 aa7c967c0bfe913371d528c4f8f00a207ed397a4	no	12
Warnings:					
Information:					
11	Other Reference-Patent/App/Search documents	US20150010106A1.PDF	808751 35c2f2e1cf0647b7ee6f0a006883b91d34bfaa	no	11
Warnings:					
Information:					
12	Other Reference-Patent/App/Search documents	US20160094326A1.PDF	5479433 45dd196846b3841bbcfbcab42a8f2f736f86c46a	no	97
Warnings:					
Information:					
13	Foreign Reference	R1-091591.pdf	211129 ef514acbaa8ec416aa15371a43264fe70ec94b7c	no	7
Warnings:					
Information:					
14	Foreign Reference	R1-103705.pdf	214643 906e893604cbba00f3d6ac1f20f1b63de16acd13	no	4
Warnings:					
Information:					
15	Foreign Reference	R1-144047.pdf	309079 c04db71e4241537714cf2359e206910c2da3d1ae8	no	5
Warnings:					
Information:					

16	Foreign Reference	R1-145169.pdf	316995 512e5130c6665c1da36b12cc857217f2666d6d7	no	6
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证　明

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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。

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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：

- 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：在第二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。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，所述第一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一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：

- 第二发送模块：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 中在第一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，所述第二接收模块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

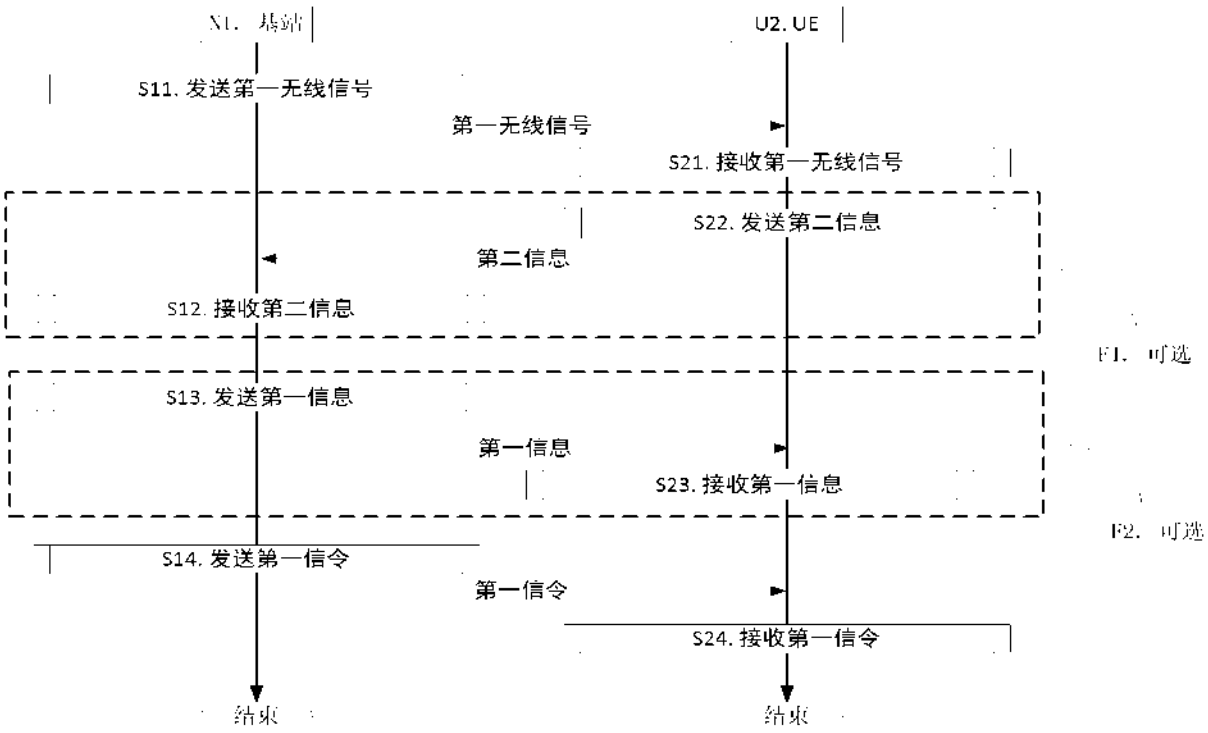

N1. 基站
U2. UE
S11. 发送第一无线信号
第一无线信号
S21. 接收第一无线信号
S22. 发送第二信息
第二信息
S12. 接收第二信息
F1. 可选
S13. 发送第一信息
第一信息
S23. 接收第一信息
F2. 可选
S14. 发送第一信令
第一信令
S24. 接收第一信令
结束
结束

图 1

说 明 书 附 图

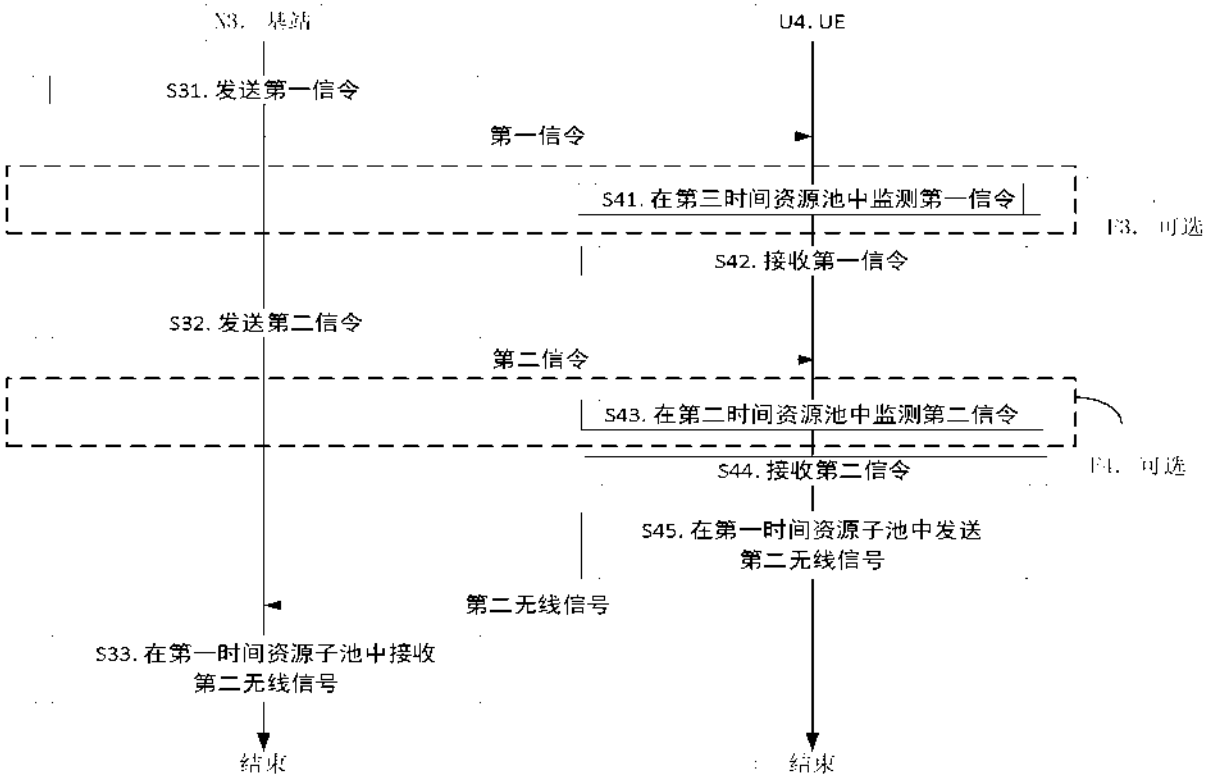

N3. 基站
U4. UE
S31. 发送第一信令
第一信令
S41. 在第三时间资源池中监测第一信令
F3. 可选
S42. 接收第一信令
S32. 发送第二信令
第二信令
S43. 在第二时间资源池中监测第二信令
F4. 可选
S44. 接收第二信令
S45. 在第一时间资源子池中发送
第二无线信号
第二无线信号
S33. 在第一时间资源子池中接收
第二无线信号
结束
结束

图 2

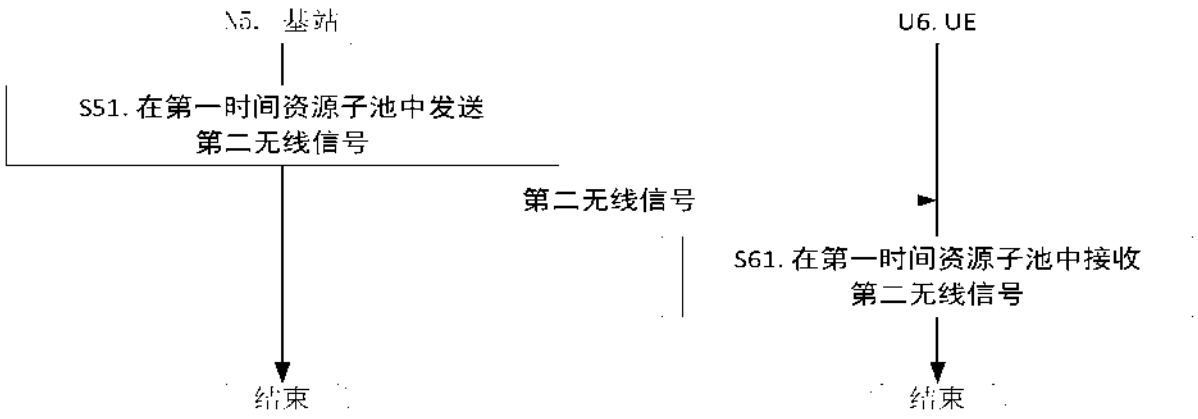

N5. 基站
U6. UE
S51. 在第一时间资源子池中发送
第二无线信号
第二无线信号
S61. 在第一时间资源子池中接收
第二无线信号
结束
结束

图 3

说 明 书 附 图

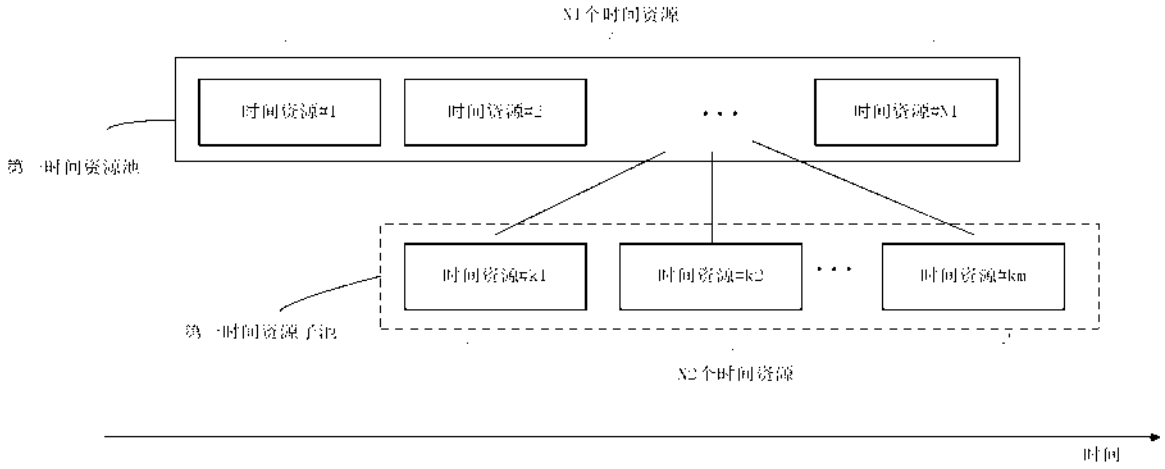

N1个时间资源
时间资源=1
时间资源=2
时间资源=N1
第一时间资源池
时间资源=k1
时间资源=k2
时间资源=km
N2个时间资源
时间

图 4

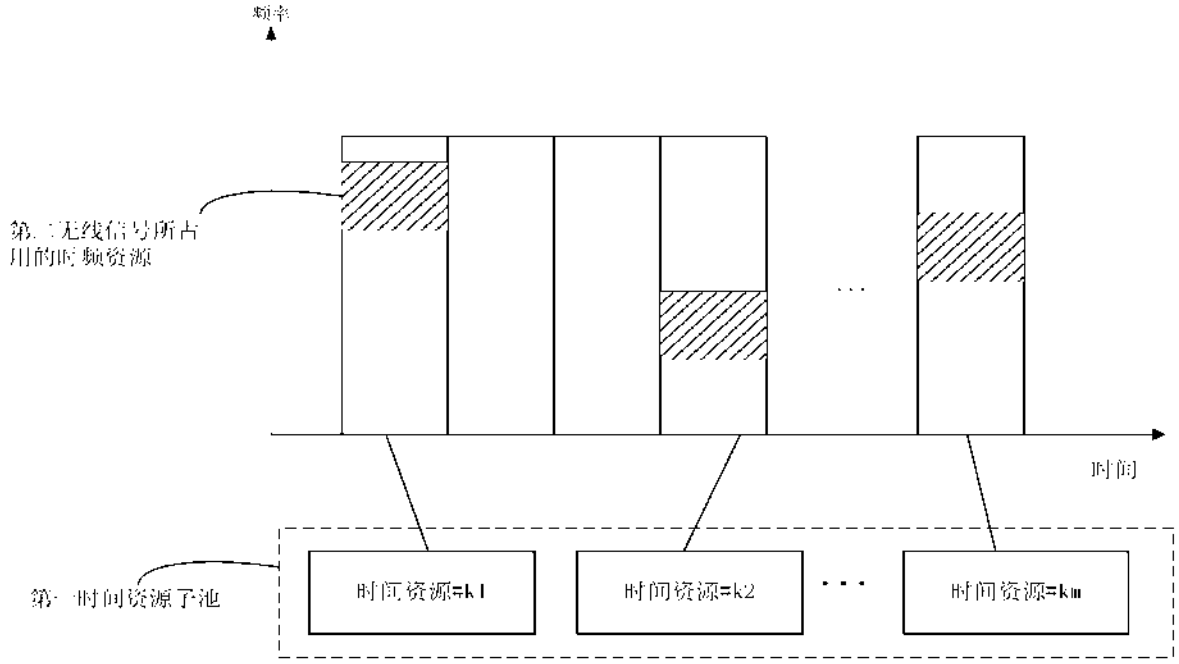

频率
第二无线信号所占用的时频资源
时间
第一时间资源子池
时间资源=k1
时间资源=k2
时间资源=km

图 5

说 明 书 附 图

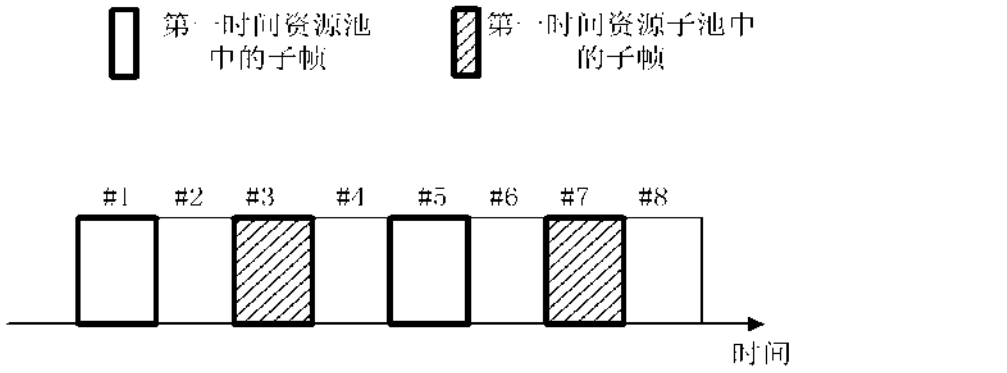

第一时间资源池中的子帧
第一时间资源子池中的子帧
#1
#2
#3
#4
#5
#6
#7
#8
时间
第一信令：
10101010
在子帧#3和#7上接收第二无线信号
第二信令：
0101

图 6

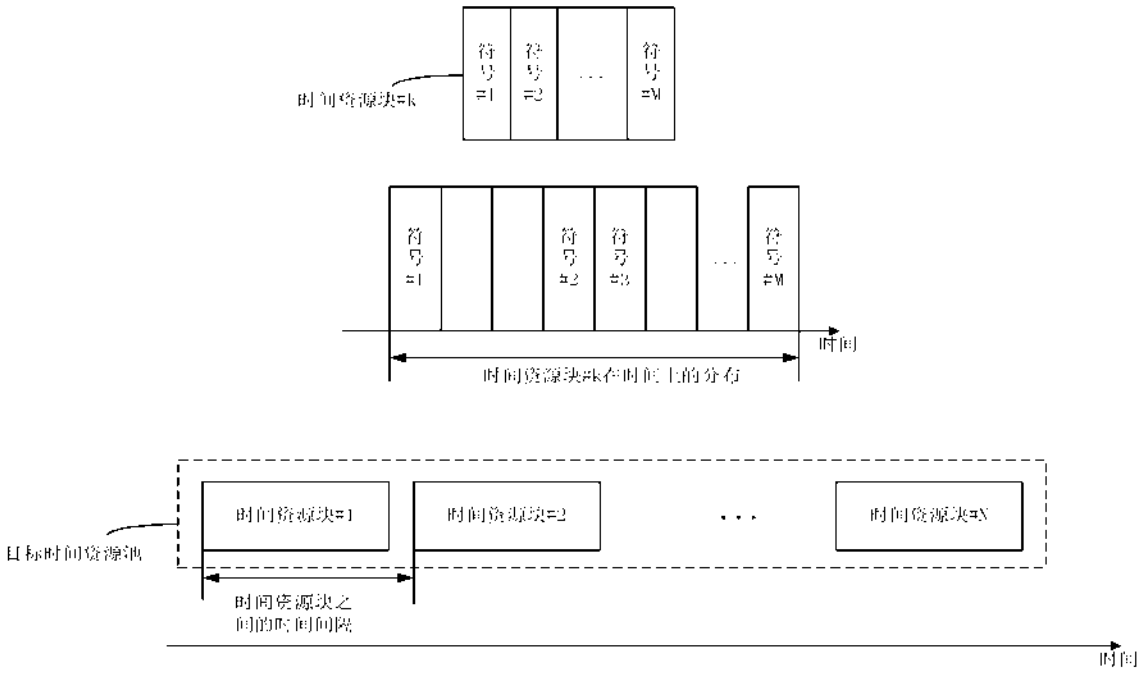

时间资源块#k
符号#1
符号#2
符号#M
时间
时间资源块#k在时间上的分布
目标时间资源池
时间资源块#1
时间资源块#2
时间资源块#N
时间资源块之间的时间间隔
时间

图 7

说 明 书 附 图

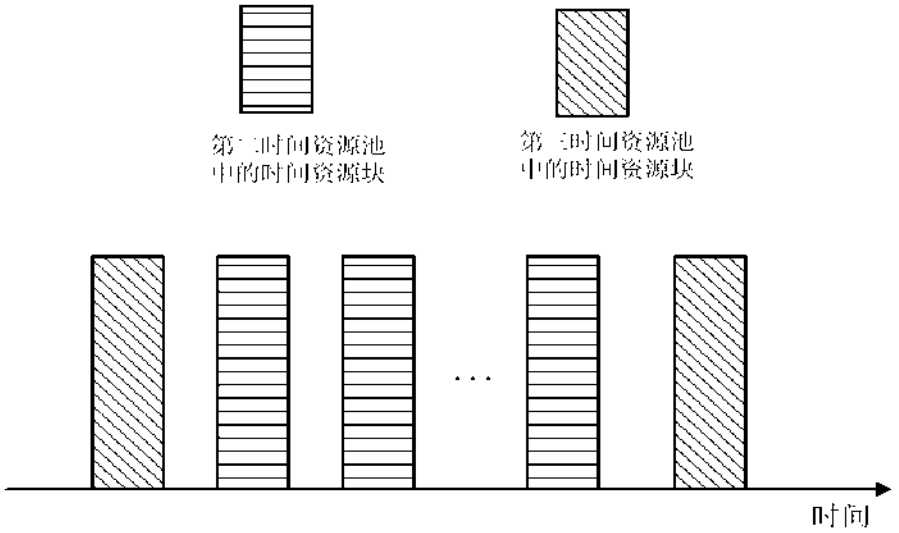

第一时间资源池
中的时间资源块
第二时间资源池
中的时间资源块
时间

图 8

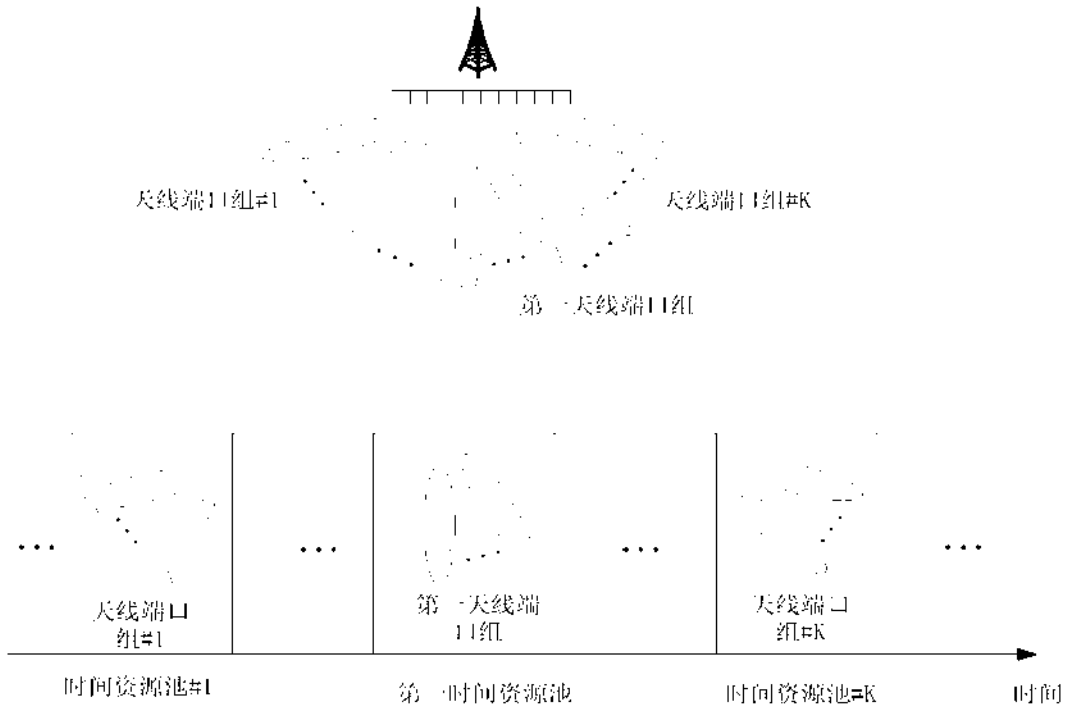

天线端口组#1
天线端口组#K
第一天线端口组
天线端口
组#1
第一天线端
口组
天线端口
组#K
时间资源池#1
第一时间资源池
时间资源池#K
时间

图 9

说 明 书 附 图

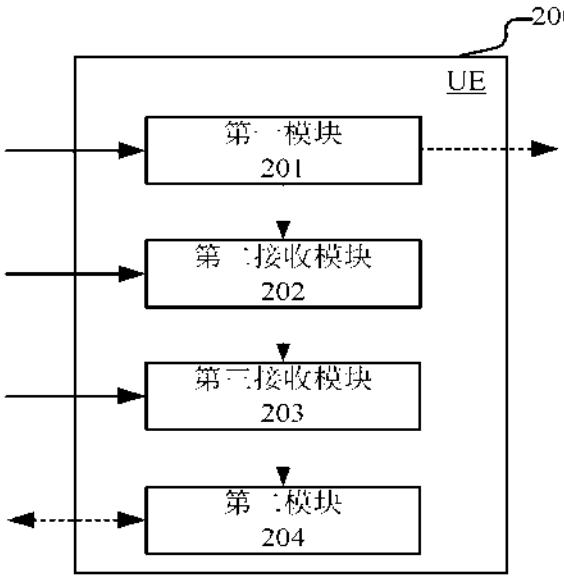


图 10

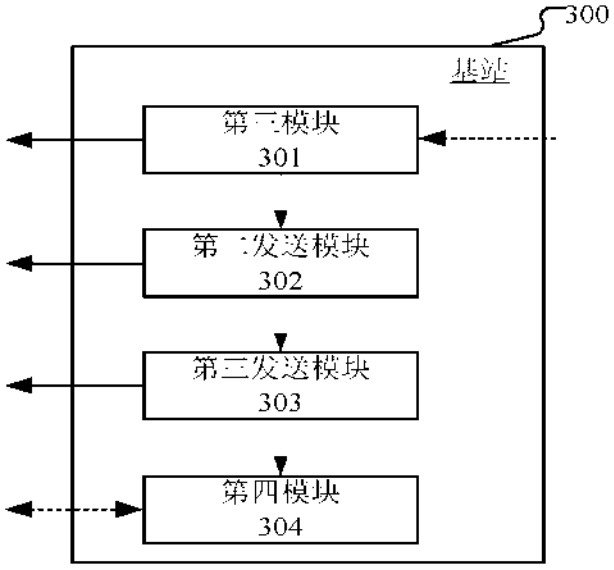


图 11

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 17/143,180

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	80		N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	350		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	400		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 240 =	240			
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	1070		TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT A

	(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($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
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	

AMENDMENT B

	(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($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
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

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/143,180	01/07/2021	2845	1070	20160089-PCT-US-DA1	20	4

CONFIRMATION NO. 3253

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

FILING RECEIPT



Date Mailed: 01/22/2021

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.

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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 16/429,077 06/03/2019
which is a CON of PCT/CN2017/112033 11/21/2017

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/143,180**

Projected Publication Date: 04/29/2021

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

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo ZHANG	
Application No.:	Unassigned	Art Unit Unassigned
Filed:	Unassigned	
Conf. No.:	Unassigned	
For:	Method and Device for Multi-Antenna Transmission in UE and Base Station	
Examiner:	Unassigned	
Customer No.:	157297	
Attorney Docket No.:	20160089-PCT-US-DA1	

NOTIFICATION OF CERTIFIED COPY IN PARENT APPLICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sirs,

The above-referenced application is a continuation application and has a foreign priority claim. The foreign priority claim was first made in the parent U.S. application.

Pursuant to MPEP 201.14(b)II, the Applicant hereby notifies the U.S. Patent & Trademark Office that a certified copy of the foreign priority application has been filed in the parent application (application no. 16/429,077 filing date June 3, 2019). Accordingly, no additional certified copy of the foreign priority application is required in the present application. The Applicant respectfully requests acknowledgment by the examiner at the appropriate time of the foreign priority claim and the certified copy of the foreign priority application using form PTOL-326.

If there are any questions regarding this matter, the Office is invited to contact the undersigned attorney.

Dated this 7th day of Jan, 2021.

Respectfully submitted,

Xiaobo Zhang

By: / Xiaobo Zhang/
Xiaobo Zhang

11422 Turtleback Ln San Diego CA 92127
Email: patent@langbomobile.com

ABSTRACT

The present disclosure discloses a method and device for multi-antenna transmission in UE and base station. The user equipment 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 first signaling is used to determine a first time resource pool; a second antenna virtualization vector is associated with the first antenna port group; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool. The invention effectively reduces signaling overhead of wireless resource dynamic scheduling of a massive MIMO system.

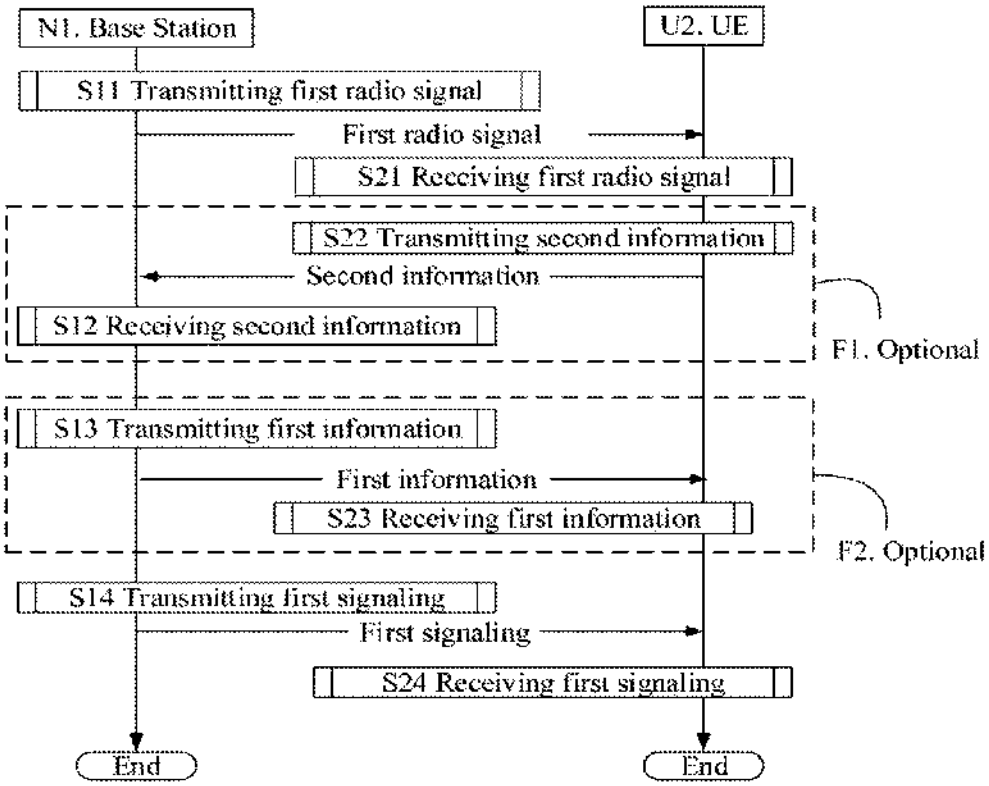

N1. Base Station
U2. UE
S11 Transmitting first radio signal
First radio signal
S21 Receiving first radio signal
S22 Transmitting second information
Second information
S12 Receiving second information
F1. Optional
S13 Transmitting first information
First information
S23 Receiving first information
F2.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

Fig. 1

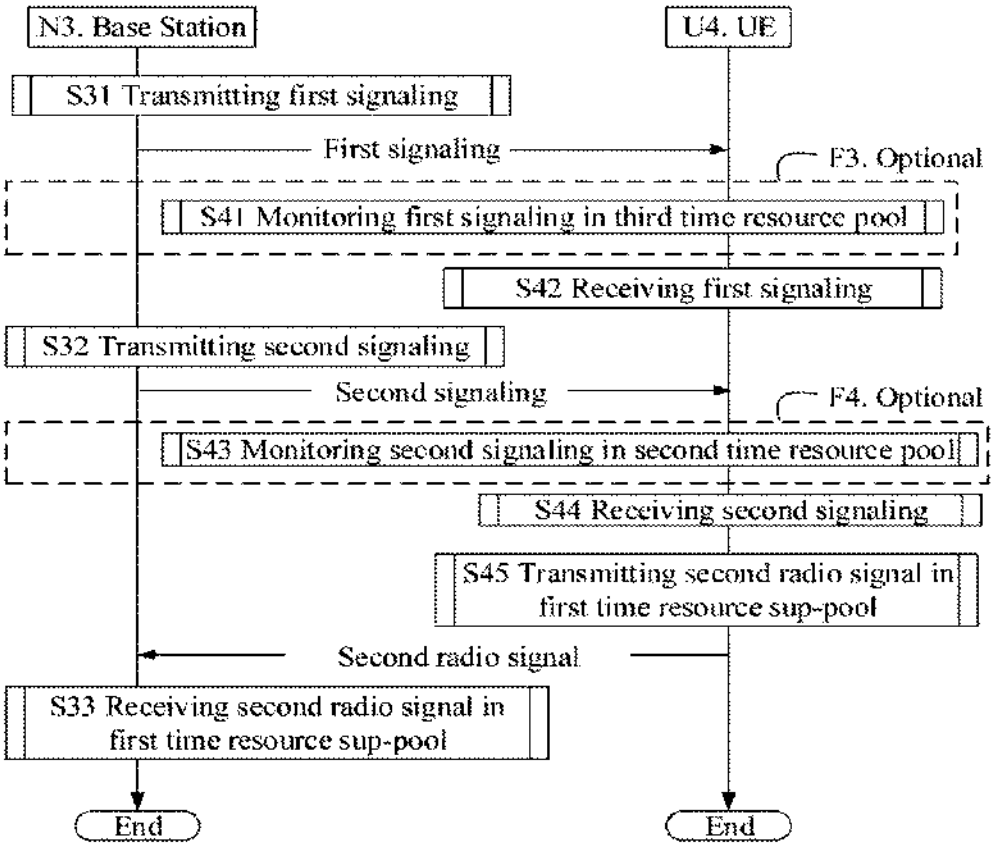

N3. Base Station
U4. UE
S31 Transmitting first signaling
First signaling
F3. Optional
S41 Monitoring first signaling in third time resource pool
S42 Receiving first signaling
S32 Transmitting second signaling
Second signaling
F4. Optional
S43 Monitoring second signaling in second time resource pool
S44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

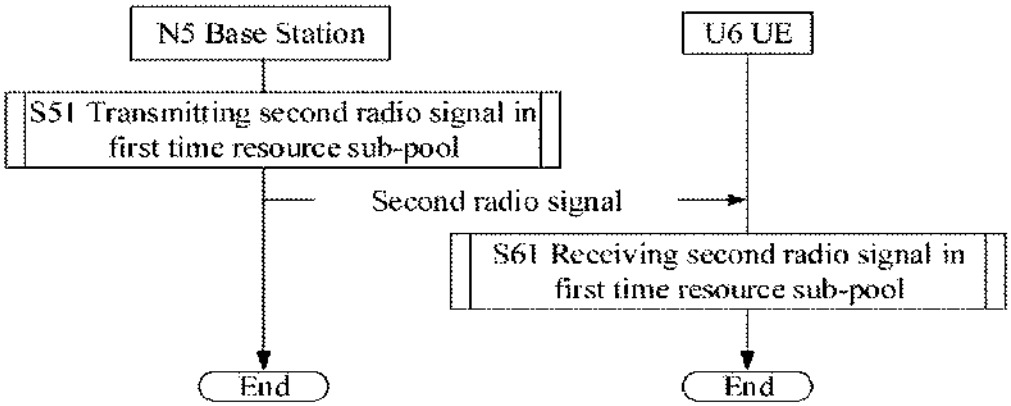

N5 Base Station
U6 UE
S51 Transmitting second radio signal in first time resource sub-pool
Second radio signal
S61 Receiving second radio signal in first time resource sub-pool
End
End

Fig. 3

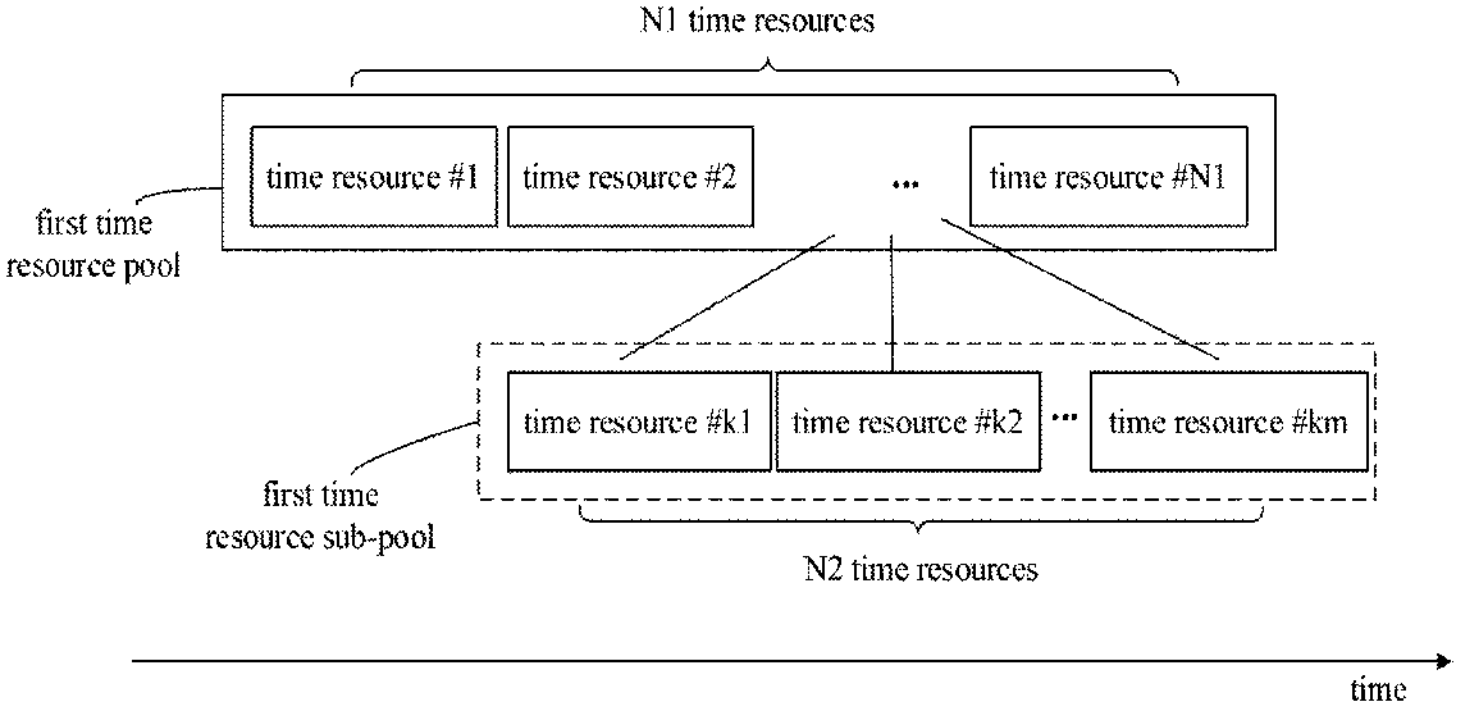

N1 time resources
time resource #1
time resource #2
...
time resource #N1
first time resource pool
time resource #k1
time resource #k2
...
time resource #km
first time resource sub-pool
N2 time resources
time

Fig. 4

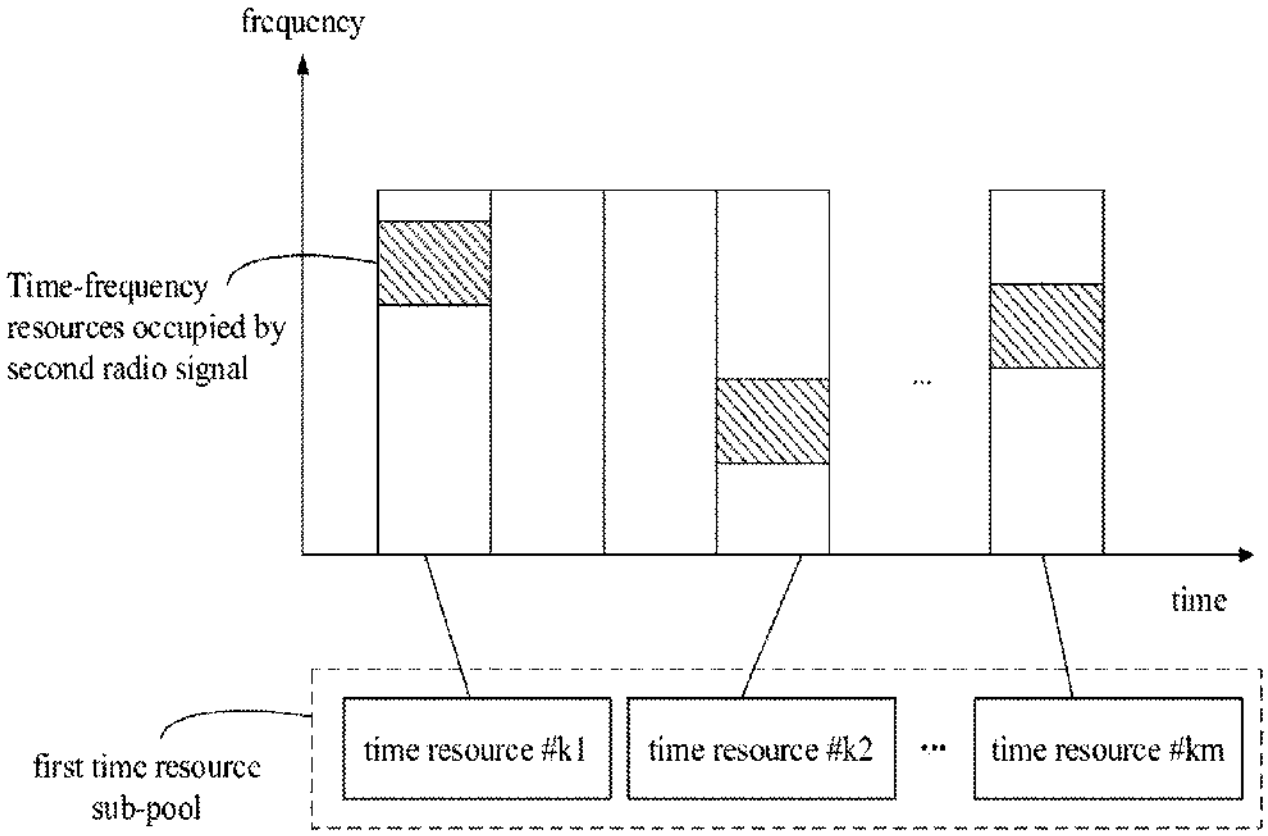

frequency
Time-frequency resources occupied by second radio signal
time
first time resource sub-pool
time resource #k1
time resource #k2
time resource #km

Fig. 5

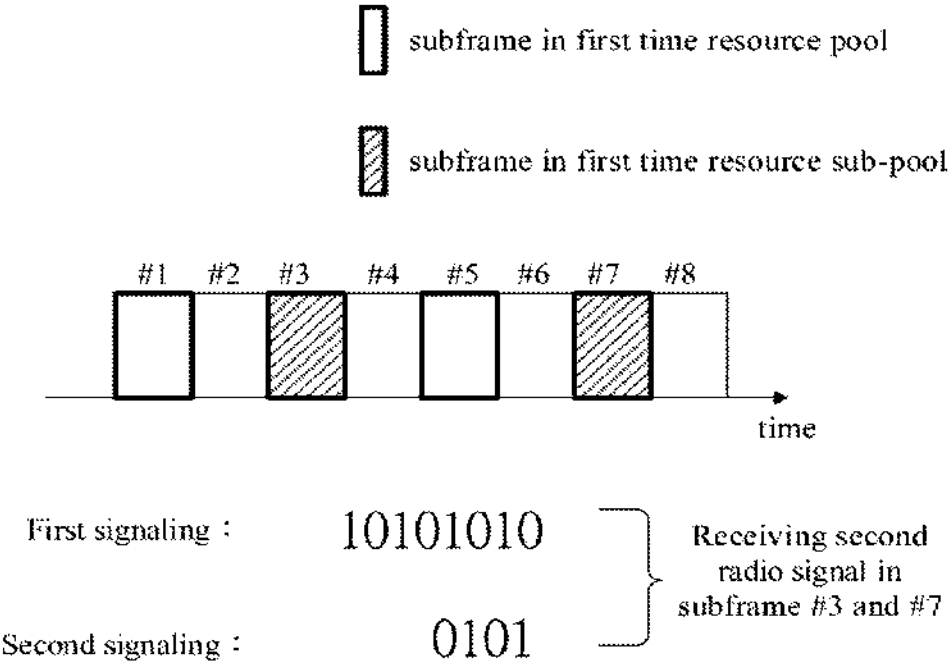
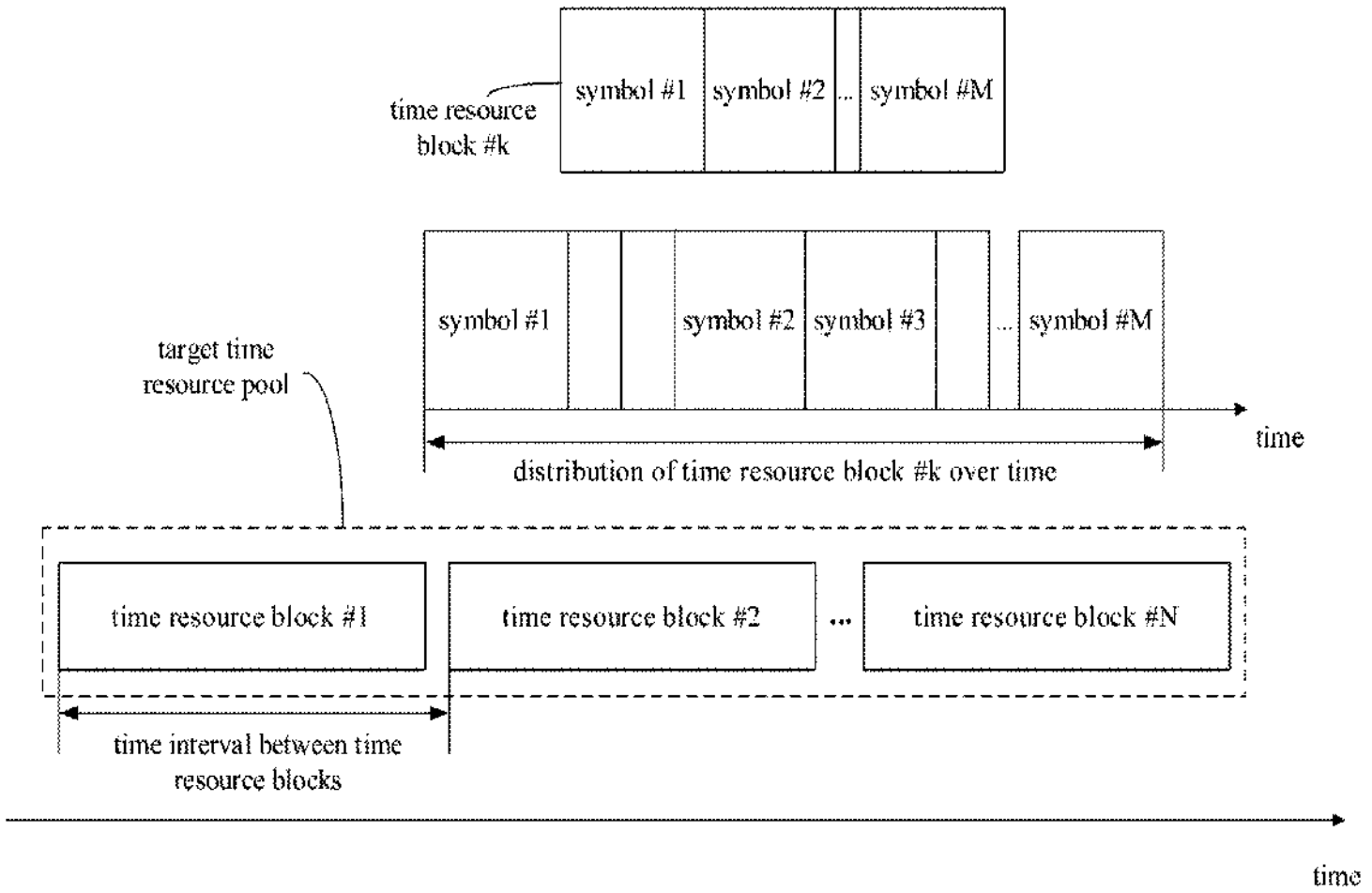

subframe in first time resource pool
subframe in first time resource sub-pool
#1
#2
#3
#4
#5
#6
#7
#8
time
First signaling：
10101010
Second signaling：
0101
Receiving second radio signal in subframe #3 and #7

Fig. 6


time resource block #k
symbol #1
symbol #2
...
symbol #M
target time resource pool
symbol #1
symbol #2
symbol #3
...
symbol #M
time
distribution of time resource block #k over time
time resource block #1
time resource block #2
...
time resource block #N
time interval between time resource blocks
time

652

Fig. 7

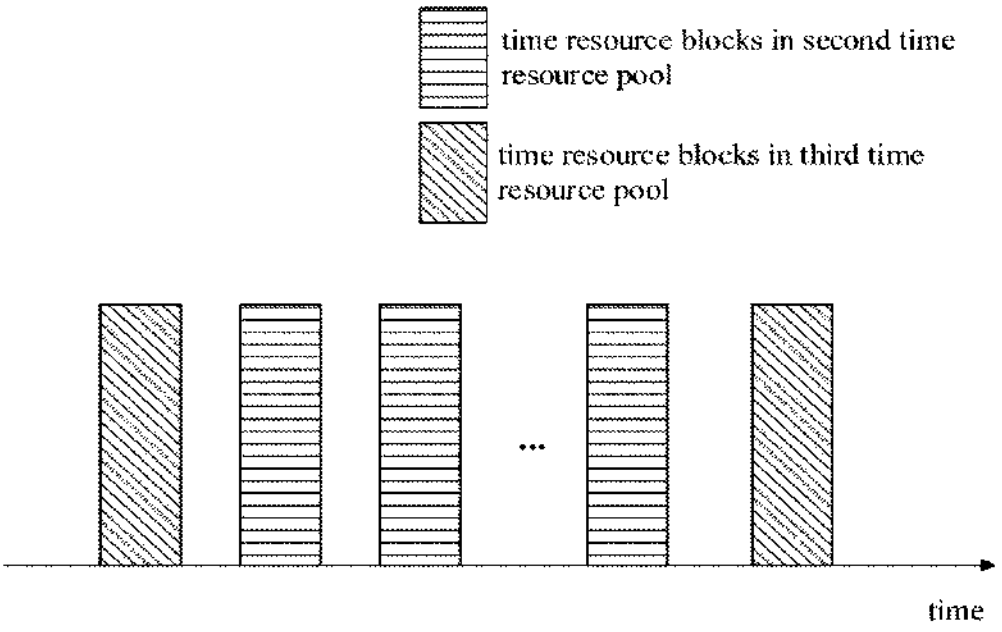

time resource blocks in second time resource pool
time resource blocks in third time resource pool
...
time

Fig. 8

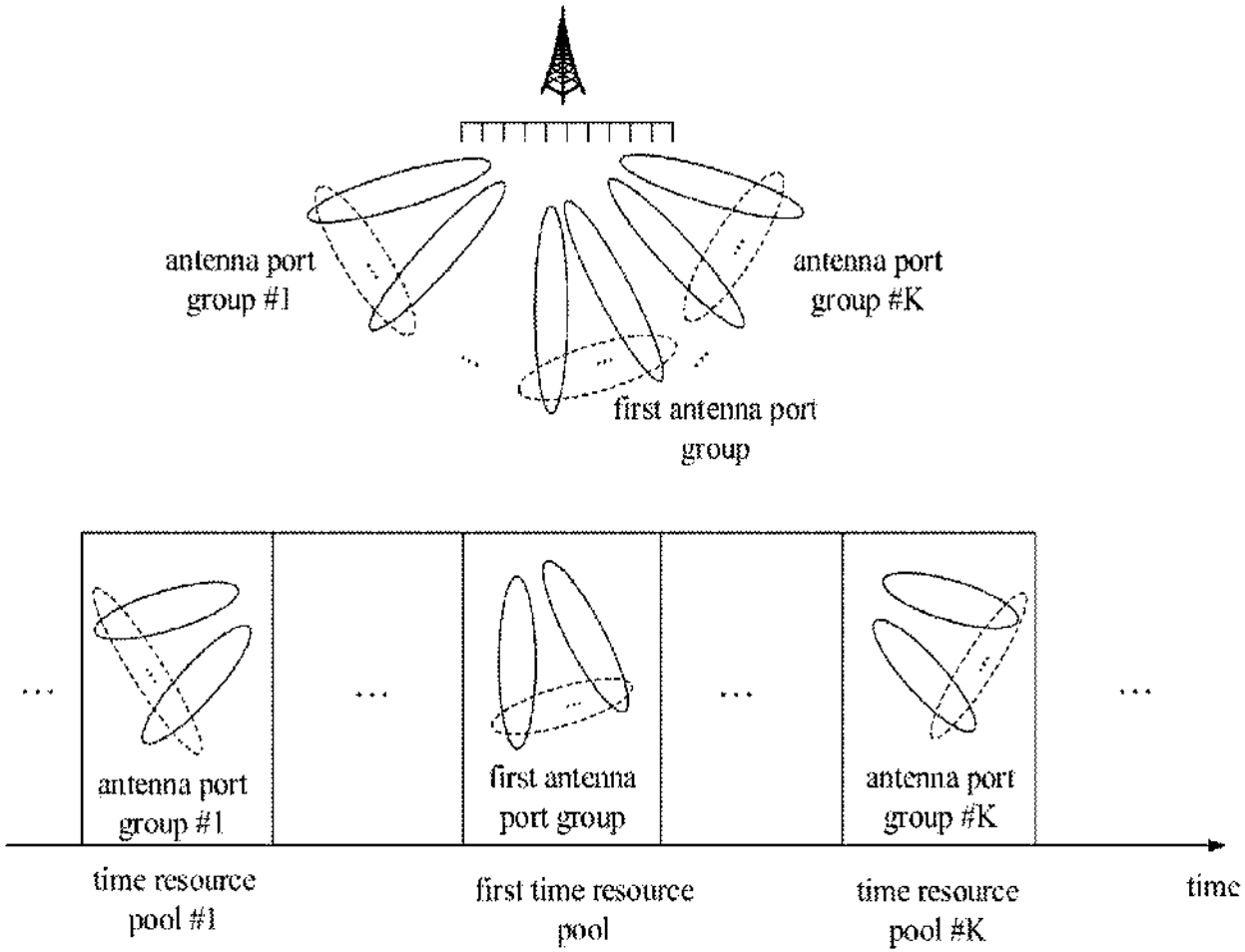

antenna port group #1
antenna port group #K
first antenna port group
antenna port group #1
first antenna port group
antenna port group #K
time resource pool #1
first time resource pool
time resource pool #K
time

Fig. 9

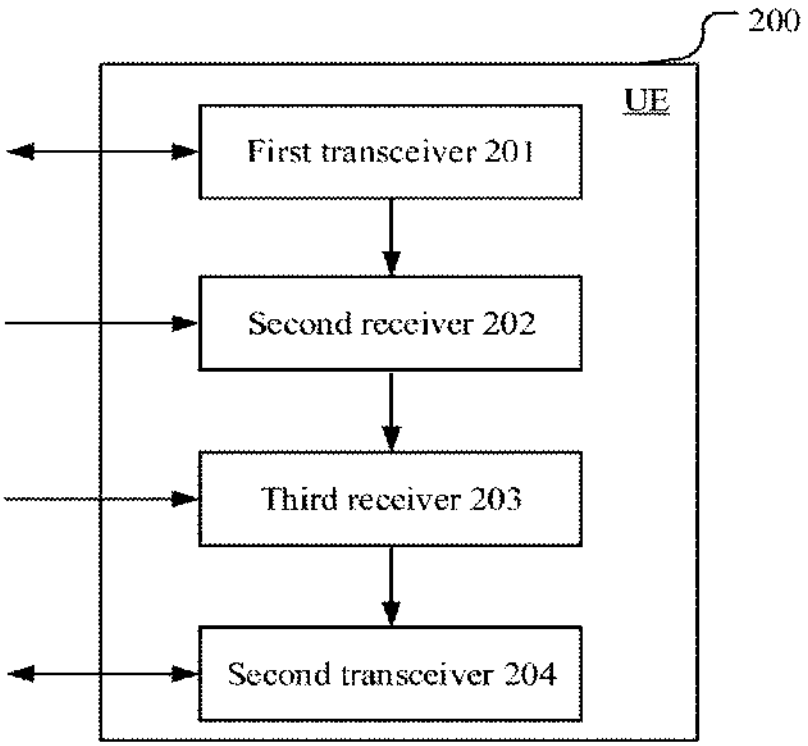

200
UE
First transceiver 201
Second receiver 202
Third receiver 203
Second transceiver 204

Fig. 10

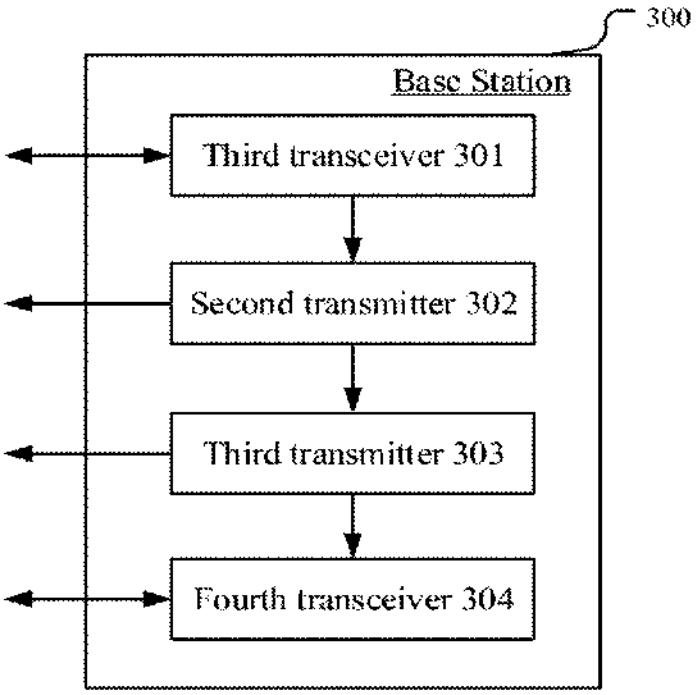

300
Base Station
Third transceiver 301
Second transmitter 302
Third transmitter 303
Fourth transceiver 304

Fig. 11

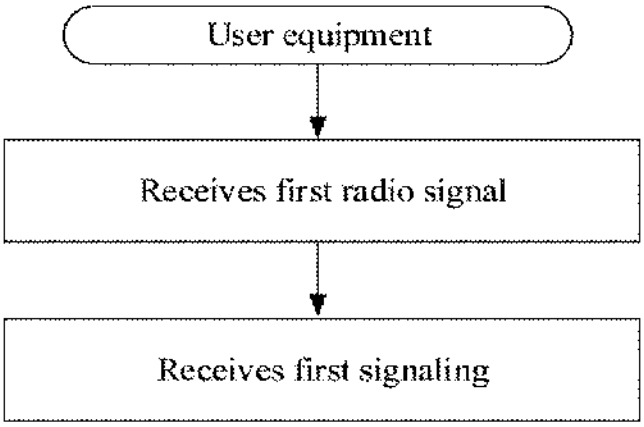

User equipment
Receives first radio signal
Receives first signaling

Fig. 12

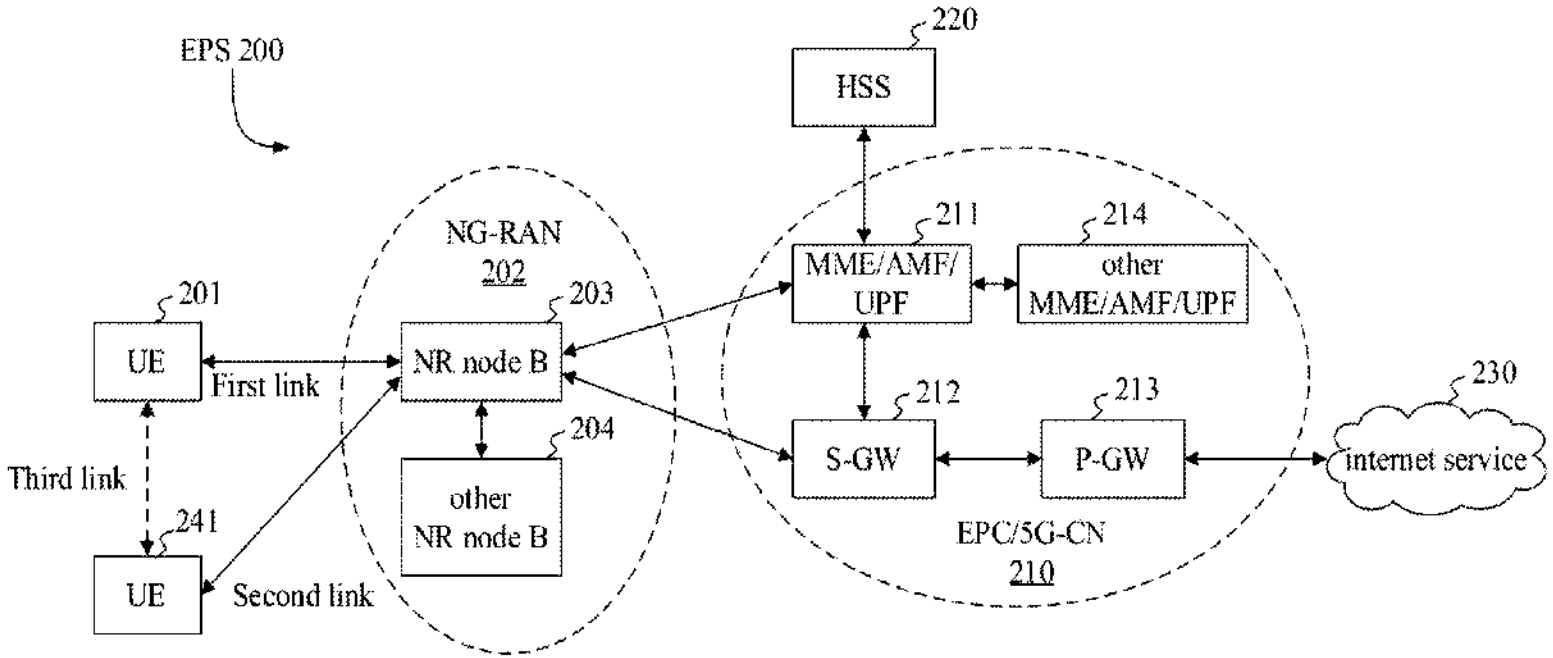

EPS 200
220
HSS
NG-RAN
202
211
MME/AMF/
UPF
214
other
MME/AMF/UPF
201
UE
First link
203
NR node B
212
213
230
S-GW
P-GW
internet service
204
other
NR node B
Third link
241
UE
Second link
EPC/5G-CN
210

Fig. 13

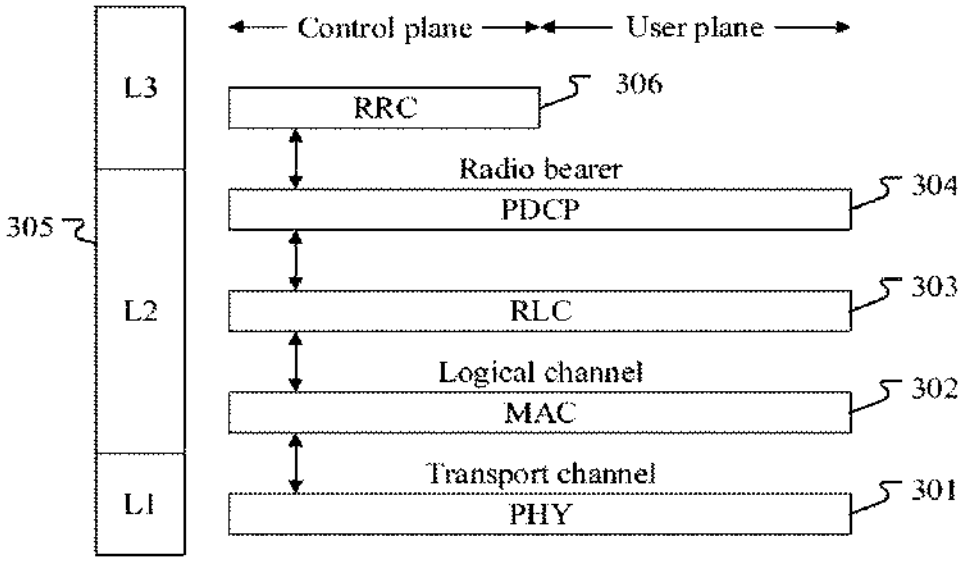

Control plane
User plane
L3
L2
L1
305
RRC
306
Radio bearer
PDCP
304
RLC
303
Logical channel
MAC
302
Transport channel
PHY
301

Fig. 14

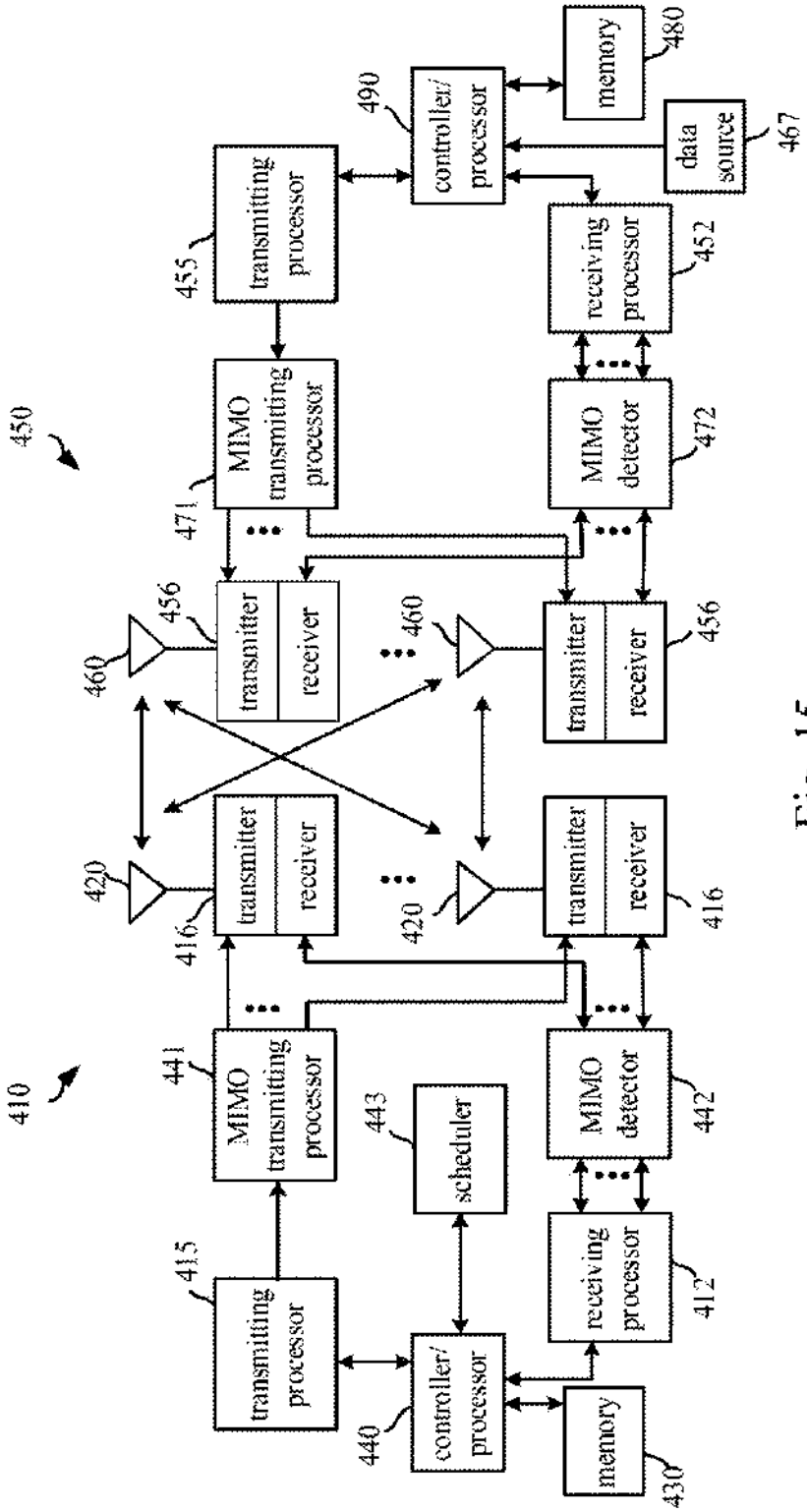

410
450
transmitting processor
415
MIMO transmitting processor
441
scheduler
443
controller/ processor
440
memory
430
receiving processor
412
MIMO detector
442
transmitter
receiver
416
420
460
transmitter
receiver
456
MIMO transmitting processor
471
transmitting processor
455
MIMO detector
472
receiving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

Fig. 15

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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

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 1, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, comprising:

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

4. The method of claim 1, further comprising:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s) indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; and the K is a positive integer greater than 1; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

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 6, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, comprising:

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

9. The method of claim 6, further comprising:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s) indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

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

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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

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 11, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, the second receiver further receives first information, wherein the first information is used to determine the first antenna port group.

14. The UE of claim 11, wherein:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s) indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

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 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; a second antenna virtualization vector is associated with the first antenna port group; 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; and the K is a positive integer greater than 1; the first radio signal includes one or more of PSS (Primary Synchronization Signal), SSS (Secondary Synchronization Signal), MIB (Master Information Block)/SIB (System Information Block) or CSI-RS (Channel State Information Reference signal); the first signaling is a downlink signaling.

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.

18. The base station equipment of claim 16, wherein the first signaling indicates the first antenna port group from the K antenna port group(s);

or, the second transmitter further transmits first information, wherein the first information is used to determine the first antenna port group.

19. The base station equipment of claim 16, wherein:

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;

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; the second information includes a CRI(CRIs) (CSI-RS Resource Indicator), and the CRI(s) indicates(indicate) the CSI-RS resource(s) corresponding to the K1 antenna port group(s) from the CSI-RS resources corresponding to the K antenna port groups;

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; the second information is a RACH preamble, and at least one of the sequence of the RACH preamble or the time-frequency resource occupied by the RACH preamble is used to determine the first antenna port group.

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; or the first signaling is a high layer signaling; or the first signaling is a physical layer signaling; or the first signaling includes one or more RRC IEs; or the first signaling is carried by a PDCCH; or the first signaling is transmitted on a PBCH; or the first signaling is cell-common; or the first signaling is for the UE.

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

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of the United States Application No.16/429,077, field on June 3, 2019, which 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.

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.

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Inventor:

XiaoBo ZHANG

XiaoBo ZHANG

Date: May. 30 2019

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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.

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LEGAL NAME OF INVENTOR

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

Signature: XiaoBo ZHANG

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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
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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	80	80
UTILITY SEARCH FEE	2111	1	350	350
UTILITY EXAMINATION FEE	2311	1	400	400
Pages:				
Claims:				
INDEPENDENT CLAIMS IN EXCESS OF 3	2201	1	240	240
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:				
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1	Application Data Sheet	WebADS.pdf	117183 c7b949c3a4c49cd690e0e5ffe0b7bd77fee5bde2	no	7
Warnings:					
Information:					
2	Transmittal Letter	20160089_PCT_US_DA1_Transmittal_Letter_VF.pdf	77455 7887f27db929490604a503fbb64c850086e509af	no	1
Warnings:					
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3	Abstract	20160089-PCT-US_APP_ABS.pdf	297569 43cc2a6985eb0b499d52c201360f22e2d06b49b3	no	1
Warnings:					
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4	Drawings-only black and white line drawings	20160089-PCT-US_APP_FIG_VF.pdf	1705978 e073c061f86135aa580d4756ee060f10b6955e6b	no	15
Warnings:					
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5	Claims	20160089-PCT-US-DA1_CLAIMS.pdf	112313 4ef10045116caf56a7f6c923aaed1ef87c0c3f95	no	6
Warnings:					
Information:					
6	Specification	20160089-PCT-US_APP_SPEC.pdf	764769 ca0c3a53f5f4b232cc290f2bc05ac4f3bb0b58b9	no	41
Warnings:					
Information:					

7	Assignee showing of ownership per 37 CFR 3.73	20160089-PCT-US_ASSIGNMENT.pdf	324959 d56c523e4f639095df2ae1ffe25f55daad211dc6	no	2
Warnings:					
Information:					
8	Oath or Declaration filed	20160089-PCT-US_DECLARATION.pdf	526342 59617923a649cd8bc364a233b361dcd202983269	no	2
Warnings:					
Information:					
9	Fee Worksheet (SB06)	fee-info.pdf	36973 a0c43a8119e737f0bb0f2a2caa78aae1441c9ef	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3963541		

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-DA1
	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 601, BUILDING 34, NO. 2777 EAST JINXIU ROAD		
Address 2	Pudong District		
City	Shanghai	**State/Province**	OT
Postal Code	201206	**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-DA1	**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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/429,077	2019-06-03

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16/429,077	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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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 601, BUILDING 34, NO. 2777 EAST JINXIU ROAD		
Address 2	Pudong District		
City	Shanghai	**State/Province**	OT
Country i	CN	Postal Code	201206
Phone Number		Fax Number	
Email Address			

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160089-PCT-US-DA1
	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.