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571-272-7822

Paper 29
Date: October 3, 2024

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. and
SAMSUNG ELECTRONICS AMERICA, INC,
Petitioner,

v.

APEX BEAM TECHNOLOGIES LLC,
Patent Owner.

IPR2023-00571
IPR2023-00747
Patent 10,951,271 B2[1]

Before JUSTIN T. ARBES, JOHN D. HAMANN, and SCOTT RAEVSKY, *Administrative Patent Judges*.

RAEVSKY, *Administrative Patent Judge*.

TERMINATION
Due to Settlement After Institution of Trial
35 U.S.C. § 317; 37 C.F.R. § 42.74

---

[1] We exercise our discretion to issue a single order in these cases. The parties are not authorized to use this caption format.

APPLE 1007

I. INTRODUCTION

On September 11, 2024, with Board authorization, Petitioner and Patent Owner filed a joint motion to terminate the above-styled proceedings. Paper 27 ("Mot.").[2] Along with the motions, the parties filed a copy of a Confidential Settlement Agreement (Ex. 2008), as well as joint requests to treat the Confidential Settlement Agreement as business confidential information (Paper 28, "Joint Request"). *See* 37 C.F.R. § 42.74(c) ("A party to a settlement may request that the settlement be treated as business confidential information and be kept separate from the files of an involved patent or application.").

II. DISCUSSION

Under 35 U.S.C. § 317(a), "[a]n inter partes review instituted under this chapter shall be terminated with respect to any petitioner upon the joint request of the petitioner and the patent owner, unless the Office has decided the merits of the proceeding before the request for termination is filed." It is also provided in 35 U.S.C. § 317(a) that if no petitioner remains, the Office may terminate the *inter partes* review.

In these proceedings, the Board issued decisions to institute *inter partes* review. Paper 10. However, the Board has not yet entered any final written decisions. In the joint motions, the parties state that they have settled their dispute and have reached an agreement to request termination of these *inter partes* reviews. Mot. 1–3. Accordingly, in the circumstances present

[2] For convenience, this Order cites solely to the papers and exhibit in the IPR2023-00571 proceeding. Similar papers and exhibits have been filed in the other styled case, IPR2023-00747.

here, we determine that it is appropriate to terminate the proceedings. 37 C.F.R. § 42.71(a). This Order does not constitute a final written decision pursuant to 35 U.S.C. § 318(a).

The parties also ask that the Confidential Settlement Agreement be treated as business confidential information and be kept separate from the file of the challenged patent. Joint Request, 1–2. We determine that it is appropriate to treat the Confidential Settlement Agreement as business confidential information, and to keep that document separate from the file of the challenged patent, pursuant to 37 C.F.R. § 42.74(c).

The parties further "request that the Board inform [them] if anyone seeks production of [the Confidential Settlement Agreement] and afford the parties an opportunity to address whether such request is supported by good cause." *Id.* at 2. The statutory and regulatory provisions governing access to such settlement agreements stand on their own and do not provide for such notice, and, therefore, we deny the parties' request here.

III. ORDER

Accordingly, it is:

ORDERED that the Joint Motion to Terminate in each styled case is *granted*;

FURTHER ORDERED that the Joint Requests to treat the Confidential Settlement Agreement as business confidential information are *granted*;

FURTHER ORDERED that the joint requests to inform the parties if anyone seeks production of the Confidential Settlement Agreement and

afford the parties an opportunity to address whether such request is supported by good cause are *denied*;

FURTHER ORDERED that the Confidential Settlement Agreement (Ex. 2008 in IPR2023-00571 and IPR2023-00747) shall remain designated as "Parties and Board Only" in the Board's electronic filing system, be kept separate from the file of the involved patent, and be made available only under the provisions of 35 U.S.C. § 317(b) and 37 C.F.R. § 42.74(c); and

FURTHER ORDERED that IPR2023-00571 and IPR2023-00747 are *terminated*.

For PETITIONER:

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FURTHER ORDERED that IPR2023-00571 and IPR2023-00747 are *terminated*.

For PETITIONER:

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ACKNOWLEDGEMENT OF LOSS OF ENTITLEMENT TO ENTITY STATUS DISCOUNT

APPLICATION #	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET #	REQUEST ID
16/454,075	06/27/2019	Xiaobo ZHANG	ZL0205-0003-PCT-US	248560

The entity status change request below filed through Patent Center on 07/22/2024 has been accepted.

Certifications

APPLICANT CHANGING TO REGULAR UNDISCOUNTED FEE STATUS

Signature

I certify, in accordance with 37 CFR 1.4(d)(4), that I am one of the signatories making the entity status change.

Signature	Name	Registration #
/Jialin Zhong/	Jialin Zhong	62937

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571-272-7822

Paper 10
Entered: November 13, 2023

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Patent 10,951,271 B2

Before JUSTIN T. ARBES, JOHN D. HAMANN, and
SCOTT RAEVSKY, *Administrative Patent Judges*.

RAEVSKY, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, "Petitioner") filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–20 of U.S. Patent No. 10,951,271 B2 (Ex. 1001, "the '271 patent"). Pet. 1. Apex Beam Technologies LLC ("Patent Owner") filed a Preliminary Response (Paper 8, "Prelim. Resp.").

Under 35 U.S.C. § 314(a), an *inter partes* review may not be instituted unless it is determined that there is a reasonable likelihood that the petitioner would prevail with respect to at least one of the claims challenged in the petition. After considering the parties' arguments and evidence, and for the reasons set forth below, Petitioner demonstrates a reasonable likelihood of prevailing with respect to at least one of the challenged claims of the '271 patent. Accordingly, we institute an *inter partes* review with respect to all challenged claims and grounds asserted in the Petition. 37 C.F.R. § 42.108(a) (2022).

Our factual findings and conclusions at this stage of the proceeding are based on the evidentiary record developed thus far. This is not a final decision as to patentability of the challenged claims.

II. BACKGROUND

A. Related Matters

The parties identify the following infringement lawsuits involving the '271 patent: *Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, No. 2:22-cv-00188-JRG (E.D. Tex.); *Apex Beam Technologies LLC v. ZTE Corporation*, No. 2:22-cv-00031-JRG-RSP (E.D. Tex.); *Apex Beam Technologies LLC v. OnePlus Technology (Shenzhen) Co., Ltd.*, No. 2:22-

cv-00032-JRG (E.D. Tex.); and *Apex Beam Technologies LLC v. TCT Mobile International Limited et al.*, No. 2:21-cv-00438-JRG (E.D. Tex.) (collectively, the "related District Court litigation"). Pet. 65–66; Paper 5, 3.

The following *inter partes* review has also been filed against the '271 patent: *Samsung Electronics Co. v. Apex Beam Technologies LLC*, IPR2023-00747 (PTAB filed March 29, 2023).

B. Real Parties-in-Interest

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. identify themselves as the only real parties-in-interest (RPI). Pet. 65. Patent Owner identifies itself as the sole RPI. Paper 5, 2.

C. The '271 patent

The '271 patent describes a scheme for multi-antenna transmission in a wireless communication system. Ex. 1001, 1:18–19. The '271 patent explains that massive Multi-Input Multi-Output (MIMO) is a research hotspot of next-generation mobile communications. *Id.* at 1:23–25. In massive MIMO, multiple antennas use beamforming to form a relatively narrow beam which points to a particular direction to improve the quality of communication. *Id.* at 1:25–27. Hybrid beamforming, combining analog beamforming and digital precoding, has become an important research topic for New Radio Technology (NR) systems. *Id.* at 1:33–36.

The '271 patent further explains that in a massive MIMO system, the base station can perform beam scanning over a period of time resources. *Id.* at 1:40–42. The User Equipment (UE) selects and reports the beam. *Id.* at 1:42–43. However, due to the limitation of air interface resources, the number of beams used for beam scanning and the number of beams reported by the UE are limited. *Id.* at 1:43–45. In addition, due to the uncertainty of

the UE location, the beam used for beam scanning does not necessarily include the beam that best serves the UE. *Id.* at 1:45–48. How to use the information reported by the UE to form the best beam to serve the UE service is a problem the '271 patent attempts to solve. *Id.* at 1:48–50.

In the disclosed method, "K antenna port groups are used to transmit [a] first wireless signal," and "first signaling is used to determine the K antenna port groups," where "K is a positive integer greater than 1." *Id.* at 1:64–67. "[T]he K antenna port groups respectively correspond to K channel quality values," which "are K non–negative real numbers," and "the channel quality value is . . . Reference Signal Received Power (RSRP)." *Id.* at 1:67–2:2, 3:63–65. Similarly, "K1 antenna port groups of the K antenna port groups" correspond to "K1 channel quality values of the K channel quality values," where K1 "is a positive integer less than or equal to the K." *Id.* at 2:2–5.

Further, "a first proportional sequence corresponds to a ratio(ratios) among the Kl channel quality values," and "the first information is used to determine . . . the Kl antenna port groups [and] the first proportional sequence." *Id.* at 2:5–9. The "K1 channel quality values" include "a first channel quality [that] is a best channel quality value" and "a second channel quality [that] is a worse channel quality value," and "a ratio between the second channel quality and the first channel quality is greater than or equal to [a] target threshold" determined from the first signaling. *Id.* at 2:9–16. When discussing antenna port groups, the '271 patent explains that an antenna port group may be "composed of one antenna port." *Id.* at 2:45–46, 13:64–65.

D. Challenged Claims

Claim 1, below, is illustrative of the challenged claims. Additional paragraph breaks and Petitioner's claim element labels are included for ease of reference.

> 1. A method for multi-antenna transmission in a user equipment (UE), comprising:
>
> [1a] receiving, by the UE, a first signaling originating from a base station;
>
> [1b] receiving, by the UE, a first wireless signal originating from the base station; and
>
> [1c] transmitting, by the UE, first information to the base station;
>
> [1d]
>
> [1d1] wherein, K antenna port groups of the base station are used to transmit the first wireless signal;
>
> [1d2] the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;
>
> [1d3] the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs);
>
> [1d4] K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;
>
> [1d5] a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;
>
> [1d6] the first information is used to determine the K1 antenna port groups and the first proportional sequence;
>
> [1d7] the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;

[1d8] a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;

[1d9] a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

Ex. 1001, 27:14–47; *see* Pet. 10–35, Claims Appendix.

E. Asserted Ground of Unpatentability

Petitioner asserts the following ground of unpatentability (Pet. 9):

Claim(s) Challenged	35 U.S.C. §[1]	Reference(s)/Basis
1–20	103	Liu,[2] Park[3]

Petitioner also relies on the declaration of Dr. Apostolos K. Kakaes (Ex. 1003). Patent Owner has not submitted declaration testimony at this stage.

III. ANALYSIS

A. Discretion under 35 U.S.C. § 314(a)

Patent Owner argues that we should exercise discretion under § 314(a) to deny institution in light of the related District Court litigation. Prelim. Resp. 25–32.

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[1] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 285–88 (2011), revised 35 U.S.C. §§ 102, 103 effective March 16, 2013. The '113 patent's earliest claimed priority application was filed after March 16, 2013, so the AIA versions of §§ 102, 103 apply. Ex. 1001, code (30).

[2] WIPO Publication No. WO 2016/015307 A1 to Liu, published Feb. 4, 2016 (Ex. 1006).

[3] WIPO Publication No. WO 2016/126099 A1 to Park, published Aug. 11, 2016 (Ex. 1009).

We consider the following factors when determining whether to deny institution under § 314(a) based on a parallel district court proceeding:

> 1. whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;
>
> 2. proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;
>
> 3. investment in the parallel proceeding by the court and the parties;
>
> 4. overlap between issues raised in the petition and in the parallel proceeding;
>
> 5. whether the petitioner and the defendant in the parallel proceeding are the same party; and
>
> 6. other circumstances that impact the Board's exercise of discretion, including the merits.

Apple Inc. v. Fintiv, Inc., IPR2020-00019, Paper 11 at 5–6 (PTAB Mar. 20, 2020) (precedential) ("*Fintiv*"). We also consider "several clarifications" made by the Director of the United States Patent and Trademark Office ("USPTO"). *See* USPTO Memorandum, Interim Procedure for Discretionary Denials in AIA Post Grant Proceedings with Parallel District Court Litigation, 2 (June 21, 2022) ("Director's Memo").[4]

The Director's Memo provides that "[c]onsistent with *Sotera Wireless, Inc.*,[5] the PTAB will not discretionarily deny institution in view of parallel district court litigation where a petitioner presents a stipulation not to pursue in a parallel proceeding the same grounds or any grounds that

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[4] *Available at* https://www.uspto.gov/sites/default/files/documents/interim_proc_discretionary_denials_aia_parallel_district_court_litigation_memo_20220621_.pdf.

[5] *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 at 18–19 (PTAB Dec. 1, 2020) (precedential).

could have reasonably been raised before the PTAB." Director's Memo 3. With our authorization, Petitioner has filed a stipulation which stipulates that "if the PTAB institutes *inter partes* review, Petitioner 'will not pursue in [*Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, Case No. 2:22-cv-00188-JRG (E.D. Tex.) (consolidated with *Apex Beam Technologies LLC v. ZTE Corporation*, Case No. 2:22-cv-00031-JRG-RSP (E.D. Tex.))] the specific grounds [asserted in IPR2023-00571], or . . . any other ground . . . that was raised or could have been reasonably raised in an IPR (i.e., any ground that could be raised under §§ 102 or 103 on the basis of prior art patent or printed publications).'" Ex. 1032, 1.

We determine that the language of this stipulation sufficiently comports with the language of the Director's Memo, consistent with *Sotera Wireless, Inc.* *See* Director's Memo 3. We accordingly decline to discretionarily deny institution in view of the related District Court litigation.[6]

B. Notice Ranking Petitions

Petitioner filed two concurrent petitions (IPR2023-00571 and IPR2023-00747) challenging the patentability of claims 1–20 of the '271 patent. Consistent with the Board's practice for handling parallel petitions provided in the Consolidated Trial Practice Guide ("CTPG" or "Trial Practice Guide"),[7] Petitioner filed a Notice Ranking Petitions (Paper 2,

[6] Patent Owner urges us not to accept a "late" *Sotera* stipulation. Prelim. Resp. 33–35. We disagree that Petitioner's *Sotera* stipulation is late. It is within our discretion to permit Petitioner to file a stipulation prior to institution. *See NXP USA, Inc. v. Impinj, Inc.*, IPR2021-01566, Paper 13 (PTAB Sept. 7, 2022) (precedential).

[7] *Available at* https://www.uspto.gov/TrialPracticeGuideConsolidated.

"Notice"). *See* CTPG 59–60. Patent Owner did not file a response to Petitioner's Notice or address the Notice in its Preliminary Response.

In the Notice, Petitioner states that although it "believes that both Petitions are meritorious and justified," it ranks the Petition filed in this proceeding first and the -00747 petition second. Notice, 1. Although we have discretion to deny a parallel petition under 35 U.S.C. § 314(a) (*see* CTPG 61), in light of Petitioner ranking this Petition first, we decline to exercise that discretion here.

C. Principles of Law

A claim is unpatentable as obvious if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (quoting 35 U.S.C. § 103(a)). We resolve the question of obviousness based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the prior art and the claims; (3) the level of skill in the art; and (4) when in evidence, objective indicia of nonobviousness. *See Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17–18 (1966).

We apply these principles to the Petition's challenges.

D. Level of Ordinary Skill in the Art

We review the grounds of unpatentability in view of the understanding of a person of ordinary skill in the art at the time of the invention. *Graham*, 383 U.S. at 13, 17. Petitioner asserts that

> A person of ordinary skill in the art ("POSITA") would have had at least a master's degree in electrical engineering or a similar field and at least two years of experience working with telecommunications systems, including multiple-input multiple-output ("MIMO") technology. Additional relevant work experience can compensate for less education, and vice versa.

Pet. 9 (citing Ex. 1003 ¶ 81).

Patent Owner uses Petitioner's proposed level of skill in the art at this stage. Prelim. Resp. 9. We are persuaded, on the present record, that Petitioner's proposal is consistent with the problems and solutions in the '271 patent and prior art of record. We adopt Petitioner's definition of the level of skill for the purposes of this Decision, except that we do not include in our definition Petitioner's last sentence regarding additional relevant work experience compensating for less education and *vice versa*, as this sentence is vague.

E. Claim Construction

In *inter partes* review, we construe a claim using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. 37 C.F.R. § 42.100(b).

The parties do not propose any claim constructions. *See* Pet. 4; Prelim. Resp. 9. As no terms are in dispute, we determine that no terms require construction at this stage. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368 (Fed. Cir. 2019) ("The Board is required to construe 'only those terms . . . that are in controversy, and only to the extent necessary to resolve

the controversy.'" (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

However, for reasons explained below, we invite the parties to construe limitation [1d5] during trial.

F. Asserted Obviousness over Liu and Park

Petitioner contends that claims 1–20 would have been obvious over the combination of Liu and Park. Pet. 9–63.

1. *Overview of Liu*

Liu describes a "signal transmission method and an associated device for performing more effective antenna selection." Ex. 1006, 1. Liu further discloses that "[d]uring antenna configuration, a second network device transmits configuration information of M antenna ports . . . and transmits signals of the M antenna ports to [a] first network device, which receives the signals of the M antenna ports transmitted by the second network device based on the configuration information." *Id.* at 15. Liu explains that "the first network device may be user equipment (UE), and the second network device may be a base station." *Id.*

2. *Overview of Park*

Park "relates to a wireless communication system" and discloses a "method for feeding back [channel state information (CSI)] from a terminal based on a reference signal." Ex. 1009 ¶ 1. Park's UE measures the signal strength of a serving cell and a neighbor cell, "including measuring the reference signal receive power (RSRP)." *Id.* ¶ 292. Based on these RSRP measurements, Park selects antenna ports "that are received strongly" and "limits reporting to RSRPs of ports that are within a certain difference compared to the RSRP of the selected antenna ports." *Id.* ¶ 372.

3. *Independent Claim 1*

a. Undisputed limitations

Petitioner asserts that, to the extent the preamble is limiting, Liu teaches the preamble by disclosing "a first network device [UE] receives signals of M antenna ports transmitted by a second network device [base station]."[8] Pet. 10 (citing Ex. 1006, 15; Ex. 1003 ¶¶ 96–97).

Petitioner contends that Liu discloses limitation [1a], "receiving, by the UE, a first signaling originating from a base station," by describing that its base station "transmits configuration information of M antenna ports to a first network device [UE]." *Id.* at 10–11 (citing Ex. 1006, 15; Ex. 1003 ¶¶ 98–100).

Petitioner also contends that Liu discloses limitation [1b], "receiving, by the UE, a first wireless signal originating from the base station," by describing the "second network device [base station] . . . transmits signals of the M antenna ports to the first network device [UE]." *Id.* at 13 (citing Ex. 1006, 15; Ex. 1003 ¶¶ 101–103).

Petitioner further contends that Liu discloses limitation [1d7], "the first signaling is used to determine a target threshold; the target threshold is a non-negative real number," by disclosing that the UE uses a "first criterion" or threshold, such as an SNR threshold, throughput threshold, or codebook information, to determine the selected (N or K1) antenna ports, and that the threshold "may be predefined or provided through base station broadcasting." *Id.* at 32 (citing Ex. 1006, 16–17; Ex. 1003 ¶¶ 144–148).

[8] We omit both parties' italicization of reference names throughout this decision.

Petitioner further contends that Liu discloses limitation [1d8], "a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values," by disclosing calculating the RSRP ("channel quality value") for each of the N (K1) antenna port groups within the M or X antenna port groups, where the RSRP values are compared and ranked from best (maximum value) to worse (less than the maximum value). *Id.* at 34 (citing Ex. 1003 ¶¶ 149–151; Ex. 1006, 17, 26).

Finally, Petitioner contends that Liu and Park disclose limitation [1d9], "a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold." *Id.* at 35. For instance, Petitioner argues, Liu discloses that the criterion or threshold for selecting antenna port groups may rely on a power ratio calculation that is "greater than or equal to" a particular threshold, including power ratios, such as signal-to-noise (SNR) ratios. *Id.* (citing Ex. 1006, *passim*; Ex. 1003 ¶¶ 153–163). Petitioner further argues this limitation based on the combination of Liu and Park, asserting that "Liu and Park both teach determining power ratio measurements (e.g., SNR or RSRP ratio) for antenna port groups and comparing the power ratio to a threshold value." *Id.* at 36 (citing Ex. 1009 ¶ 385; Ex. 1003 ¶ 154). Petitioner also sets forth a rationale to combine these references, with a reasonable expectation of success, for both limitations [1d5] and [1d9]. *See id.* at 27–29, 38–39.

Patent Owner does not dispute Petitioner's arguments regarding the preamble or these limitations at this stage; nor does Patent Owner dispute Petitioner's rationale to combine Liu and Park. We determine that on this record, Petitioner has made a sufficient showing that the combination of Liu

and Park discloses the preamble (whether or not limiting) and these limitations, and that one of ordinary skill in the art would have combined Liu and Park, with a reasonable expectation of success.

> *b. [1d1] wherein, K antenna port groups of the base station are used to transmit the first wireless signal; . . . [1d2] the K is a positive integer greater than 1*

Patent Owner argues limitations [1d1] and a portion of limitation [1d2] together, so we also address them together. Prelim. Resp. 12–15.[9]

For limitation [1d1], Petitioner first argues that Liu's base station "transmits signals of the M antenna ports" to the UE. Pet. 16 (citing Ex. 1006, 15). Noting that the '271 patent teaches that an "antenna port group may include only one antenna port," Petitioner contends that Liu's "M individual antenna ports . . . correspond to K antenna port groups having one port per group." *Id.* (citing Ex. 1001, 13:64–65, 2:45–46; Ex. 1003 ¶ 110).

On this point, Patent Owner contends that Liu's "M antenna ports" do not disclose "K antenna ***port groups***," as "Liu makes an explicit distinction between antenna port groups and singular antenna ports." Prelim. Resp. 12–13 (citing Ex. 1006, 32 ("***transmitting signals of M antenna ports***")). We find this argument unavailing, as Patent Owner does not address the disclosure in the '271 patent, cited by Petitioner in the Petition, that "the antenna port group [may] include[] only one antenna port." Ex. 1001, 13:64–65; *see also id.* at 2:45–46 ("In one embodiment, the antenna port group is composed of one antenna port."). Thus, on this record, we find

[9] We address the remainder of limitation [1d2], "the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE," in the next section.

persuasive Petitioner's argument that Liu's "M individual antenna ports . . . correspond to K antenna port groups having one port per group." Pet. 16.[10]

Petitioner sets forth an alternative argument for this limitation, which is that Liu discloses "the M antenna ports are divided into X groups," and the "base station individually configures one codebook set for each antenna port group." Pet. 16–17. Petitioner contends that "a POSITA would have understood [this] describes the base station transmitting the wireless signal for each of the X (K) antenna port groups." *Id.* at 17 (citing Ex. 1006, 21; Ex. 1003 ¶ 112). This is "because the codebook information for each group corresponds to the matrix that describes the beam pattern transmitted by the base station and received by the UE for that port group." *Id.* (citing Ex. 1006, 21; Ex. 1003 ¶ 112). For example, Petitioner argues, Liu's UE "measures . . . 5 groups of antenna ports" and records the receive signal power (RSRP) for each cell's wireless signal, "which confirms a POSITA's understanding that each group of antenna ports (e.g., cell) is used to transmit a corresponding wireless signal." *Id.* (citing Ex. 1006, 26; Ex. 1003 ¶ 112).

Patent Owner disputes Petitioner's reliance on Liu's "codebook sets" because "Liu's codebook sets . . . are not the same as the claimed first wireless signal." Prelim. Resp. 14. Rather, Patent Owner argues, Liu describes codebook information relating to "antenna configuration, but ***configuration*** is not a base station ***transmission*** of a first wireless signal." *Id.* at 14–15 (citing Ex. 1006, 21). Further, Patent Owner contends that Liu's UE uses the codebooks, which is "not the same as transmitting the first

[10] To the extent Patent Owner disagrees that the term "antenna port groups" should be interpreted as Petitioner argues, Patent Owner should make its claim construction position explicit during trial.

wireless signal ***from the base station***." *Id.* at 15 (citing Ex. 1006, 21–22). Even if Liu's codebook information were transmitted from the base station, Patent Owner argues, "it would be on an antenna port by antenna port basis as described above, and not collectively transmitted by multiple antenna port groups." *Id.*

It appears, on this record, that Liu's codebook disclosure may meet this limitation, as Liu teaches, for example, that "alternatively, first information of the N antenna ports is transmitted to the second network device [base station], which determines the N antenna ports," and that "the M antenna ports are divided into X groups, and *the base station* individually configures one codebook set *for each antenna port group*." Ex. 1006, 16, 21 (emphasis added). Liu further teaches that the UE calculates "mean reference signal receiving power (RSRP)" and "feeds back the index corresponding to the antenna configuration having the largest RSRP to the base station," which appears to suggest that the base station will use this information to transmit the first wireless signal on "the antenna configuration." *Id.* at 21–22. All these disclosures appear to support Dr. Kakaes's testimony that "a POSITA would have understood [that Liu] describes the base station transmitting the wireless signal for each of the X (K in the '271 patent) antenna port groups." Ex. 1003 ¶ 112.

However, Liu's teaching that "the base station individually configures one codebook set for each antenna port group" is somewhat unclear. *See* Ex. 1006, 21. This statement refers to the base station *configuring* antenna port groups but, standing alone, does not appear to refer to *transmitting* using multiple antenna port groups, although such appears to be implied by this statement and the surrounding disclosure discussed above. *See id.* The

parties should clarify how Liu's codebook disclosure allegedly meets, or does not meet, limitation [1d1] during trial. Regardless, Petitioner's first argument based on the '271 patent's broad disclosure that "the antenna port group [may] include[] only one antenna port," addressed above, is sufficient to meet Petitioner's institution burden for limitation [1d1]. *See* Pet. 16 (citing Ex. 1001, 13:64–65, 2:45–46; Ex. 1003 ¶ 110).

For the portion of limitation [1d2] highlighted above, "the K is a positive integer greater than 1," Petitioner argues that Liu discloses "M is a positive integer" and "X is a positive integer." Pet. 17 (citing Ex. 1006, 15, 23, 31). Petitioner also points to Liu's Figure 2, which shows "a configuration diagram of multiple [greater than one] antennas in an exemplary active antenna array." *Id.* at 17–18 (citing Ex. 1006, 15; Ex. 1003 ¶ 114). Petitioner also quotes Liu's disclosure of "M antenna ports," i.e., plural antenna ports. *Id.* at 18 (citing Ex. 1006, 16, 23, 25, 32).

Patent Owner responds that "Petitioner failed to specify where this required element of the claim is found in the prior art," but Patent Owner does not address the disclosures of Liu relied on by Petitioner and discussed above. Prelim. Resp. 13. Based on those disclosures, we determine that Petitioner sufficiently explains for institution purposes that Liu discloses "the K is a positive integer greater than 1." *See* Pet. 17–18.

Accordingly, at this stage, Petitioner persuades us that Liu discloses limitations [1d1] and the portion of [1d2] addressed in this section.

c. [1d2] the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE

We next address the remainder of limitation [1d2], "the first signaling is used by the UE to determine the K antenna port groups transmitting the

first wireless signal received by the UE." Petitioner contends that Liu uses the configuration information described above for limitation [1a] to determine the M antenna port groups transmitting the first wireless signal received by the UE. Pet. 18 (citing Ex. 1003 ¶ 115). Petitioner contends that a POSITA would have understood that the UE uses this configuration information and broadcasting and signal notifications ("first signaling") to determine the M antenna port groups "because the configuration information specifies the antenna port groups and includes 'an antenna port pattern' and '[c]odebook information [that] refers to information containing multiple precoding matrices' of the antenna port groups." *Id.* (citing Ex. 1006, 16, 21; Ex. 1003 ¶ 115). Petitioner further contends that the "UE uses this information to determine and measure the antenna port groups," and once it has done so, the UE "selects the best antenna configuration and sends the identifying information to the base station." *Id.* at 18–19 (citing Ex. 1006, 16, 21; Ex. 1003 ¶ 115).

Patent Owner repeats arguments from the previous limitations, which we find unavailing on this record. Prelim. Resp. 16–17. Patent Owner additionally argues that "Liu does not disclose any of the types of information that would be indicative of disclosing the claimed first signaling." *Id.* at 18. Pointing to the '271 patent specification's disclosure of quasi-co-located (QCL) information as the claimed "first signaling," Patent Owner contends that Liu lacks a description of such QCL information. *Id.* (citing Ex. 1001, 6:44–49).

At this stage, Petitioner persuades us that Liu discloses this limitation. On this record, we find that Liu discloses the first signaling information (including configuration information) as explained above for limitation [1a],

which Patent Owner does not challenge. Further, we agree on this record that Liu's UE uses this configuration information to determine the M antenna port groups "because the configuration information specifies the antenna port groups and includes 'an antenna port pattern' and '[c]odebook information [that] refers to information containing multiple precoding matrices' of the antenna port groups." Pet. 18 (citing Ex. 1006, 16, 21; Ex. 1003 ¶ 115). Patent Owner's argument based on disclosed but not claimed QCL information is unavailing.[11]

> *d. [1d3] the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs); . . . [1d5] a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values*

Patent Owner argues limitations [1d3] through [1d5] together.[12] Prelim. Resp. 19–22. We address limitations [1d3] and [1d5] in this section and address limitation [1d4] in the next section.

For limitation [1d3], Petitioner contends that Liu's channel state information ("CSI") includes "a channel quality value, such as RSRP." Pet.

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[11] To the extent Patent Owner is relying on an implicit claim construction of "first signaling," Patent Owner should make this construction explicit during trial. However, we note that the QCL disclosure Patent Owner relies on is couched in "embodiment" language and, without more, does not warrant limiting the claims. *See* Prelim. Resp. 18 (citing Ex. 1001, 6:44–49).

[12] Limitations [1d3] through [1d5] constitute a large block of text. To the extent possible during trial, for clarity, the Board requests Patent Owner to address individual limitations separately in its briefing, preferably under separate headings. For consistency, Patent Owner should also follow Petitioner's claim element numbering.

19–20 (citing Ex. 1006, 21 ("the [UE] employs a random beamforming approach in the codebook set . . . to calculate and report mean reference signal receiving power (RSRP)")). Petitioner adds, "a POSITA would have recognized [RSRP] is a non-negative real number, because RSRP is the received power in Watts of the wireless signal, which a POSITA would have known is always a non-negative real number." *Id.* at 19–20 (citing Ex. 1006, 21; Ex. 1003 ¶ 117).

For limitation [1d5], Petitioner asserts obviousness based on Liu alone as well as Liu in combination with Park. *Id.* at 22. Petitioner first contends that "Liu discloses determining a reference signal receiving quality (RSRQ), which a POSITA would have recognized is a ratio of RSRP over the received signal strength indicator (RSSI)." *Id.* (citing Ex. 1003 ¶ 126; Ex. 1006, 21, 30–31, 16, 26). Petitioner further explains that Liu's RSRQ for the N (K1) antenna port groups of the M antenna port groups (see limitation [1d4] below) "together form a proportional sequence of RSRP and RSSI ratios." *Id.* (citing Ex. 1009 ¶ 295; Ex. 1014, 514; Ex. 1003 ¶ 126). In so stating, Petitioner and Dr. Kakaes cite Park, rather than Liu. *Id.*; Ex. 1003 ¶ 126. Because Petitioner appears to argue earlier that Liu alone discloses or suggests this limitation, but then cites to Park for the claimed "first proportional sequence," Petitioner should clarify during trial whether it truly relies on Liu alone. For purposes of determining whether to institute trial, we assume that Petitioner relies solely on the combination of Liu and Park for limitation [1d5].

Patent Owner, addressing Petitioner's reliance on Liu for limitation [1d3] and the "ratio(ratios)" portion of [1d5], argues that "Liu's RSSI falls squarely outside of the claim language that describes 'the K channel quality

values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs).'" Prelim. Resp. 19. Patent Owner provides no further explanation for this assertion. For example, Patent Owner does not dispute Dr. Kakaes's testimony that a POSITA would have recognized RSRP as a ratio of RSRP over the received signal strength indicator (RSSI). *See id.*; Ex. 1003 ¶ 126; Pet. 22. We find Petitioner's argument for limitation [1d3] and limitation [1d5]'s "ratio(ratios) among the K1 channel quality values" to be supported by Dr. Kakaes's testimony and persuasive at this stage.

We now turn to Petitioner's Park-specific arguments regarding the "first proportional sequence" portion of limitation [1d5]. Petitioner contends that in Park, "[a] POSITA would have recognized that an 'RSRP ratio' describes the power ratio RSRP(r,m)/max(RSRP(r,m))." Pet. 24 (citing Ex. 1003 ¶ 129). Petitioner explains that "Park's FIG. 12 confirms the comparison of each measured RSRP to the max(RSRP), which forms a proportional sequence of RSRP ratios." *Id.* (citing Ex. 1009 ¶¶ 376–378; Ex. 1003 ¶ 130).

Patent Owner argues that Petitioner mischaracterizes Park, which "merely describ[es] that differences in RSRP can be expressed as a ratio." Prelim. Resp. 20 (citing Ex. 1009 ¶¶ 372–378). Regardless, Patent Owner contends, Park still does not disclose "creating a proportional ***sequence***" as claimed. *Id.* at 20–21. On this point, Patent Owner points to the '271 patent specification, arguing that the claimed "proportional sequence" has a meaning related to a "best channel quality value":

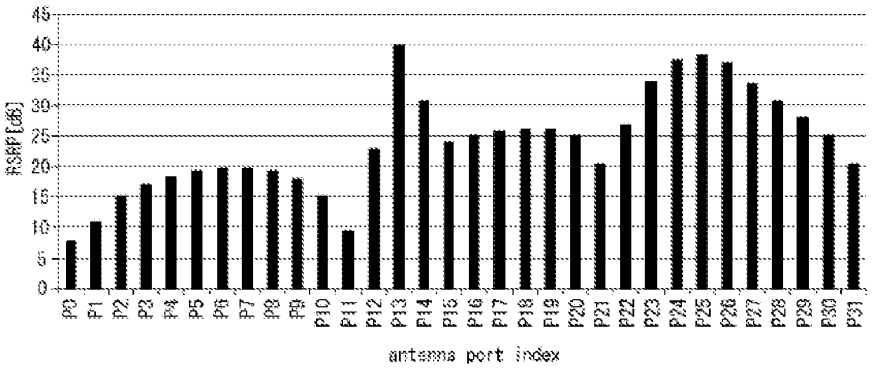
> [t]he claimed language, in view of the '271 Patent specification, is clear that the embodiment utilizing channel quality values of RSRP would create a proportion of one RSRP to all the other

> RSRPs in the K1 subset of antenna port groups to create a proportional sequence (*i.e.*, a sequence comprising ratios between channel quality values ***other than the best channel quality value***).

Id. at 21 (citing Ex. 1001, 4:29–36); *see also id.* at 21–22 (similar) (citing Ex. 1001, 24:18–31).

On this record, Petitioner persuades us that the combination of Liu and Park discloses this limitation. Petitioner persuasively explains, as supported by Dr. Kakaes's testimony, that "[a] POSITA would have recognized that an 'RSRP ratio' describes the power ratio RSRP(r,m)/max(RSRP(r,m)). . . . Park's FIG. 12 confirms the comparison of each measured RSRP to the max(RSRP), which forms a proportional sequence of RSRP ratios." Pet. 24 (citing Ex. 1009 ¶¶ 376–378, Fig. 12; Ex. 1003 ¶¶ 129–130). We reproduce Figure 12 of Park below:

[FIG. 12]



Park explains that Figure 12 shows exemplary RSRPs for each antenna port of 32 antenna ports. Ex. 1009 ¶ 377. We agree at this stage that Figure 12 and the corresponding context in paragraphs 372–378 of Park appear to disclose a proportional sequence corresponding to ratios of channel quality values (e.g., RSRP values compared to a maximum RSRP value). *See*

Ex. 1003 ¶ 130. We note, however, that the parties have not addressed in detail the meaning of limitation [1d5], including the meaning of the terms "proportional" and "corresponds." It is unclear, for example, if the word "corresponds" in "first proportional sequence corresponds to a ratio(ratios)" means that the first proportional sequence *is* merely a sequence of ratios. It is also unclear whether the word "proportional" imposes an additional, as yet unspecified, requirement for the sequence of ratios, or what quantity the sequence may be proportional to. We invite the parties to construe limitation [1d5] during trial.

Patent Owner's argument against Petitioner's application of Park is unavailing because Patent Owner attempts to import unclaimed embodiments from the '271 patent specification. *See* Prelim. Resp. 21–22. The portions of the specification Patent Owner relies on are couched in "embodiment" language, which on this record, is not shown to be limiting. *See id.*; Ex. 1001, 4:29–36 ("In one embodiment"), 24:15–31 ("In Embodiment 9").

Petitioner also sets forth an alternative argument on limitation [1d5]. Petitioner points to Patent Owner's infringement contentions from the related District Court litigation, which allegedly argue that limitations [1d5]–[1d9] "can be satisfied by subtracting dB values." Pet. 25. Petitioner contends that Park also teaches limitation [1d5] due to Park's Equation 13: "RSRP(r,m) – max(RSRP(r,m)) > Threshold." *Id.* (citing Ex. 1009 ¶¶ 372–373; Ex. 1003 ¶ 131). At this stage, Petitioner's alternative argument may have merit, but it is unclear at this stage. We invite the parties to address this argument further at trial. But the parties should address more specifically whether Equation 13 teaches the claimed proportional sequence,

independent of any reference to Patent Owner's infringement contentions. The relevant inquiry is whether the proposed combination of Liu and Park discloses the claim limitation at issue, not whether Patent Owner made a similar comparison to any allegedly infringing device. Thus, during trial, the parties should avoid discussing the alleged infringing device(s) and instead should focus on comparing the claims with the proposed combination. *See* 35 U.SC. § 311(b) ("A petitioner in an inter partes review may request to cancel as unpatentable 1 or more claims of a patent only on a ground that could be raised under section 102 or 103 and *only on the basis of prior art consisting of patents or printed publications*." (emphasis added)).

As for rationale to combine, Petitioner contends, for example, that "[a] POSITA would have been motivated to use Park's proportional sequence to compare a ratio of Liu's measured RSRP values for each of the K1 antenna port groups to identify the 'strongly received' signals, as explained by Park." Pet. 27 (citing Ex. 1003 ¶¶ 134–137). Petitioner sets forth a detailed rationale to combine with reasonable expectation of success, which Patent Owner does not challenge at this stage. *Id.* at 27–29.

On this record, we agree with Petitioner that the combination of Liu and Park discloses limitations [1d3] and [1d5] and that one of ordinary skill in the art would have combined Liu and Park, with a reasonable expectation of success.[13]

[13] As we assume above that Petitioner relies solely on the combination of Liu and Park for this limitation, and not Liu alone, we do not decide at this stage whether Liu alone discloses limitation [1d5].

e. [1d4] K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K

For this limitation, Petitioner contends that "Liu's UE determines the channel quality values (RSRP) for a subset, N, of the M antenna ports transmitting the wireless signal where 'N is an integer less than or equal to M.'" Pet. 21 (citing Ex. 1006, Abstract, 16, Fig. 1; Ex. 1003 ¶ 123). Petitioner further explains that the "UE selects N (K1) antenna port groups and sends the channel quality value information (RSRP) back to the base station as first information, for example, using a 'feedback unit' for 'selecting N antenna ports from among M antenna ports.'" *Id.* (citing Ex. 1006, 7, 11; Ex. 1003 ¶ 124).

Patent Owner contends that "the description of Park discusses creating RSRP ratios for 'a maximum of L antenna ports,' instead of RSRP ratios for a subset of antenna port groups (*e.g.*, K1 out of a K total antenna port groups), as the claim limitation requires." Prelim. Resp. 22 (citing Ex. 1009 ¶ 372). At this stage, Patent Owner's argument is inapposite because Petitioner relies on Liu, not Park, for this limitation. We agree with Petitioner at this stage that Liu discloses limitation [1d4].

f. [1d6] the first information is used to determine the K1 antenna port groups and the first proportional sequence [and] [1c] transmitting, by the UE, first information to the base station

Patent Owner argues limitations [1d6] and [1c] together, so we also address them together. Prelim. Resp. 22–24. For limitation [1c], Petitioner argues that "Liu's UE transmits first information about the received wireless signal back to the base station after measuring each port signal, including

'channel state information (CSI),' such as RSRP, or 'index information' corresponding to antenna port or port groups selected by the UE." Pet. 14 (citing Ex. 1006, 16, 17; Ex. 1003 ¶ 105). For limitation [1d6], Petitioner argues that "Park's 'UE reports antenna ports with an RSRP' ratio or difference from the max(RSRP) over a desired threshold to determine the selected port groups (e.g., Liu's N or K1 antenna port groups)." *Id.* at 30 (citing Ex. 1009 ¶ 378; Ex. 1003 ¶ 141). Further, Petitioner contends that "[a] POSITA would have found it obvious to use Liu's RSRP values to create the proportional sequence, as described for [1d5], which would, in turn, be used to select Liu's N (K1) antenna port groups that 'cause the [base station] to transmit data on these N antenna ports to the [UE].'" *Id.* at 31 (citing Ex. 1006, 17; Ex. 1003 ¶ 142).

Patent Owner contends that because the Liu-Park combination does not disclose the claimed "first proportional sequence" in limitation [1d5], it cannot disclose limitation [1d6]. Prelim. Resp. 23. Similarly, Patent Owner contends that "Liu does not describe determining a subdivision of antenna port groups from K into K1," appearing to rely on its prior argument that Liu's ports "are individual ports" and not the claimed "determin[ation] of K1 antenna port groups." *Id.* We have addressed these arguments above and find them unavailing on this record. Finally, Patent Owner charges Petitioner with failing to set forth a motivation to combine Liu and Park for this limitation. *Id.* at 23–24. We also find this contention unavailing because Petitioner relies on its rationale to combine from the previous limitation [1d5], which we find sufficient at this stage. Pet. 31.

Thus, at this stage we agree with Petitioner that the combination of Liu and Park discloses limitations [1c] and [1d6].

g. Petitioner's Expert Declaration

Relying on our recent precedential *Xerox* decision, Patent Owner also contends that we should give "no weight" to Dr. Kakaes's declaration because it is "almost entirely a recitation of the Petition." Prelim. Resp. 32–33 (citing *Xerox Corp. v. Bytemar, Inc.*, IPR2022-00624, Paper 9 (PTAB Aug. 24, 2022) (precedential); 37 C.F.R. § 42.65(a)). Patent Owner asserts that "[b]ecause Dr. Kakaes provides nearly no independent analysis, aside from copying the attorney arguments in the Petition, and does not disclose the underlying facts or data upon which his opinions are based, his opinion should be entitled to no weight." *Id.*

We do not read *Xerox* to require us to give little weight to an expert declaration solely because some or all of it is also within the Petition. Rather, the Board in *Xerox* found a declaration entitled to little weight where the declaration "merely repeat[ed], *verbatim*, the conclusory assertion for which it is offered to support." *Xerox*, Paper 9 at 15. Patent Owner does not point to any specific statements in Dr. Kakaes's declaration that Patent Owner believes are conclusory, and thus, Patent Owner has not persuasively explained the applicability of *Xerox* here. Moreover, we will also be able to more fully assess the weight to be given to Dr. Kakaes's declaration in the context of a full trial record, which may include Dr. Kakaes's cross-examination testimony. Accordingly, at this stage, we decline Patent Owner's invitation to assign little weight to Dr. Kakaes's declaration.

h. Summary as to Claim 1

Based on the preliminary record before us, Petitioner has shown a reasonable likelihood that claim 1 would have been obvious over the combination of Liu and Park.

4. *Independent Claims 6, 11, 16*

Petitioner sets forth similar arguments for independent claims 6, 11, and 16 as for claim 1. *See* Pet. 53–62. Patent Owner relies on the same arguments for these claims as it does for claim 1. Prelim. Resp. 24–25. For similar reasons as discussed above, Petitioner has shown a reasonable likelihood that claims 6, 11, and 16 would have been obvious over the combination of Liu and Park.

5. *Dependent Claims 2–5, 7–10, 12–15, 17–20*

Petitioner contends that dependent claim 2–5, 7–10, 12–15, and 17–20 would have been obvious over the combination of Liu and Park. Pet. 40–54, 58, 62–63. Petitioner provides a detailed analysis explaining where the combination of Liu and Park discloses or suggests the limitations in these dependent claims, which Patent Owner does not contest at this stage. Prelim. Resp. 25.

We leave for trial the issue of whether Petitioner establishes that the combination of Liu and Park would have rendered obvious claims 2–5, 7–10, 12–15, and 17–20.

IV. CONCLUSION

At this stage of the proceeding, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing on its challenges as to at least one challenged claim. At this preliminary stage, we have not made a final determination as to the patentability of the challenged claims or any underlying factual and legal issues.

V. ORDER

It is, therefore,

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of all challenged claims of the '271 patent is instituted with respect to all grounds of unpatentability set forth in the Petition; and

FURTHER ORDERED that pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial commencing on the entry date of this Decision.

IPR2023-00571
Patent 10,951,271 B2

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Paper 10
Entered: November 13, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD., and
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner,

v.

APEX BEAM TECHNOLOGIES LLC,
Patent Owner.

IPR2023-00747
Patent 10,951,271 B2

Before JUSTIN T. ARBES, JOHN D. HAMANN, and
SCOTT RAEVSKY, *Administrative Patent Judges*.

RAEVSKY, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, "Petitioner") filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–20 of U.S. Patent No. 10,951,271 B2 (Ex. 1001, "the '271 patent"). Pet. 1. Apex Beam Technologies LLC ("Patent Owner") filed a Preliminary Response (Paper 8, "Prelim. Resp.").

Under 35 U.S.C. § 314(a), an *inter partes* review may not be instituted unless it is determined that there is a reasonable likelihood that the petitioner would prevail with respect to at least one of the claims challenged in the petition. After considering the parties' arguments and evidence, and for the reasons set forth below, Petitioner demonstrates a reasonable likelihood of prevailing with respect to at least one of the challenged claims of the '271 patent. Accordingly, we institute an *inter partes* review with respect to all challenged claims and grounds asserted in the Petition. 37 C.F.R. § 42.108(a) (2022).

Our factual findings and conclusions at this stage of the proceeding are based on the evidentiary record developed thus far. This is not a final decision as to patentability of the challenged claims.

II. BACKGROUND

A. Related Matters

The parties identify the following infringement lawsuits involving the '271 patent: *Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, No. 2:22-cv-00188-JRG (E.D. Tex.); *Apex Beam Technologies LLC v. ZTE Corporation*, No. 2:22-cv-00031-JRG-RSP (E.D. Tex.); *Apex Beam Technologies LLC v. OnePlus Technology (Shenzhen) Co., Ltd.*, No. 2:22-

cv-00032-JRG (E.D. Tex.); and *Apex Beam Technologies LLC v. TCT Mobile International Limited et al.*, No. 2:21-cv-00438-JRG (E.D. Tex.) (collectively, the "related District Court litigation"). Pet. 74; Paper 5, 3.

The following *inter partes* review has also been filed against the '271 patent: *Samsung Electronics Co. v. Apex Beam Technologies LLC*, IPR2023-00571 (PTAB filed March 29, 2023).

B. Real Parties-in-Interest

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. identify themselves as the only real parties-in-interest (RPI). Pet. 73. Patent Owner identifies itself as the sole RPI. Paper 5, 2.

C. The '271 patent

The '271 patent describes a scheme for multi-antenna transmission in a wireless communication system. Ex. 1001, 1:18–19. The '271 patent explains that massive Multi-Input Multi-Output (MIMO) is a research hotspot of next-generation mobile communications. *Id.* at 1:23–25. In massive MIMO, multiple antennas use beamforming to form a relatively narrow beam which points to a particular direction to improve the quality of communication. *Id.* at 1:25–27. Hybrid beamforming, combining analog beamforming and digital precoding, has become an important research topic for New Radio Technology (NR) systems. *Id.* at 1:33–36.

The '271 patent further explains that in a massive MIMO system, the base station can perform beam scanning over a period of time resources. *Id.* at 1:40–42. The User Equipment (UE) selects and reports the beam. *Id.* at 1:42–43. However, due to the limitation of air interface resources, the number of beams used for beam scanning and the number of beams reported by the UE are limited. *Id.* at 1:43–45. In addition, due to the uncertainty of

the UE location, the beam used for beam scanning does not necessarily include the beam that best serves the UE. *Id.* at 1:45–48. How to use the information reported by the UE to form the best beam to serve the UE service is a problem the '271 patent attempts to solve. *Id.* at 1:48–50.

In the disclosed method, "K antenna port groups are used to transmit [a] first wireless signal," and "first signaling is used to determine the K antenna port groups," where "K is a positive integer greater than 1." *Id.* at 1:64–67. "[T]he K antenna port groups respectively correspond to K channel quality values," which "are K non–negative real numbers," and "the channel quality value is . . . Reference Signal Received Power (RSRP)." *Id.* at 1:67–2:2, 3:63–65. Similarly, "K1 antenna port groups of the K antenna port groups" correspond to "K1 channel quality values of the K channel quality values," where K1 "is a positive integer less than or equal to the K." *Id.* at 2:2–5.

Further, "a first proportional sequence corresponds to a ratio(ratios) among the Kl channel quality values," and "the first information is used to determine . . . the Kl antenna port groups [and] the first proportional sequence." *Id.* at 2:5–9. The "K1 channel quality values" include "a first channel quality [that] is a best channel quality value" and "a second channel quality [that] is a worse channel quality value," and "a ratio between the second channel quality and the first channel quality is greater than or equal to [a] target threshold" determined from the first signaling. *Id.* at 2:9–16. When discussing antenna port groups, the '271 patent explains that an antenna port group may be "composed of one antenna port." *Id.* at 2:45–46, 13:64–65.

D. Challenged Claims

Claim 1, below, is illustrative of the challenged claims. Additional paragraph breaks and Petitioner's claim element labels are included for ease of reference.

> 1. A method for multi-antenna transmission in a user equipment (UE), comprising:
>
> [1a] receiving, by the UE, a first signaling originating from a base station;
>
> [1b] receiving, by the UE, a first wireless signal originating from the base station; and
>
> [1c] transmitting, by the UE, first information to the base station;
>
> [1d]
>
> [1d1] wherein, K antenna port groups of the base station are used to transmit the first wireless signal;
>
> [1d2] the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;
>
> [1d3] the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs);
>
> [1d4] K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;
>
> [1d5] a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;
>
> [1d6] the first information is used to determine the K1 antenna port groups and the first proportional sequence;
>
> [1d7] the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;

[1d8] a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;

[1d9] a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

Ex. 1001, 27:14–47; *see* Pet. 9–36, Claims Appendix.

E. Asserted Ground of Unpatentability

Petitioner asserts the following ground of unpatentability (Pet. 8):

Claim(s) Challenged	35 U.S.C. §[1]	Reference(s)/Basis
1–20	103	Kim,[2] Chen[3]

Petitioner also relies on the declaration of Dr. Apostolos K. Kakaes (Ex. 1003). Patent Owner has not submitted declaration testimony at this stage.

III. ANALYSIS

A. Discretion under 35 U.S.C. § 314(a)

Patent Owner argues that we should exercise discretion under § 314(a) to deny institution in light of the related District Court litigation. Prelim. Resp. 25–32.

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[1] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 285–88 (2011), revised 35 U.S.C. §§ 102, 103 effective March 16, 2013. The '113 patent's earliest claimed priority application was filed after March 16, 2013, so the AIA versions of §§ 102, 103 apply. Ex. 1001, code (30).

[2] U.S. Publication No. 2015/0036612 A1 to Kim, published Feb. 5, 2015 (Ex. 1027).

[3] WIPO Publication No. WO 2015/131494 A1 to Chen, published Sept. 11, 2015 (Ex. 1029). Exhibit 1029 is a certified translation of Chen (Exhibit 1028). We refer solely to Exhibit 1029 throughout this decision.

We consider the following factors when determining whether to deny institution under § 314(a) based on a parallel district court proceeding:

> 1. whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;
>
> 2. proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;
>
> 3. investment in the parallel proceeding by the court and the parties;
>
> 4. overlap between issues raised in the petition and in the parallel proceeding;
>
> 5. whether the petitioner and the defendant in the parallel proceeding are the same party; and
>
> 6. other circumstances that impact the Board's exercise of discretion, including the merits.

Apple Inc. v. Fintiv, Inc., IPR2020-00019, Paper 11 at 5–6 (PTAB Mar. 20, 2020) (precedential) ("*Fintiv*"). We also consider "several clarifications" made by the Director of the United States Patent and Trademark Office ("USPTO"). *See* USPTO Memorandum, Interim Procedure for Discretionary Denials in AIA Post Grant Proceedings with Parallel District Court Litigation, 2 (June 21, 2022) ("Director's Memo").[4]

The Director's Memo provides that "[c]onsistent with *Sotera Wireless, Inc.*,[5] the PTAB will not discretionarily deny institution in view of parallel district court litigation where a petitioner presents a stipulation not to pursue in a parallel proceeding the same grounds or any grounds that

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[4] *Available at* https://www.uspto.gov/sites/default/files/documents/interim_proc_discretionary_denials_aia_parallel_district_court_litigation_memo_20220621_.pdf.

[5] *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 at 18–19 (PTAB Dec. 1, 2020) (precedential).

could have reasonably been raised before the PTAB." Director's Memo 3. With our authorization, Petitioner has filed a stipulation which stipulates that "if the PTAB institutes *inter partes* review, Petitioner 'will not pursue in [*Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, Case No. 2:22-cv-00188-JRG (E.D. Tex.) (consolidated with *Apex Beam Technologies LLC v. ZTE Corporation*, Case No. 2:22-cv-00031-JRG-RSP (E.D. Tex.))] the specific grounds [asserted in IPR2023-00571], or . . . any other ground . . . that was raised or could have been reasonably raised in an IPR (i.e., any ground that could be raised under §§ 102 or 103 on the basis of prior art patent or printed publications).'" Ex. 1032, 1.

We determine that the language of this stipulation sufficiently comports with the language of the Director's Memo, consistent with *Sotera Wireless, Inc.* *See* Director's Memo 3. We accordingly decline to discretionarily deny institution in view of the related District Court litigation.[6]

B. Notice Ranking Petitions

Petitioner filed two concurrent petitions (IPR2023-00571 and IPR2023-00747) challenging the patentability of claims 1–20 of the '271 patent. Consistent with the Board's practice for handling parallel petitions provided in the Consolidated Trial Practice Guide ("CTPG" or "Trial Practice Guide"),[7] Petitioner filed a Notice Ranking Petitions (Paper 2,

[6] Patent Owner argues that we should not accept a late Sotera stipulation. Prelim. Resp. 32–34. We disagree that Petitioner's *Sotera* stipulation is late. It is within our discretion to permit Petitioner to file a stipulation prior to institution. *See NXP USA, Inc. v. Impinj, Inc.*, IPR2021-01566, Paper 13 (PTAB Sept. 7, 2022) (precedential).

[7] *Available at* https://www.uspto.gov/TrialPracticeGuideConsolidated.

"Notice"). *See* CTPG 59–60. Patent Owner did not file a response to Petitioner's Notice or address the Notice in its Preliminary Response.

In the Notice, Petitioner states that although it "believes that both Petitions are meritorious and justified," it ranks the Petition filed in this proceeding second and the -00571 petition first. Notice, 1. Petitioner's justification for filing two petitions is based in part upon each petition relying on different prior art references with different priority dates, "which may result in a dispute regarding whether the references qualify as prior art." *Id.* Petitioner explains that "[t]he '271 patent claims priority to a Chinese Application filed December 28, 2016," while the Park reference at issue in IPR2023-00571 was filed on February 3, 2016. *Id.* at 1–2. Accordingly, Petitioner contends, "if Patent Owner attempts to challenge the priority date of Park and/or contends that a prior art exception under 35 U.S.C. § 102(b) applies to remove Park as prior art, the Kim petition [IPR2023-00747] provides arguments based on Kim and Chen, each of which was published more than a year before the earliest claims priority date of the '271 patent." *Id.* at 3.[8] Petitioner also presents other reasons for filing two petitions, including that the obviousness grounds include material differences. *Id.* at 2.

The Trial Practice Guide provides that "multiple petitions by a petitioner are not necessary in the vast majority of cases" but acknowledges that "there may be circumstances in which more than one petition may be necessary, including, for example, . . . when there is a dispute about priority date requiring arguments under multiple prior art references." CTPG 59. Although Patent Owner has raised no priority dispute at this stage, Petitioner

[8] We omit both parties' italicization of reference names throughout.

notes the potential for a dispute regarding whether the references qualify as prior art. Notice 1–2. Patent Owner has not stipulated that any of the references at issue in the -00571 petition qualify as prior art. *See* CTPG 61 (permitting a patent owner to "seek to avoid additional petitions by proffering a stipulation . . . that certain references qualify as prior art"). Thus, there exists the potential for a prior art dispute during trial.

Although we have discretion to deny a parallel petition under 35 U.S.C. § 314(a) (*see* CTPG 61), in light of the potential for a prior art dispute and Patent Owner's silence on the matter, we decline to exercise that discretion here.

C. Principles of Law

A claim is unpatentable as obvious if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (quoting 35 U.S.C. § 103(a)). We resolve the question of obviousness based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the prior art and the claims; (3) the level of skill in the art; and (4) when in evidence, objective indicia of nonobviousness. *See Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17–18 (1966).

We apply these principles to the Petition's challenges.

D. Level of Ordinary Skill in the Art

We review the grounds of unpatentability in view of the understanding of a person of ordinary skill in the art at the time of the invention. *Graham*, 383 U.S. at 13, 17. Petitioner asserts that

> A person of ordinary skill in the art ("POSITA") would have had at least a master's degree in electrical engineering or a similar field and at least two years of experience working with telecommunications systems, including multiple-input multiple-output ("MIMO") technology. Additional relevant work experience can compensate for less education, and vice versa.

Pet. 8 (citing Ex. 1003 ¶ 81).

Patent Owner uses Petitioner's proposed level of skill in the art at this stage. Prelim. Resp. 9. We are persuaded, on the present record, that Petitioner's proposal is consistent with the problems and solutions in the '271 patent and prior art of record. We adopt Petitioner's definition of the level of skill for the purposes of this Decision, except that we do not include in our definition Petitioner's last sentence regarding additional relevant work experience compensating for less education and *vice versa*, as this sentence is vague.

E. Claim Construction

In *inter partes* review, we construe a claim using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. 37 C.F.R. § 42.100(b).

The parties do not propose any claim constructions. *See* Pet. 3; Prelim. Resp. 9. As no terms are in dispute, we determine that no terms

require construction at this stage. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368 (Fed. Cir. 2019) ("The Board is required to construe 'only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.'" (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

However, for reasons explained below, we invite the parties to construe limitation [1d5] during trial.

F. Asserted Obviousness over Kim and Chen

Petitioner contends that claims 1–20 would have been obvious over the combination of Kim and Chen. Pet. 9–71.

1. *Overview of Kim*

Kim describes a method for a terminal carrying out a measurement report in a wireless communication system. Ex. 1027, code (57). Figure 12 of Kim is reproduced below:

FIG. 12

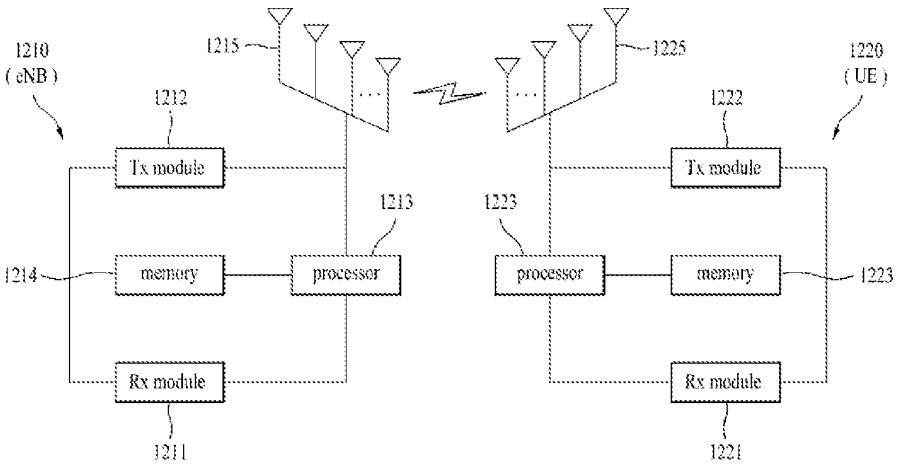


Figure 12 shows a UE device 1220 that includes an Rx module 1221, a Tx module 1222, and a plurality of antennas 1225, and a BS (base station) device 1210 that includes a reception (Rx) module 1211, a transmission (Tx) module 1212, and a plurality of antennas 1215. *Id.* ¶¶ 174, 177. The plurality of antennas of the base station and UE indicate the devices support MIMO transmission and reception. *Id.* ¶ 177.

2. *Overview of Chen*

Chen describes a channel information feedback method and pilot and beam transmission methods. Ex. 1029, 1. In Chen, a base station configures N pilot ports in M pilot ports for a terminal according to terminal information reported by the terminal. *Id.* at 11, Fig. 1. The terminal (UE) receives and detects pilot signals from the N pilot ports and detects the N pilot signals according to the port information to obtain received powers corresponding to the N types of pilot signals. *Id.* at 13. The terminal selects K pilot ports from the N pilot ports according to received signal quality, and feeds back channel information of channels formed by the K pilot ports, where the K pilot ports are selected according to a power threshold configured by the base station. *Id.* at 14.

3. *Independent Claim 1*

a. Undisputed limitations

Petitioner asserts that, to the extent the preamble is limiting, Kim teaches the preamble by disclosing "a method for a terminal carrying out a measurement report in a wireless communication system.'" Pet. 9 (citing Ex. 1027, code (57), 1; Ex. 1003 ¶¶ 96–98).

Petitioner contends that Kim discloses limitation [1a], "receiving, by the UE, a first signaling originating from a base station," by describing that

its UE receives first signaling, for example, "RRC [Radio Resource Control] signaling" that includes "CSI-RS [Channel State Information-Reference Signal] config information element[s]," from a base station. *Id.* at 10–11 (citing Ex. 1027 ¶¶ 79–81; Ex. 1003 ¶¶ 99–103).

Petitioner also contends that Kim discloses limitation [1b], "receiving, by the UE, a first wireless signal originating from the base station," by disclosing that its UE receives a first wireless signal, for example, a pilot signal or reference signal (e.g., cell-specific reference signal ("CRS") or channel state information-reference signal ("CSI-RS")), originating from the base station. *Id.* at 12 (citing Ex. 1027 ¶¶ 52, 57–64; Ex. 1003 ¶¶ 104–108).

Petitioner further contends that Kim discloses, or alternatively, that Kim and Chen render obvious, limitation [1d7], "the first signaling is used to determine a target threshold; the target threshold is a non-negative real number." *Id.* at 30–35 (citing Ex. 1003 ¶¶ 136–143). Petitioner contends that Kim alone discloses that the RSRP-to-max(RSRP) ratio of each CSI-RS RSRP value is compared to a threshold value. *Id.* at 30 (citing Ex. 1027 ¶ 149; Ex. 1003 ¶ 137). Petitioner also contends that Chen discloses that its UE selects the K antenna ports "according to a power threshold," such as "a relative threshold" (e.g., RSRP ratio), "configured by the base station." *Id.* at 31 (citing Ex. 1029, 4, 5, 7, 9, 14–15). Petitioner further contends that a POSITA would have found it obvious "to have the base station configure the relative power threshold used in both Kim and Chen at the base station, as taught by Chen and suggested by Kim's transmitting other threshold values for antenna port selection." *Id.* at 32 (citing Ex. 1003 ¶ 139; Ex. 1027 ¶ 163; Ex. 1029, code (57), 11, 18, 21, 23). Petitioner also sets forth a detailed

rationale to combine Kim and Chen, with a reasonable expectation of success. *See id.* at 32–35.

Petitioner further contends that Kim discloses limitation [1d8], "a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values," by disclosing a first or "best" channel quality, e.g., "max(RSRP_i)" or "best CSI-RS average Rx power level" among the selected M antenna ports. *Id.* at 35 (citing Ex. 1027 ¶¶ 136, 149; Ex. 1003 ¶¶ 144–146).

Finally, Petitioner contends that Kim discloses limitation [1d9], "a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold," arguing that Kim discloses that a ratio between the second ("worse") channel quality (RSRP_n) and first ("best") channel quality (max(RSRP_i)) is greater than Equation 4's target threshold. *Id.* at 36–37 (citing Ex. 1027 ¶¶ 136, 148–149; Ex. 1003 ¶¶ 147–148).

Patent Owner does not dispute Petitioner's arguments regarding the preamble or these limitations at this stage; nor does Patent Owner dispute the combinability of Kim and Chen. We determine that on this record, Petitioner has made a sufficient showing that the combination of Kim and Chen discloses the preamble (whether or not limiting) and these limitations, and that one of ordinary skill in the art would have combined Kim and Chen, with a reasonable expectation of success.

b. [1d1] wherein, K antenna port groups of the base station are used to transmit the first wireless signal; . . . [1d2] the K is a positive integer greater than 1

Patent Owner argues limitations [1d1] and a portion of limitation [1d2] together, so we also address them together. Prelim. Resp. 11–16.[9] For limitation [1d1], Petitioner argues that Kim, or alternatively, Kim and Chen, disclose this limitation. Pet. 16. Petitioner first contends that Kim's base station transmits wireless signals "through 1, 2, 4, or 8 antenna ports" of the base station. *Id.* (citing Ex. 1027 ¶ 71; Ex. 1003 ¶ 113). Noting that the '271 patent states that "the antenna port group" may be "composed of one antenna port," Petitioner contends that each of Kim's "antenna ports" is an "antenna port group" under the '271 patent's disclosure. *Id.* n.6 (citing Ex. 1001, 2:45–46, 13:64–65).

On this point, Patent Owner contends that Kim's "antenna ports" do not disclose "K antenna ***port groups***," as "Kim distinguishes antenna port groups and singular antenna ports." Prelim. Resp. 12–13 (citing Ex. 1027 ¶¶ 65, 74, 76. We find this argument unavailing, as Patent Owner does not sufficiently address the disclosure in the '271 patent, cited by Petitioner in the Petition, that "the antenna port group [may] include[] only one antenna port." Ex. 1001, 13:64–65; *see also id.* at 2:45–46. In particular, Patent Owner contends that the claim language explicitly requires "K is a positive integer ***greater than 1***," so "even if a group comprised one antenna port, there are still multiple (greater than 1) groups transmitting the claimed first wireless signal." Prelim. Resp. 13–14. This argument is unavailing on this

[9] We address the remainder of limitation [1d2], "the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE," in the next section.

record because Petitioner persuades us that Kim discloses transmitting multiple antenna ports—"through 1, 2, 4, or 8 antenna ports." Ex. 1027 ¶ 71. As each port may be one group under the '271 patent's disclosure, this means that Kim discloses transmitting through "greater than 1" antenna port groups.[10]

Petitioner sets forth an alternative argument based on Kim for this limitation, which is that when a pair (group) of two CSI-RS antenna ports in Kim are "mapped to the same RE [resource element]," then each CSI-RS in the pair "may be identified by different orthogonal codes." *Id.* at 18 (citing Ex. 1027 ¶ 76). Thus, Petitioner argues, Kim teaches that a CSI-RS may be an "antenna port group" having either (1) one port per group or (2) an antenna port pair having two antenna ports per group. *Id.* (citing Ex. 1027 ¶¶ 76, 141). Patent Owner does not address this argument. We find Petitioner's alternative argument over Kim sufficiently persuasive for institution.

Petitioner also sets forth an alternative argument based on the combination of Kim and Chen for this limitation, which is that Chen discloses "N pilot ports are formed by virtualization of a same group of antennas," which "a POSITA would have understood describes a group of antennas at a single base station." Pet. 19 (citing Ex. 1029, 3, 5, 7, 11, 18; Ex. 1003 ¶ 117). Petitioner contends that "[a] POSITA would have found it obvious to configure Kim's system such that the K antenna port groups transmit from a single base station so that the base station can provide

[10] To the extent Patent Owner disagrees that the term "antenna port groups" should be interpreted as Petitioner argues, Patent Owner should make its claim construction position explicit during trial.

improved transmission to the UEs within its broadcast area." *Id.* at 20 (citing Ex. 1003 ¶ 118). Petitioner sets forth further details regarding motivation to combine for this limitation with a reasonable expectation of success, which Patent Owner does not dispute at this stage. *Id.* at 20–22.

On this record, we find Petitioner's arguments regarding the combination of Kim and Chen persuasive. Chen discloses that "N pilot ports are formed by virtualization of a same group of antennas," which Dr. Kakaes testifies "a POSITA would have understood describes a group of antennas at a single base station." *See* Pet. 19 (citing Ex. 1029, 3, 5, 7, 11, 18; Ex. 1003 ¶ 117). We find this testimony persuasive at this stage.

Patent Owner first argues that Chen does not cure the deficiencies of Kim because Petitioner concedes that "Chen describes the same transmission and reporting process as Kim." Prelim. Resp. 14 (citing Pet. 18). We find this argument unavailing, as Petitioner relies on additional disclosure in Chen regarding antenna virtualization that is not present in Kim. *See, e.g.*, Pet. 19 (citing Ex. 1029, 3, 5, 7, 11, 18).

Patent Owner's next argument is difficult to follow and may be better understood by first reading the following statement by Petitioner, made prior to discussing the disclosure of Chen:

> Kim describes transmitting the first wireless signal from antenna ports at a [*sic*] one or more base stations. . . . *Although "a" means "one or more," . . . to the extent Patent Owner argues that a single base station is required* and that Kim does not disclose K antenna port groups of a single base station being used to transmit the first wireless signal, a POSITA would have found this obvious [over Chen].

Pet. 18 (emphasis added). Patent Owner argues that the above statement by Petitioner "recogniz[es] that this aspect of Kim contravenes the plain claim

language of 'K antenna port groups of ***the base station*** are used to transmit the first wireless signal." Prelim. Resp. 14. Continuing, Patent Owner states that "Petitioner's argument that 'a' means 'one or more' is inapposite because the claim language, 'the base station,' is clearly in the singular form." *Id.* That is, Patent Owner appears to argue that Kim does not disclose a single "base station" but then does not explain why this difference matters, as in the combination, Petitioner relies on Chen for "the base station." *See* Pet. 18 ("Chen discloses . . . 'a base station transmits . . .'" (citing Ex. 1029, code (57), 3–5, 11, 18)). To the extent Patent Owner asserts that Kim does not disclose a limitation for which Petitioner relies on Chen instead, Patent Owner impermissibly argues the references individually. *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986).

Patent Owner next argues that "Chen uses M pilot ports to transmit the same M amount of pilot signals, meaning that Chen discloses one pilot signal per pilot port, instead of the claimed 'K antenna port groups of the base station are used to transmit the first wireless signal.'" Prelim. Resp. 14–15 (citing Ex. 1029, code (57), 3, 4, 6). Even where the concept of a grouping of antennas is disclosed in the context of antenna virtualization, Patent Owner argues, "Chen clarifies that ***each pilot port*** (*i.e.*, not antenna port groups) corresponds to a set of virtualized precoding weights." *Id.* at 15–16 (citing Ex. 1029, 3, 6–9, 11, 15, 18, 20). "Moreover," Patent Owner continues, "each of Chen's virtualizations is configured to a singular 'group' of antennas, rather than the claimed multiple K antenna port ***groups***, where 'K is a positive integer greater than 1.'" *Id.* at 16.

Patent Owner does not sufficiently explain how Chen's disclosure of virtualized precoding weights undermines Dr. Kakaes's testimony regarding

Chen's virtualization disclosure. It is unclear, for instance, on this record how Patent Owner's emphasis on "virtualized precoding weights" undermines Chen's disclosure that "N pilot ports are formed by virtualization of a same group of antennas."

Finally, Patent Owner's point that Chen's virtualizations are configured to a singular group of antennas is inapposite because in the combination, Petitioner argues that Kim's system would have been configured to include the K antenna port groups based on Chen's virtualization teachings. Pet. 18–20. Kim discloses multiple antenna ports, and Chen discloses a group of antenna ports, resulting in a combination that achieves the claimed limitation, on this record. *See* Ex. 1003 ¶ 118.

For the portion of limitation [1d2] highlighted above, "the K is a positive integer greater than 1," Petitioner argues that Kim discloses "a positive integer greater than 1, for example, 2, 4, or 8 antenna ports." Pet. 23 (citing Ex. 1003 ¶ 123). Patent Owner responds that "Petitioner failed to specify where this required element of the claim is found in the prior art." Prelim. Resp. 13. We disagree. Petitioner sufficiently explains for institution purposes that Kim discloses a positive, plural number of integer antenna ports.

Accordingly, at this stage, Petitioner persuades us that Kim alone or the combination of Kim and Chen discloses limitations [1d1] and the portion of [1d2] addressed in this section.

c. [1d2] the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE

We next address the remainder of limitation [1d2], "the first signaling is used by the UE to determine the K antenna port groups transmitting the

first wireless signal received by the UE." Petitioner contends that Kim's first signaling is used by the UE to determine the K antenna port groups used to transmit the CSI-RS first wireless signal received by the UE and identified in the Resource Block by the corresponding Resource Elements. Pet. 22–23 (citing Ex. 1003 ¶ 123).

Patent Owner raises similar arguments as for the previous limitations, which we find unavailing on this record. Prelim. Resp. 16–18. Patent Owner additionally argues that "Kim does not disclose any of the types of information that would be indicative of disclosing the claimed first signaling." *Id.* at 18. Pointing to the '271 patent specification's disclosure of quasi-co-located (QCL) information as the claimed "first signaling," Patent Owner contends that Kim lacks a description of such QCL information. *Id.* (citing Ex. 1001, 6:44–49).

At this stage, Petitioner persuades us that Kim discloses this limitation. On this record, Kim discloses the first signaling information as explained above for limitation [1a], which Patent Owner does not challenge. Further, we agree on this record that Kim's UE uses this signaling information to determine the K antenna port groups used to transmit the CSI-RS first wireless signal received by the UE and identified in the Resource Block by the corresponding Resource Elements. Pet. 22–23 (citing Ex. 1003 ¶ 123). Patent Owner's argument based on disclosed but not claimed QCL information is unavailing.[11]

[11] To the extent Patent Owner is relying on an implicit claim construction of "first signaling," Patent Owner should make this construction explicit during trial. However, we note that the QCL disclosure Patent Owner relies on is couched in "embodiment" language and, without more, does not warrant limiting the claims. *See* Prelim. Resp. 18 (citing Ex. 1001, 6:44–49).

> d. *[1d3] the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs);*
> *[1d4] K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;*
> *[1d5] a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values*

Patent Owner argues limitations [1d3] through [1d5] together, so we likewise address them together.[12] Prelim. Resp. 19–22.

For limitation [1d3], Petitioner contends that "Kim discloses that each antenna port transmitting the CSI-RSs has a corresponding channel quality value, e.g., RSRP." Pet. 25 (citing Ex. 1027 ¶¶ 111, 132, 135, 148–149; Ex. 1003 ¶ 127). Petitioner further contends, "RSRP is measured in milliwatts (mW), which are non-negative real numbers." *Id.* (citing Ex. 1027 ¶ 135; Ex. 1003 ¶ 127). Although Patent Owner's argument groups this limitation together with limitations [1d4] and [1d5], Patent Owner does not appear to specifically dispute limitation [1d3].

For limitation [1d4], Petitioner argues that "Kim discloses measuring K antenna port groups (e.g., management set of N antenna ports) that have real, non-negative RSRP channel quality values." *Id.* at 27. According to

[12] Limitations [1d3] through [1d5] constitute a large block of text. To the extent possible during trial, for clarity, the Board requests Patent Owner to address individual limitations separately in its briefing, preferably under separate headings. For consistency, Patent Owner should also follow Petitioner's claim element numbering.

Petitioner, Kim's measurement set of M antenna port groups is included within the N channel quality values because "a maximum of M CSI-RSs . . . from among [the] N CSI-RSs contained in the CoMP management set" is reported by the UE to the base station. *Id.* (citing Ex. 1027 ¶ 149). Continuing, Petitioner argues, the M reported RSRP values (measurement set) correspond to the K1 antenna port groups that satisfy a threshold measurement. *Id.* (citing Ex. 1027 ¶¶ 111, 136, 149).

Patent Owner contends that "Kim's RSRPs are keyed to reported antenna ports, and not an antenna port group, let alone the claimed 'K1 antenna port ***groups***.'" Prelim. Resp. 20. This argument relies on Patent Owner's earlier argument for limitation [1d1], which we preliminarily reject above.

For limitation [1d5], Petitioner points to Kim's disclosure of reporting the K1 antenna ports that satisfy "the RSRP ratio" of a received port that "is higher than a predetermined threshold value" when compared to the maximum received RSRP. Pet. 28 (citing Ex. 1027 ¶¶ 149, 136; Ex. 1003 ¶ 132). Specifically, Petitioner argues, Kim discloses the indexes and RSRP values "of a maximum of M [CSI-RSs] configured to satisfy Equation 4 may be reported":

$$RSRP\_n/max(RSRP\_i)>Threshold$$

Id. (citing Ex. 1027 ¶¶ 149, 136). According to Petitioner, this equation results in ratios that comprise a first proportional sequence:

> [a] POSITA would have understood that, because each of the RSRP values of the reported antenna ports (K1 antenna ports) satisfies Equation 4's threshold ratio, the corresponding ratios comprise a first proportional sequence among the reported (K1) channel quality RSRP values because they would be compared against the measured values to determine which are above the

> threshold requirement to determine "a maximum of M" to be reported, thus creating a sequence.

Id. (citing Ex. 1003 ¶ 132).

Patent Owner contends that Kim's equation 4 "is inapposite to the creation of a sequence of ratio(s)." Prelim. Resp. 20 (citing Ex. 1027 ¶ 149). This equation does not create a "proportional ***sequence***," Patent Owner contends, because the specification of the '271 patent makes "clear that the embodiment utilizing channel quality values of RSRP would create a proportion of one RSRP to all the other RSRPs in the K1 subset of antenna port groups to create a proportional sequence (*i.e.*, a sequence comprising ratios between channel quality values ***other than the best channel quality value***)." *Id.* at 20–21 (citing Ex. 1001, 4:29–36, 24:18–31).

On this record, we find Petitioner's argument more convincing, as Dr. Kakaes persuasively testifies at this stage that Kim's equation 4 would result in the claimed proportional sequence. Ex. 1003 ¶ 132. Patent Owner's argument to the contrary is unavailing because Patent Owner attempts to import unclaimed embodiments from the '271 patent specification. *See id.* Prelim. Resp. 20–21. The portions of the specification Patent Owner relies on are couched in "embodiment" language, which on this record, is not shown to be limiting. *See id.* (citing Ex. 1001, 4:29–36 ("In one embodiment"), 24:15–31 ("In Embodiment 9")).

We note, however, that the parties have not addressed in detail the meaning of limitation [1d5], including the meaning of the terms "proportional" and "corresponds." It is unclear, for example, if the word "corresponds" in "first proportional sequence corresponds to a ratio(ratios)" means that the first proportional sequence *is* merely a sequence of ratios. It is also unclear whether the word "proportional" imposes an additional, as yet

unspecified, requirement for the sequence of ratios, or what quantity the sequence may be proportional to. We invite the parties to construe limitation [1d5] during trial.

Thus, at this stage we agree with Petitioner that Kim discloses limitations [1d3] through [1d5].

> e. *[1d6] the first information is used to determine the K1 antenna port groups and the first proportional sequence [and] [1c] transmitting, by the UE, first information to the base station*

Patent Owner argues limitations [1d6] and [1c] together, so we also address them together. Prelim. Resp. 22–24. For limitation [1c], Petitioner argues that "Kim's UE transmits a 'measurement report' containing first information, such as antenna port indices, RSRP values, RSRP-to-max(RSRP) ratios, and other information of the CRS and/or CSI-RS wireless signals to the base station." Pet. 15 (citing Ex. 1027 ¶¶ 105–106, 110–111, 136, 149). For limitation [1d6], Petitioner refers back to limitation [1d5], arguing that

> As explained for [1d5], the first information, such as antenna port indices, RSRP values, and RSRP-to-max(RSRP) ratios, is used to determine the M reported antenna port groups satisfying the threshold of Equation 4 (K1 antenna port groups) and the first proportional sequence of RSRP-to-max(RSRP) values, such as determined using Equation 4.

Pet. 29–30 (citing Ex. 1003 ¶ 135).

Patent Owner argues that Kim does not disclose a "first proportional sequence" or "a subdivision of antenna port groups from K into K1." Prelim. Resp. 23. "[E]ven if Kim's CSI-RS configuration is for an antenna port group," Patent Owner argues, "RSRPs are 'respectively measured' for each antenna port." *Id.* (citing Ex. 1027 ¶ 138). We preliminarily reject

similar "antenna port groups" and "proportional sequence" arguments above. On this record, we agree with Petitioner that Kim discloses limitations [1c] and [1d6].

f. Petitioner's Expert Declaration

Relying on our recent precedential *Xerox* decision, Patent Owner also contends that we should give "no weight" to Dr. Kakaes's declaration because it is "almost entirely a recitation of the Petition." Prelim. Resp. 32 (citing *Xerox Corp. v. Bytemar, Inc.*, IPR2022-00624, Paper 9 (PTAB Aug. 24, 2022) (precedential); 37 C.F.R. § 42.65(a)). Patent Owner asserts that "[b]ecause Dr. Kakaes provides nearly no independent analysis, aside from copying the attorney arguments in the Petition, and does not disclose the underlying facts or data upon which his opinions are based, his opinion should be entitled to no weight." *Id.*

We do not read *Xerox* to require us to give little weight to an expert declaration solely because some or all of it is also within the Petition. Rather, the Board in *Xerox* found a declaration entitled to little weight where the declaration "merely repeat[ed], *verbatim*, the conclusory assertion for which it is offered to support." *Xerox*, Paper 9 at 15. Patent Owner does not point to any specific statements in Dr. Kakaes's declaration that Patent Owner believes are conclusory, and thus, Patent Owner has not persuasively explained the applicability of *Xerox* here. Moreover, we will also be able to more fully assess the weight to be given to Dr. Kakaes's declaration in the context of a full trial record, which may include Dr. Kakaes's cross-examination testimony. Accordingly, at this stage, we decline Patent Owner's invitation to assign little weight to Dr. Kakaes's declaration.

g. Summary as to Claim 1

Based on the preliminary record before us, Petitioner has shown a reasonable likelihood that claim 1 would have been obvious over the combination of Kim and Chen.

4. *Independent Claims 6, 11, 16*

Petitioner sets forth similar arguments for independent claims 6, 11, and 16 as for claim 1. *See* Pet. 56–71. Patent Owner relies on the same arguments for these claims as it does for claim 1. Prelim. Resp. 24. For similar reasons as discussed above, Petitioner has shown a reasonable likelihood that claims 6, 11, and 16 would have been obvious over the combination of Kim and Chen.

5. *Dependent Claims 2–5, 7–10, 12–15, and 17–20*

Petitioner contends that dependent claim 2–5, 7–10, 12–15, and 17–20 would have been obvious over Kim or the combination of Kim and Chen. Pet. 37–55, 57, 64, 71. Petitioner provides a detailed analysis explaining where the combination of Kim and Chen discloses or suggests the limitations in these dependent claims, which Patent Owner does not contest at this stage. Prelim. Resp. 24–25.

We leave for trial the issue of whether Petitioner establishes that Kim or the combination of Kim and Chen would have rendered obvious claims 2–5, 7–10, 12–15, and 17–20.

IV. CONCLUSION

At this stage of the proceeding, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing on its challenges as to at least one challenged claim. At this preliminary stage, we have not made a

final determination as to the patentability of the challenged claims or any underlying factual and legal issues.

V. ORDER

It is, therefore,

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of all challenged claims of the '271 patent is instituted with respect to all grounds of unpatentability set forth in the Petition; and

FURTHER ORDERED that pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial commencing on the entry date of this Decision.

PETITIONER:

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Keven Rodkey
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Mingji Jin
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AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Eastern District of Texas, Marshall Division on the following

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-000188	06-01-2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	SAMSUNG ELECTRONICS CO., LTD. and SAMSUNG ELECTRONICS AMERICA, INC.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
2	10,568,113	2/18/2020	Apex Beam Technologies LLC
3	10,912,081	2/2/2021	Apex Beam Technologies LLC
4	10,944,527	3/9/2021	Apex Beam Technologies LLC
5	10,951,271	3/16/2021	Apex Beam Technologies LLC

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00032	02-01-2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00031	02/01/2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	ZTE CORPORATION

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AMENDED

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:21-cv-00438	11/30/2021	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	TCT Mobile International Limited, TCL Electronics Holdings Limited, TCL Technology Group Corporation, TCLCommunication Limited, and TCL Communication Technology Holdings Limited

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/454,075	06/27/2019	Xiaobo ZHANG	ZL0205-0003-PCT-US

CONFIRMATION NO. 3768

155075
Zhong Law, LLC
100 Connell Drive
Suite 2300
Berkeley Heights, NJ 07922

POA ACCEPTANCE LETTER

OC000000129833835

Date Mailed: 11/18/2021

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/12/2021.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/zabraha/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/454,075	06/27/2019	Xiaobo ZHANG	S3876.10059US01

CONFIRMATION NO. 3768

97149
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

POWER OF ATTORNEY NOTICE

OC000000129833734

Date Mailed: 11/18/2021

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/12/2021.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/zabraha/

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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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	16/454,075
Filing Date	06-27-2019
First Named Inventor	Xiaobo ZHANG
Title	Method and Device for Multi-Antenna Transmission in UE and Base Station
Art Unit	2474
Examiner Name	DUONG, FRANK
Attorney Docket Number	ZL0205-0003-PCT-US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Jialin Zhong/	Date (Optional)	
Name	Jialin Zhong	Registration Number	62937
Title (if Applicant is a juristic entity)	Registered Patent Attorney		
Applicant Name (if Applicant is a juristic entity)	APEX BEAM TECHNOLOGIES LLC		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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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.**

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

Privacy Act Statement

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

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

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

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: APEX BEAM TECHNOLOGIES LLC

Application No./Patent No.: 16/454,075 Filed/Issue Date: 06-27-2019

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

APEX BEAM TECHNOLOGIES LLC, a Limited Liability Company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: XIAOBO ZHANG To: SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED

The document was recorded in the United States Patent and Trademark Office at
Reel 049602, Frame 0035, or for which a copy thereof is attached.

2. From: SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED To: APEX BEAM TECHNOLOGIES LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 058068, Frame 0338, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

PTO/AIA/96 (08-12)
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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.

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

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

Electronic Acknowledgement Receipt	
EFS ID:	44268432
Application Number:	16454075
International Application Number:	
Confirmation Number:	3768
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Jialin Zhong/Eddie Rowell
Filer Authorized By:	Jialin Zhong
Attorney Docket Number:	S3876.10059US01
Receipt Date:	12-NOV-2021
Filing Date:	27-JUN-2019
Time Stamp:	12:55:48
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	ZL0205-0003-PCT-US_Marked_UP_ADS.pdf	1625851 34f86a7c9b77366c2ba7687fd20d92b0802f8e00	no	7

Warnings:

Information:					
This is not an USPTO supplied ADS fillable form					
2	Power of Attorney	ZL0205-0003-PCT-US_82A.pdf	292404 74591d058286f7883fdc798d50b35a8729221a85	no	1
Warnings:					
Information:					
3	Power of Attorney	POA82B_Apex_ex.pdf	1100582 d420eaec9e65ed86bfe977d519b96e062166a185	no	2
Warnings:					
Information:					
4	Assignee showing of ownership per 37 CFR 3.73	ZL0205-0003-PCT-US_3_73c.pdf	121280 a1f6459b1fce1b3ac5ea4a8f3e4bb49988cf4b46	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	3140117		

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	20160102-PCT-US
	Application Number	16/454,075
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

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

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xiaobo		ZHANG	

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

City	Shanghai	Country of Residence i	CN

Mailing Address of Inventor:

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

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

Correspondence Information:

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

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

Customer Number	157297		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station		
Attorney Docket Number	20160102-PCT-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	10	**Suggested Figure for Publication (if any)**	10

PTO/AIA/14 (08-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Filing By Reference:

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

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

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

Publication Information:

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

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

Representative Information:

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

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

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Domestic Benefit/National Stage Information:

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

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/CN2017/094209	2017-07-25

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)
201611236923.2	CN	2016-12-28	0770

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

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

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

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Applicant Information:

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

Applicant 1

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

Clear

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

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

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. [X] APEX BEAM TECHNOLOGIES LLC

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

Mailing Address Information For Applicant:

Address 1	104 EAST HOUSTON STREET		
Address 2	SUITE 180		
City	MARSHALL	**State/Province**	TX
Country[i]	US	Postal Code	75670
Phone Number		Fax Number	
Email Address			

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Assignee Information including Non-Applicant Assignee Information:

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

Assignee 1

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

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

Organization Name	~~SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED~~ APEX BEAM TECHNOLOGIES LLC

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	~~Room 210, 2nd Floor, No. 2088, Xietu Road~~ 104 EAST HOUSTON STREET		
Address 2	~~Xuhui District~~ SUITE 180		
City	~~Shanghai~~ MARSHALL	**State/Province**	~~CN~~ TX
Country i	~~CN~~ US	Postal Code	~~200032~~ 75670
Phone Number		Fax Number	
Email Address			

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Signature:

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

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

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

Signature	~~/Xiaobo ZHANG/~~ /Jialin Zhong/			Date (YYYY-MM-DD)	2021-11-12
First Name	~~Xiaobo~~ Jialin	Last Name	~~ZHANG~~ Zhong	Registration Number	62937

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/454,075	03/16/2021	10951271	S3876.10059US01	3768

97149 7590 02/24/2021

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

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

Xiaobo ZHANG, Shanghai, CHINA;
SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, Shanghai, CHINA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

IR103 (Rev. 10/09)

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	16454075
Filing Date	2019-06-27
First Named Inventor	XiaoBo ZHANG
Art Unit	2464
Examiner Name	NGO, RICKY QUOC
Attorney Docket Number	20160102-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
Change(s) applied to document, /SD/ 12/15/2020	1	20160143055	A1	2016-05-19	~~TELEFONAKTIEBOLAGET L M ERICSSON~~ Nammi et al.	

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]	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	2016047505	WO	A1	2016-03-31	NTT DOCOMO INC	English Abstract	☓
	2	102170335	CN	A	2011-08-31	ZTE CORPORATION	English Abstract	☒
	3	103918195	CN	A	2014-07-09	MOTOROLA MOBILITY LLC	English Abstract	☒

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo ZHANG	
Application No.:	16/454,075	Art Unit
Filed:	06/27/2019	2474
Conf. No.:	3768	
For:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION	
Examiner:	DUONG,FRANK	
Attorney Docket No.:	S3876.10059US01	

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sirs,

Applicant acknowledges Examiner's statements of Reasons for Allowance of the above-referenced patent application and agrees that the claimed subject matter is patentable. However, Applicant takes no position regarding the Reasons for Allowance presented by the Examiner other than the position Applicant may have previously taken during prosecution. Therefore, the Examiner's Reasons for Allowance should not be attributed to Applicant as an indication of the basis for Applicant's belief that the claims are patentable. Furthermore, Applicant respectfully asserts that there may also be additional reasons for patentability of the claimed subject matter not explicitly stated in this record and Applicant does not waive its rights to such arguments by not further addressing such reasons herein.

Dated this 27th day of January, 2021.

Respectfully submitted,

The Inventor: Xiaobo Zhang

By: / Xiaobo Zhang/
Xiaobo Zhang

4132 SNOWBANK CT., SAN JOSE CA 95135
Email: patent@langbomobile.com

Electronic Patent Application Fee Transmittal

Application Number:	16454075
Filing Date:	27-Jun-2019
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Filer:	Qi Zhou
Attorney Docket Number:	S3876.10059US01

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:	41753448
Application Number:	16454075
International Application Number:	
Confirmation Number:	3768
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Qi Zhou
Filer Authorized By:	
Attorney Docket Number:	S3876.10059US01
Receipt Date:	27-JAN-2021
Filing Date:	27-JUN-2019
Time Stamp:	03:39:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$600
RAM confirmation Number	E20211Q442325798
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)	20160102-PCT-US_S3876-10059US01_Issue_Fee_Transmittal.pdf	254704 e9ee63dd9f8b3f319f4029a630608297a7827b0e	no	2
Warnings:					
Information:					
2	Miscellaneous Incoming Letter	20160102_PCT_US_S3876-10059US01_Transmittal_Letter.pdf	437224 90a8629cb6203e849b7c10188b7575cf56396143	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30590 52b9398e15f59fa7caddd186522dc7c669ce2131	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	722518		

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.

<u>New Applications Under 35 U.S.C. 111</u>
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.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B – FEE(S) TRANSMITTAL

Complete and send this form, together with the applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

By fax, send to: (571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate " FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

97149 7590 11/03/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO	CONFIRMATION NO
16/454,075	06/27/2019	Xiaobo ZHANG	S3876.10059US01	3768

TITLE OF INVENTION:

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/03/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
DUONG,FRANK	2474	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363)

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1. Maschoff Brennan
2.
3.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED

(B) RESIDENCE: (CITY and STATE or COUNTRY): SHANGHAI, CHINA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees Submitted: ☑ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment (*Please first reapply any previously paid fee shown above*):

☑ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. Change of Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29. NOTE: Absent a valid Certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27. NOTE: If the application was previously under micro entity status, checking this box will be taken as a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status. NOTE: Checking this box will be taken as a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Xiaobo ZHANG/ Date January 27,2021

Typed or printed name Xiaobo ZHANG Registration No.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/454,075	06/27/2019	Xiaobo ZHANG	S3876.10059US01	3768

97149 7590 12/14/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

EXAMINER
DUONG, FRANK

ART UNIT	PAPER NUMBER
2474	

NOTIFICATION DATE	DELIVERY MODE
12/14/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

d@mabr.com

Response to Rule 312 Communication	Application No.	Applicant(s)	
	16/454,075	ZHANG, Xiaobo	
	Examiner	Art Unit	AIA (FITF) Status
	FRANK DUONG	2474	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 06 December 2020 under 37 CFR 1.312 has been considered, and has been:

a) ☑ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

/FRANK DUONG/ Primary Examiner, Art Unit 2474	

OK TO ENTER: /F.D/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo ZHANG	
Application No.:	16/454,075	Art Unit 2474
Filed:	June 27, 2019	
Conf. No.:	3768	
For:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION	
Examiner:	Frank Duong	
Customer No.:	97149	
Attorney Docket No.:	S3876.10059US01	

AMENDMENT UNDER 37 C.F.R. §1.312

Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Notice of Allowance mailed November 3, 2020, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper. **Remarks** begin on page 10 of this paper.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo ZHANG	
Application No.:	16/454,075	Art Unit 2474
Filed:	June 27, 2019	
Conf. No.:	3768	
For:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION	
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Dear Sir:

In response to the Notice of Allowance mailed November 3, 2020, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper. **Remarks** begin on page 10 of this paper.

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions and listings of claims in the application:

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

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

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

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

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

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

value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

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

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

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

receiving a second wireless signal;

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

6. **(Currently Amended)** A method for multi-antenna transmission in a base station, comprising:

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

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

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

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

7. **(Original)** The method according to claim 6, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

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

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

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

transmitting a second wireless signal;

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

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

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

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

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

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

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

13. **(Original)** The user equipment to claim 11, wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values;

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

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

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

16. **(Currently Amended)** A base station for multi-antenna transmission comprising:

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

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

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

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

17. **(Original)** The base station to claim 16, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

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

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

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

REMARKS

The amendments to the claims of this allowed application embody the correction of formal matters without changing the scope of the claims. Thus, the Applicant respectfully requests entry of the changes to the claims before the issuance and publication of the patent. In the event that Examiner finds remaining impediment to the entry of this amendment, the Examiner is requested to contact the undersigned attorney.

Dated this 6th day of December, 2020.

Respectfully submitted,

/R. Burns Israelsen, Reg. No. 42685/

R. Burns Israelsen
Registration No. 42685
Attorney for Applicant
Customer No. 97149
Telephone No. (435) 252-1360

Electronic Acknowledgement Receipt

EFS ID:	41305528
Application Number:	16454075
International Application Number:	
Confirmation Number:	3768
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Robert Burns Israelsen/Clarissa Gundersen
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	S3876.10059US01
Receipt Date:	06-DEC-2020
Filing Date:	27-JUN-2019
Time Stamp:	15:28:08
Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		S3876-10059US01_312_Amendment.pdf	338864 35135817b9e5da2165e0e738d8679c32b8702d56	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment after Notice of Allowance (Rule 312)	1	1
	Claims	2	9
	Applicant Arguments/Remarks Made in an Amendment	10	10
Warnings:			
Information:			
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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.
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<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

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NOTICE OF ALLOWANCE AND FEE(S) DUE

97149 7590 11/03/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

EXAMINER
DUONG, FRANK

ART UNIT	PAPER NUMBER
2474	

DATE MAILED: 11/03/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/454,075	06/27/2019	Xiaobo ZHANG	S3876.10059US01	3768

TITLE OF INVENTION: Method and Device for Multi-Antenna Transmission in UE and Base Station

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/03/2021

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

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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
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Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

97149 7590 11/03/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/454,075	06/27/2019	Xiaobo ZHANG	S3876.10059US01	3768

TITLE OF INVENTION: Method and Device for Multi-Antenna Transmission in UE and Base Station

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/03/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
DUONG, FRANK	2474	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1_____

2_____

3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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97149 7590 11/03/2020

Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

EXAMINER	
DUONG, FRANK	
ART UNIT	PAPER NUMBER
2474	

DATE MAILED: 11/03/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

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

Notice of Allowability	**Application No.** 16/454,075	**Applicant(s)** ZHANG, Xiaobo	
	Examiner FRANK DUONG	**Art Unit** 2474	**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 communications dated 09/30/2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-20 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/FRANK DUONG/
Primary Examiner, Art Unit 2474

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

2. This Office Action is a response to communications dated 09/30/2020. Claims 1-20 are still pending in the application.

Allowable Subject Matter

3. Claims 1-20 are allowed.

4. The following is an examiner's statement of reasons for allowance: The prior art of record, considered individually or in combination, appears to fail to fairly show or suggest a claimed invention comprising, among other limitations, novel and unobvious limitations of "*transmitting first information; wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality value is a Reference Signal Received Power (RSRP) or a Signal to Interference plus Noise Ratio (SINR); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional*

sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold," as recited in group claims 1-5 and 11-15; and "*receiving, by the base station, first information from the UE; wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality value is a Reference Signal Received Power (RSRP) or a Signal to Interference plus Noise Ratio (SINR); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold*," as recited in group claims 6-10 and 16-20, structurally and functionally interconnected in a manner as recited in the claims.

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

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to FRANK DUONG whose telephone number is (571)272-3164. The examiner can normally be reached on 7:00AM-3:30PM.

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, MICHAEL THIER can be reached on 571-272-2832. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/FRANK DUONG/
Primary Examiner, Art Unit 2474
October 29, 2020

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	**Art Unit**
	FRANK DUONG	2474

✓	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	06/25/2020	10/29/2020							
	1	✓	=							
	2	✓	=							
	3	✓	=							
	4	✓	=							
	5	✓	=							
	6	✓	=							
	7	✓	=							
	8	✓	=							
	9	✓	=							
	10	✓	=							
	11	✓	=							
	12	✓	=							
	13	✓	=							
	14	✓	=							
	15	✓	=							
	16	✓	=							
	17	✓	=							
	18	✓	=							
	19	✓	=							
	20	✓	=							

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	**Art Unit**
	FRANK DUONG	2474

CPC						
Symbol					**Type**	**Version**
H04B	/	7	/	0408	F	2013-01-01
H04B	/	7	/	0413	I	2013-01-01
H04B	/	7	/	0617	I	2013-01-01
H04W	/	72	/	085	I	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/FRANK DUONG/ Primary Examiner, Art Unit 2474	29 October 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5

U.S. Patent and Trademark Office — Part of Paper No.: 20201029

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	**Art Unit**
	FRANK DUONG	2474

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04B	/	7	/	0452

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/FRANK DUONG/ Primary Examiner, Art Unit 2474	29 October 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5

U.S. Patent and Trademark Office — Part of Paper No.: 20201029

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	**Art Unit**
	FRANK DUONG	2474

☑ 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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/FRANK DUONG/ Primary Examiner, Art Unit 2474	29 October 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5

U.S. Patent and Trademark Office — Part of Paper No.: 20201029

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	Art Unit
	FRANK DUONG	2474

CPC - Searched*		
Symbol	Date	Examiner
H04B1/0064 H04B7/024 H04B7/04 H04B7/0404 H04B7/0408 H04B7/0413 H04B7/0452 H04B7/0456 H04B7/0495 H04B7/06 H04B7/0617 H04B7/0491 H04B7/0695 H04L5/0023 H04L5/0048 H04W52/40 H04W72/085	10/28/2020	FD

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
EAST Search (see printout)	10/28/2020	FD
Inventorship Search (see printout)	10/28/2020	FD
IEEE/Internet Search using terms from the specification (see printout)	10/28/2020	FD
H04B1/0064 H04B7/024 H04B7/04 H04B7/0404 H04B7/0408 H04B7/0413 H04B7/0452 H04B7/0456 H04B7/0495 H04B7/06 H04B7/0617 H04B7/0491 H04B7/0695 H04L5/0023 H04L5/0048 H04W52/40 H04W72/085 (text search only-see printout)	10/28/2020	FD

/FRANK DUONG/ Primary Examiner, Art Unit 2474	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	Art Unit
	FRANK DUONG	2474

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	Interference Search (see printout)	10/29/2020	FD

/FRANK DUONG/ Primary Examiner, Art Unit 2474	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	10,706	(massive near3 (MIMO or (multiple adj input adj multiple adj output))) or mMIMO or ((large adj scale) near3 (MIMO or (multiple adj input adj multiple adj output))) or ("large-scale MIMO" or "massive MIMO" or "large-scale antenna systems" or "large-scale antenna" or "very large MIMO" or "very large multi-user-MIMO" or "full-dimensional MIMO" or "FD-MIMO" or "Scaling up MIMO" or "hyper MIMO" or "3-D MIMO" or "LS-MIMO")	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:54
L2	200	1 and ((antenna near3 port near4 group) or (antenna near3 group)) and (beam near3 sweep$4)	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:55
L3	75	2 and ((antenna near3 virtualiz$8) or ((beamform$4 or ("beam-form"$4)) near3 vector))	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:55
L4	65	3 and (((analog near3 (beamform$4 or (beam adj form$4))) and (digital near3 (beamform$4 or (beam adj form$4)))) or (hybrid near3 (beamform$4 or (beam adj form$4))))	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:55
L5	40	4 and (H04B1/0064 H04B7/024 H04B7/04 H04B7/0404 H04B7/0408 H04B7/0413 H04B7/0452 H04B7/0456 H04B7/0495 H04B7/06 H04B7/0617 H04B7/0491 H04B7/0695 H04L5/0023 H04L5/0048 H04W52/40 H04W72/085).CPC.	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:56

10/28/2020 2:56:26 PM

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	((antenna adj port adj group) and ((channel adj quality adj value) or ((RSRP or (reference adj signal adj receiv$4 adj power)) or (SINR or (signal near4 interference near6 noise)))) and (target adj threshold) and ((best or worse) near3 (channel adj quality))).clm.	US-PGPUB; USPAT	OR	ON	2020/10/29 09:24

10/29/2020 9:24:38 AM

IQQueryQuickExport-202010281954

Main Concept Document
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US20190319680
Title: Method and Device for Multi-Antenna Transmission in UE and Base Station

(No Concept Modifiers)
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Filters (5)
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Title+Abstract+Body Text+Related Terms limited to: analog beamform; analog beam-form; analog beamformer; analog beamforming; analog beam-former; analog beam-forming

Title+Abstract+Body Text+Related Terms limited to: digital beamform; digital beam-form; digital beamformer; digital beamforming; digital beam-former; digital beam-forming

Title+Abstract+Body Text+Related Terms limited to: Scaling up MIMO; Massive MIMO; large-scale antenna; large-scale MIMO; large-scale antenna system; very large MIMO; very large multi-user-MIMO; full-dimensional MIMO; hyper MIMO; 3-D MIMO; LS-MIMO

Title+Abstract+Body Text+Related Terms limited to: antenna port virtualization; antenna virtualization; port virtualization

Title+Abstract+Body Text+Related Terms limited to: Analog beam-forming vector; Analog beamforming vector; digital beam-forming vector; digital beamforming vector; beam-forming vector; beamforming vector

Options
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De-dup: None
Cut-off: None
Sort: Relevance

Content: Non-Patent Literature (25)
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IEEE Xplore Publications: IEEE Periodicals
IEEE Xplore Publications: IEEE Conferences
IEEE Xplore Publications: IEEE Standards
IEEE Xplore Publications: IEEE Early Access
IEEE Xplore Publications: IET Periodicals
IEEE Xplore Publications: IET Conferences

IEEE Xplore Publications: SMPTE Periodicals
IEEE Xplore Publications: SMPTE Conferences
IEEE Xplore Publications: SMPTE Standards
IEEE Xplore Publications: MIT Press eBooks
IEEE Xplore Publications: Wiley-IEEE eBooks
IEEE Xplore Publications: IBM Periodicals
IEEE Xplore Publications: URSI Periodicals
IEEE Xplore Publications: VDE Conferences
IEEE Xplore Publications: Periodicals from China
IP.com Prior Art Database: The IP.com Journal
IP.com Prior Art Database: Internet Society RFC
IP.com Prior Art Database: IBM TDB Archive
IP.com Prior Art Database: Legacy Journals
IP.com Prior Art Database: Software Patent Institute
OnePetro.org: Periodicals at OnePetro.org
OnePetro.org: Conferences at OnePetro.org
OnePetro.org: Standards at OnePetro.org
Other Literature: IBM Redbooks
Other Literature: PubMed Central

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	365	Zhang-Xiaobo.in.	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:39
L2	1	"16454075"	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:40
L3	60	1 and (RSRP or (reference adj signal adj receiv$4 adj power))	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:40
L4	41	3 and (antenna near3 (port or group))	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/10/28 14:41

10/28/2020 2:41:28 PM
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IQQueryQuickExport-202010281931

Main Concept Document
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US20190319680
Title: Method and Device for Multi-Antenna Transmission in UE and Base Station

(No Concept Modifiers)
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Filters (6)
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Title+Abstract+Description+Claims+Related Terms limited to: digital beamform; digital beam-form; digital beamformer; digital beamforming; digital beam-former; digital beam-forming

Title+Abstract+Description+Claims+Related Terms limited to: Scaling up MIMO; Massive MIMO; large-scale antenna; large-scale MIMO; large-scale antenna system; very large MIMO; very large multi-user-MIMO; full-dimensional MIMO; hyper MIMO; 3-D MIMO; LS-MIMO

Title+Abstract+Description+Claims+Related Terms limited to: antenna port virtualization; antenna virtualization; port virtualization

Title+Abstract+Description+Claims+Related Terms limited to: Analog beam-forming vector; Analog beamforming vector; digital beam-forming vector; digital beamforming vector; beam-forming vector; beamforming vector

Title+Abstract+Description+Claims+Related Terms limited to: beam sweep; beam sweeping

Options
==========
De-dup: None
Cut-off: None
Sort: Relevance

Content: Patent Publications (164)
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US Patents
US Designs

US Applications
EPO Patents
EPO Applications
China Patents
China Applications
Japan Patents
Japan Applications
Korea Patents
Korea Applications
WIPO Applications
Argentina Patents
Argentina Applications
Brazil Patents
Brazil Applications
Canada Patents
Canada Applications
Chile Patents
Chile Applications
Colombia Applications
Costa Rica Applications
Cuba Patents
Cuba Applications
Dominican Republic Applications
Ecuador Patents
Ecuador Applications
El Salvador Applications
Guatemala Applications
Honduras Applications
Mexico Patents
Mexico Applications
Nicaragua Patents
Panama Applications
Peru Applications
Trinidad & Tobago Patents
Uruguay Applications
Austria Patents
Austria Applications
Belarus Patents
Belgium Patents
Belgium Applications
Bosnia & Herzegovina Patents
Bosnia & Herzegovina Applications
Bulgaria Patents
Bulgaria Applications
Croatia Patents
Croatia Applications
Czech Republic Patents
Czech Republic Applications

Czechoslovakia Patents
Czechoslovakia Applications
Denmark Patents
Denmark Applications
Estonia Patents
Estonia Applications
EUIPO Patents
Finland Patents
Finland Applications
France Patents
France Applications
Germany Patents
Germany Applications
Great Britain Patents
Great Britain Applications
Greece Patents
Greece Applications
Hungary Patents
Hungary Applications
Iceland Patents
Iceland Applications
Ireland Patents
Ireland Applications
Italy Patents
Italy Applications
Latvia Patents
Latvia Applications
Lithuania Patents
Lithuania Applications
Luxembourg Patents
Malta Patents
Monaco Patents
Montenegro Patents
Montenegro Applications
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Norway Patents
Norway Applications
Poland Patents
Poland Applications
Portugal Patents
Portugal Applications
Republic of Moldova Patents
Republic of Moldova Applications
Romania Patents
Romania Applications
San Marino Patents
San Marino Applications

Serbia Patents
Serbia Applications
Slovakia Patents
Slovakia Applications
Slovenia Patents
Spain Patents
Spain Applications
Sweden Patents
Sweden Applications
Switzerland Patents
Switzerland Applications
Ukraine Patents
Yugoslavia/Serbia and Montenegro Patents
Yugoslavia/Serbia and Montenegro Applications
Armenia Patents
Australia Patents
Australia Applications
Cyprus Patents
Gulf Cooperation Council Patents
Hong Kong Patents
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo Zhang	
Application No.:	16/454,075	Art Unit 2474
Filed:	June 27, 2019	
Conf. No.:	3768	
For:	METHOD AND DEVICEFOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION	
Examiner:	Frank Duong	
Customer No.:	97149	
Attorney Docket No.:	20160102-PCT-US (S3876.10059US01)	

AMENDMENT AND RESPONSE TO OFFICE ACTION UNDER 37 C.F.R. § 1.111

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action dated July 2, 2020 (the "Office Action"), please consider the following:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 10 of this paper.

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions and listings of claims in the application:

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

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

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

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

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

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

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

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

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

receiving a second wireless signal;

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

6. **(Currently Amended)** A method for multi-antenna transmission in a base station, comprising:

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

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

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

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

7. **(Original)** The method according to claim 6, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

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

beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

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

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

transmitting a second wireless signal;

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

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

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

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

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

wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are

K non-negative real numbers; the K channel quality value is a Reference Signal Received Power (RSRP) or a Signal to Interference plus Noise Ratio (SINR); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

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

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

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

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

16. (**Currently Amended**) A base station for multi-antenna transmission comprising:

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

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

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

wherein, K antenna port groups of the base station are used to transmit the first wireless signal; the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality value is a Reference Signal Received Power (RSRP) or a Signal to Interference plus Noise Ratio (SINR); K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the

K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

17. **(Original)** The base station to claim 16, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

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

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

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

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

REMARKS

The above amendments amend claims 1, 6, 11, and 16. Claims 1-20 remain pending. Applicant respectfully requests reconsideration of the application in view of the above amendments to the claims and the following remarks.

Applicant reserves the right to pursue any previously pending claims or other claims that capture any subject matter supported by the present disclosure. Additionally, Applicant reserves the right, both during and after prosecution of this case, to modify or revoke the views expressed with regard to any cited reference. The term "Applicant" is used herein to refer to any entity with authority to prosecute this application.

The following remarks are not intended to exhaustively identify all distinctions between any cited reference and the claims

Rejections Under 35 U.S.C. § 112

The Office Action rejects claims 1-20 as being indefinite under 35 U.S.C. § 112. Applicant has herein amended claims 1, 6, 11, and 16 to provide more clarity with respect to the claims in a manner that renders the current rejections under § 112 moot. Applicant therefore respectfully requests that the Examiner withdraw the rejections of claims 1-20 under 35 U.S.C. § 112.

Rejections under 35 U.S.C. § 103

The Office Action rejects claims 1-20 under 35 U.S.C. § 103 over *Kim et al* (U.S. Patent No. 9,520,973) in view of *Nam et al* (U.S. Patent Publication No. 2017/0288743). Applicant respectfully submits that *Kim* and *Nam* do not disclose the claims as currently recited.

For example, amended independent claims 1, 6, 11, and 16 recite, "the K channel quality value is a Reference Signal Received Power (RSRP) or a Signal to Interference plus Noise Ratio (SINR)."

The Office Action cites *Kim* at col. 17, 18, 22, and 23 in addition to tables 6, 10, and 11 to reject the following elements of claims 1, 6, 11, and 16:

> the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a

> first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence

Applicant respectfully submits that *Kim* fails to disclose the above-recited elements of the independent claims as there is no counterpart of the first proportional sequence in *Kim*. In particular, the first proportional sequence in the claims and the parameters mention in in *Kim* have totally different physical meanings.

For example, in amended independent claims 1, 6, 11, and 16, Applicant has clarified that "a first proportional sequence corresponds to a ratio(ratios) among the K1 **channel quality values**", and "the K channel quality values **are RSRP or SINR**". Thus, the first proportional sequence is **calculated based on the result of the channel measurement** using CSI-RS.

By comparison, cols. 17, 18, 22, and 23 in *Kim* discuss the configuration of CSI-RS. Further, all parameters listed in tables 6, 10, and 11 in *Kim* are configuration parameters for the transmission of CSI-RS, such as the time/frequency resources, antenna port, transmission power, etc. These parameters **do not depend on the results of channel measurement nor do they include channel quality information such as RSRP or SINR**. Whereas, as indicated above, the first proportional sequence of the claims is calculated based on the results of channel measurements indicated by channel quality values of RSRP or SINR.

The Office Action on page 8 also cites *Nam* para. [0222] to reject the following elements of claims 1, 6, 11, and 16:

> the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold

Applicant respectfully submits that *Nam* fails to disclose the above-recited elements of claims 1, 6, 11, and 16 as there is no counterpart to the claimed target threshold in *Nam*.

For example, the target threshold in the present application and the claims is a threshold of a ratio between two channel qualities such as **RSRP and SINR**. By contrast, the threshold in *Nam*

is a threshold of **delay spread or Doppler**. (*See, e.g., Nam,* para. [0228]). Thus, the physical meanings of the target threshold in the present application and threshold discussed in *Nam* are different.

Additionally, the purpose of the target threshold in the present application and claims is a restriction of channel quality report, i.e., to restrict the difference between the largest and smallest channel qualities in a UE report. By contrast, the purpose of the threshold in *Nam* appears to be to provide a condition for a UE to decide when to trigger a request for an MRS pattern change. (*See, e.g., Nam,* para. [0227]).

In summary, *Kim* and *Nam* do not appear to disclose the elements of amended independent claims 1, 6, 11, and 16, specifically "a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence", "the K channel quality values are RSRP or SINR", "the first signaling is used to determine the target threshold", and "a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold".

For at least the reasons discussed above, claims 1, 6, 11, and 16 appear to be allowable. Applicant therefore respectfully requests that the Examiner withdraw the rejections under 35 U.S.C. § 103 of claims 1, 6, 11, and 16 and of claims 2-5, 7-10, 12-15, and 17-20 which depend therefrom.

Charge Authorization

The Commissioner is hereby authorized to charge payment of any of the following fees that may be applicable to this communication, or credit any overpayment, to Deposit Account No. 50-5394: (1) any filing fees required under 37 C.F.R. § 1.16; (2) any patent application and reexamination processing fees under 37 C.F.R. § 1.17; and/or (3) any post issuance fees under 37 C.F.R. § 1.20. In addition, if any additional extension of time is required, which has not otherwise been requested, please consider this a petition therefor and charge any additional fees that may be required to Deposit Account No. 50-5394.

CONCLUSION

In view of the foregoing, Applicant submits that the pending claims are allowable. In the event that Examiner finds remaining impediment to allowance of this application that may be clarified through a telephone interview or overcome by an Examiner's Amendment, Examiner is requested to contact the undersigned attorney.

Dated this 30th day of September, 2020.

Respectfully submitted,

/B. Lance Jensen/

B. Lance Jensen
Registration No. 68,022
Attorney for Applicant
Customer No. 97149
Telephone No. (435) 252-1360

Electronic Acknowledgement Receipt	
EFS ID:	40721371
Application Number:	16454075
International Application Number:	
Confirmation Number:	3768
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	97149
Filer:	Brian Lance Jensen/Debbie Evans
Filer Authorized By:	Brian Lance Jensen
Attorney Docket Number:	S3876.10059US01
Receipt Date:	30-SEP-2020
Filing Date:	27-JUN-2019
Time Stamp:	15:47:41
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		S3876_10059US01_Response_093020.pdf	82504 cdd7afd610e20a6d5b16d90f976ee12730151a8c	yes	13

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	9
	Applicant Arguments/Remarks Made in an Amendment	10	13
Warnings:			
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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

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)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/454,075	Filing Date 06/27/2019	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

	(Column 1)	(Column 2)			
FOR	NUMBER FILED	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), (i), 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 $230 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ 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

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	09/30/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	= 0		x $230 =	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

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	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.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/NICOLE L NICHOLSON/
*** 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 NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/454,075	06/27/2019	2474	1015	S3876.10059US01	20	4

CONFIRMATION NO. 3768

CORRECTED FILING RECEIPT

97149
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

OC000000120017566

Date Mailed: 09/21/2020

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

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

Inventor(s)

Xiaobo ZHANG, Shanghai, CHINA;

Applicant(s)

SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, Shanghai, CHINA;

Assignment For Published Patent Application

SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, Shanghai, CHINA

Power of Attorney: The patent practitioners associated with Customer Number 97149

Domestic Priority data as claimed by applicant

This application is a CON of PCT/CN2017/094209 07/25/2017

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 201611236923.2 12/28/2016 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: 07/09/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/454,075**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

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

Preliminary Class

370

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign

patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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

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

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

NOT GRANTED

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

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/454,075	06/27/2019	Xiaobo ZHANG	S3876.10059US01

CONFIRMATION NO. 3768

97149
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

POA ACCEPTANCE LETTER

OC000000120017487

Date Mailed: 09/21/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 09/17/2020.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/byemane/

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number	16/454,075		
Filing Date	June 27, 2019		
First Named Inventor	Xiaobo Zhang		
Title	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN UE AND BASE STATION		
Art Unit	2474		
Examiner Name	Frank Duong		
Attorney Docket Number	S3876.10059US01		
SIGNATURE of Applicant or Patent Practitioner			
Signature	/R. Burns Israelsen/	**Date**	September 17, 2020
Name	R. Burns Israelsen	**Telephone**	(435) 252-1360
Registration Number	42685		

MASCHOFF BRENNAN, PLLC
1389 Center Drive, SUITE 300
PARK CITY, UTAH 84098, USA

POWER OF ATTORNEY BY APPLICANT

[Assignee, Legal Representative or Person with Proprietary Interest]

I hereby revoke all previous powers of attorney given in the application identified in the attached Transmittal for Power of Attorney form.

■ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter:

97149

Please recognize or change the correspondence address for the above-identified patent to:

■ The address associated with the above-mentioned Customer Number.

I am the Applicant:

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor

☐ Person Who Otherwise Shows Sufficient *Proprietary* Interest (*e.g.*, a petition under 37 CFR 1.46 (b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

The individual whose signature and title is supplied below is authorized to act on behalf of the Applicant

Signature	Xiaobo ZHANG	Date	January 23, 2019
Name	Xiaobo ZHANG	Telephone	
Company	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED	Title	CTO

NOTE: Signature - This form must be signed by the applicant or applicant's representative in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below*.

*Total of forms are submitted.

MASCHOFF BRENNAN, PLLC
1389 Center Drive, SUITE 300
PARK CITY, UTAH 84098, USA

Doc Code: R46C.REQ
Document Description: Request under 37 CFR 1.46(c) to correct, update or change the applicant.

PTO/AIA/41 (04-15)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

REQUEST TO CORRECT OR UPDATE THE NAME OF THE APPLICANT UNDER 37 CFR 1.46(c)(1), OR CHANGE THE APPLICANT UNDER 37 CFR 1.46(c)(2)
(FOR USE ONLY IN APPLICATIONS FILED ON OR AFTER SEPTEMBER 16, 2012)

Application Number	16/454,075
Filing Date	June 27, 2019
First Named Inventor	Xiaobo ZHANG
Art Unit	2474
Examiner Name	Frank Duong
Practitioner Docket Number	S3876.10059US01

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant hereby **requests that the name of the applicant be corrected or updated under 37 CFR 1.46(c)(1), or that the applicant be changed under 37 CFR 1.46(c)(2),** in the above-identified application. **Requests under 37 CFR 1.46(c)(1) or (c)(2) cannot be submitted after payment of the issue fee or if the application has been patented.**

Please check the applicable box(es) below.

☐ 1. This request is to **correct or update the name of the applicant** (**under 37 CFR 1.46(c)(1)**) and includes:

☐ An application data sheet (ADS) in accordance with 37 CFR 1.76(c) with the corrected or updated information shown with markings (*e.g.*, underlining for insertions, strikethrough for deletions). A Corrected Web-based ADS may be used.

Note: Requests under 37 CFR 1.46(c)(1) may be filed to correct typographical errors in the name of the § 1.46 applicant, or for updating the name of the § 1.46 applicant (*i.e.*, where there is no change in the applicant itself but just in the applicant's name). See the Manual of Patent Examining Procedure (MPEP) section 605.01.

☒ 2. This request is to **change the applicant** (**under 37 CFR 1.46(c)(2)**) and includes:

☒ An application data sheet (ADS) in accordance with 37 CFR 1.76(c) that identifies the changes with proper markings (underlining for insertions and strikethrough for deletions). A Corrected Web-based ADS may be used.

☒ A Statement Under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent). See MPEP 325.

I am the

☐ applicant* ☒ attorney or agent of record Registration number 42685 ☐ attorney or agent acting under 37 CFR 1.34 Registration number _____

Signature /R. Burns Israelsen/
Typed or printed name R. Burns Israelsen
Date September 17, 2020

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. *Juristic entities must be represented by a patent practitioner (See 37 CFR 1.31, applicable to any paper filed on or after September 16, 2012 that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below**.

☐ ** Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.36. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Privacy Act Statement

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

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

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

Electronic Acknowledgement Receipt	
EFS ID:	40585584
Application Number:	16454075
International Application Number:	
Confirmation Number:	3768
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	157297
Filer:	Robert Burns Israelsen/Vanessa Mangum
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	20160102-PCT-US
Receipt Date:	17-SEP-2020
Filing Date:	27-JUN-2019
Time Stamp:	12:32:10
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	S3876-10059US01_Supp_ADS.pdf	593315 7e75f05e783d4d200f740d223fc0b4199e2859d4	no	7

Warnings:

Information:					
This is not an USPTO supplied ADS fillable form					
2	Assignee showing of ownership per 37 CFR 3.73	S3876-10059US01_373.pdf	118018 dfcf12fda8e39bbd85868af2875b55ca8af597ba	no	3
Warnings:					
Information:					
3	Power of Attorney	S3876-10059US01_POA.pdf	1202018 685be058cc15177a62de3465dcb4d5494ef09e78	no	2
Warnings:					
Information:					
4	Request for Corrected Filing Receipt	S3876-10059US01_Req_Change_Applicant.pdf	352064 7e9f27ba0ab4d0611cfefce8e7d5113756e8b748	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2265415		

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	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

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

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xiaobo		ZHANG	

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

City	Shanghai	Country of Residence i	CN

Mailing Address of Inventor:

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

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

Correspondence Information:

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

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

Customer Number	~~157297~~ 97149		
Email Address	docket@mabr.com	Add Email	Remove Email

Application Information:

Title of the Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station		
Attorney Docket Number	20160102-PCT-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	10	**Suggested Figure for Publication (if any)**	10

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	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Filing By Reference:

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

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

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

Publication Information:

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

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

Representative Information:

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

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	~~157297~~ 97149		

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

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Domestic Benefit/National Stage Information:

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

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/CN2017/094209	2017-07-25

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)
201611236923.2	CN	2016-12-28	0770

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

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

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

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Applicant Information:

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

Applicant 1

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

Clear

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

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

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED		
Mailing Address Information For Applicant:			
Address 1	Room 210, 2nd Floor, No. 2088, Xietu Road		
Address 2	Xuhui District		
City	Shanghai	**State/Province**	
Country	CN	Postal Code	200032
Phone Number		Fax Number	
Email Address			

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

Assignee Information including Non-Applicant Assignee Information:

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

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Assignee Information including Non-Applicant Assignee Information:

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

Assignee 1

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

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

Organization Name	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED

Mailing Address Information For Assignee including Non-Applicant Assignee:

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

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Signature:

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

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

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

Signature	~~/Xiaobo ZHANG/~~ /R. Burns Israelsen/			Date (YYYY-MM-DD)	2020-09-17
First Name	~~Xiaobo~~ R. Burns	Last Name	~~ZHANG~~ Israelsen	Registration Number	42685

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

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Xiaobo ZHANG

Application No./Patent No.: 16/454,075 Filed/Issue Date: June 27, 2019

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

SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 049602, Frame 0035, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

PTO/AIA/96 (08-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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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.

/R. Burns Israelsen/	September 17, 2020
Signature	Date
R. Burns Israelsen	42685
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.

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/454,075	06/27/2019	Xiaobo ZHANG	20160102-PCT-US	3768

157297 7590 07/02/2020

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

EXAMINER
DUONG, FRANK

ART UNIT	PAPER NUMBER
2474	

NOTIFICATION DATE	DELIVERY MODE
07/02/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patent@langbomobile.com

Office Action Summary	Application No. 16/454,075	Applicant(s) ZHANG, Xiaobo	
	Examiner FRANK DUONG	Art Unit 2474	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 06/27/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 06/27/2019 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☑ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

2. This Office Action is a response to communications dated 06/27/2019. Claims 1-20 are pending in the application.

Priority

3. Receipt is acknowledged of certified copies of papers required by 37 CFR 1.55.

Information Disclosure Statement

4. The information disclosure statements filed 06/27/2019 and 08/22/2019 comply with the provisions of 37 CFR 1.97, 1.98 and MPEP § 609. They have been considered and placed in the application file.

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 1-20 are 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.

As per group claims 1-5, the claims recite a method comprising the functional steps of receiving a first signaling; receiving a first wireless signal; transmitting first information; and a lengthy wherein clause. The claims are deemed indefinite for the following rationales.

It is unclear who or what element(s) are performing the functional steps of receiving a first signaling; receiving a first wireless signal; transmitting first information. Moreover, it is unclear where the first signaling and the first wireless signal are coming from. It is also unclear where the first information is transmitted to. In addition, the wherein clause appears to fail to clearly set the metes and bounds of a claimed invention that the Applicant seeks to protect. For example, the wherein clause recites "*wherein K antenna port groups are used to transmit the first wireless signal*." It is unclear what claim limitation previously recited in the claims this exemplary wherein clause modifies because there is no functional step of transmitting the first wireless signal previously recited in the claims. In other instant, the wherein clause recites "*wherein the first signaling is used to determine the K antenna port groups*." It is also unclear what claim limitation previously recited in the claims this exemplary wherein clause modifies. Other applicable wherein chausses separates by semicolons in the claims are also indefinite for at least aforementioned rationale. As a result, the claims are deemed indefinite. For examining purpose, the claims are examined as understood hereinbelow.

Group claims 11-15 call for an apparatus claims having limitation variously and essentially mirrored functional limitations of method claims 1-5, respectively. Thus, they are deemed indefinite for the same rationales applied to method claims as discussed above.

As per group claims 6-10, the claims recite a method comprising the functional steps of transmitting a first signaling; transmitting a first wireless signal; receiving first information; and a lengthy wherein clause. The claims are deemed indefinite for the following rationales.

It is unclear who or what element(s) are performing the functional steps of transmitting a first signaling; transmitting a first wireless signal; receiving first information. Moreover, it is unclear where the first signaling and the first wireless signal are going to. It is also unclear where the first information is received from. In addition, the wherein clause appears to fail to clearly set the metes and bounds of a claimed invention that the Applicant seeks to protect. For example, the wherein clause recites "*wherein K antenna port groups are used to transmit the first wireless signal*." It is unclear what claim limitation previously recited in the claims this exemplary wherein clause modifies because there is no functional step of transmitting the first wireless signal previously recited in the claims. In other instant, the wherein clause recites "*wherein the first signaling is used to determine the K antenna port groups*." It is also unclear what claim limitation previously recited in the claims this exemplary wherein clause modifies. Other applicable wherein chausses separates by semicolons in the claims are also indefinite for at least aforementioned rationale. As a result, the claims

are deemed indefinite. For examining purpose, the claims are examined as understood hereinbelow.

Group claims 16-20 call for an apparatus claims having limitation variously and essentially mirrored functional limitations of method claims 1-5, respectively. Thus, they are deemed indefinite for the same rationales applied to method claims as discussed above.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claims 1-20 are rejected under 35 U.S.C. 103 as being unpatentable over Kim et al (US 9,520,973) (hereinafter "Kim") in view of Nam et al (US 2017/0288743) (hereinafter "Nam").

Regarding **claim 1**, in accordance with Kim reference entirety, Kim teaches a method for multi-antenna transmission in a user equipment (UE) (*Kim; Abstract and thereinafter, methods for transmitting a channel state information reference by varying a transmission period for antenna port group is discussed. In addition, Fig. 11 and col. 21, line 65 and thereinafter, details of method of transmitting a CSI-RS configuration information for a 3D beamforming is further elaborated. Or claim 3*), comprising:

receiving a first signaling (***CSI-RS configuration information element (IE)***) (*Fig. 11; step S1110 and col. 22, lines 32-37 and thereinafter, it is disclosed a base station (eNB) transmits CSI-RS IE to each user equipment. Or claim 1, first receiving limitation*);

receiving a first wireless signal (***PDSCH signal***) (*Fig. 11; step S1120,S1130 and col. 22, lines 38-42 and thereinafter, it is further disclosed the base station subsequently transmits a PDSCH signal based on the CSI-RS IE and the user equipment can measure a channel state information (CSI). Or claim 1, second receiving limitation*); and

transmitting first information (**measured CSI**) (*Fig. 11; step S1140 and col. 22, lines 43-45 and thereinafter, it is further disclosed the user equipment can report the measured CSI to the base station. Or claim 3*),

wherein, K antenna port groups are used to transmit the first wireless signal (**PDSCH signal**) (*col. 20, lines 8-14 and thereinafter, antenna port set for a transmission of PDSCH signal is discussed in reference to TABLE 7*); the first signaling (**CSI-RS Configuration IE**) is used to determine the K antenna port groups; the K is a

positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values (*CSI configuration IE is discussed in col. 18, 17 and thereinafter, in reference to TABLE 6*); the first information (**measured CSI**) is used to determine the K1 antenna port groups and the first proportional sequence (*col,. 22, line 46 to col. 23, line 56 and in reference with TABLEs 10 and 11, CSI-RS subframe configuration parameters are discussed*). It appears that Kim fails to further explicitly disclose the claimed limitation of "[wherein] *the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold*." However, such limitation lacks thereof from Kim is well-known in the art and taught by Nam.

In an analogous art in the same field of endeavor, Nam teaches method and apparatus for transmitting and receiving reference signal comprising, among other things, the limitation of "[wherein] the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio

between the second channel quality and the first channel quality is greater than or equal to the target threshold" (*Nam; para [0222] and thereinafter, it is disclosed UE initiated or requested measurement reference signal (MRS) configurations are discussed to include the UE is configured with K cell-specific MRS patterns and/or N UE-specific MRS patterns … the condition is that the UE measured delay spread or Doppler has exceed a certain threshold. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention. A motivation for doing so would be to provide improvements in radio interface efficiency and coverage (*Nam; para [0003] and thereinafter*).

Regarding **claim 2**, in addition to features recited in base claim 1 (see rationales discussed above), Kim in view of Nam also discloses wherein the K channel quality values are broadband channel quality values; **or**

the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; **or**

the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; **or**

the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s)

other than the best channel quality value among the K1 channel quality values and the best channel quality value; **or**

the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s) (*Nam, para [0023] and thereinafter, it is disclosed in verbatim that One purpose of QCL is for a* ***UE to associate large scale channel properties for improving channel estimation quality****. Due to varying UE capabilities, dynamically changing UE propagation conditions as well as different quality-of-service (QoS), an UE may need different support of QCL during its channel estimation. Therefore, it may be advantageous for a UE to request the network to configure MRS according to its needs. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention for the same rationales as discussed above.

Regarding **claim 3**, in addition to features recited in base claim 1 (see rationales discussed above), Kim in view of Nam also discloses wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving

beamforming vector and the second receive beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence (*Nam; para [0159] and thereinafter, it is also disclosed narrow analog beam can be configured to sweep across a wider range of angles by varying the phase shifter bank across symbols or subframes. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention for the same rationales as discussed above.

Regarding **claim 4**, in addition to features recited in base claim 3 (see rationales discussed above), Kim in view of Nam also discloses wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); **or**

any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; **or**

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

information is further used to determine at least one of the first channel quality and the third channel quality (*Nam, para [0023] and thereinafter, it is disclosed in verbatim that One purpose of QCL is for a* ***UE to associate large scale channel properties for improving channel estimation quality****. Due to varying UE capabilities, dynamically changing UE propagation conditions as well as different quality-of-service (QoS), an UE may need different support of QCL during its channel estimation. Therefore, it may be advantageous for a UE to request the network to configure MRS according to its needs. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention for the same rationales as discussed above.

Regarding **claim 5**, in addition to features recited in base claim 1 (see rationales discussed above), Kim in view of Nam also discloses receiving a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, **or** the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence (*Kim; col. 22, lines 46-53 and thereinafter, it is further disclosed in verbatim that the base station can differently set a CSI-RS transmission period of a logical antenna port which is mapped to a vertical physical antenna or used for a vertical beamforming. Parameters for setting a transmission period different per antenna port may be included in the CSI-RS*

configuration information element of the step S1110 shown in FIG. 11. To this end, a configuration for each antenna port should be individually defined. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition).

Regarding **claim 6**, in accordance with Kim reference entirety, Ki discloses a method for multi-antenna transmission in a base station, comprising:

transmitting a first signaling (***CSI-RS configuration information element (IE)***) (*Fig. 11; step S1110 and col. 22, lines 32-37 and thereinafter, it is disclosed a base station (eNB) transmits CSI-RS IE to each user equipment. Or claim 1, first receiving limitation*);

transmitting a first wireless signal (***PDSCH signal***) (*Fig. 11; step S1120,S1130 and col. 22, lines 38-42 and thereinafter, it is further disclosed the base station subsequently transmits a PDSCH signal based on the CSI-RS IE and the user equipment can measure a channel state information (CSI). Or claim 1, second receiving limitation*); and

receiving first information (**CSI report**) (*Fig. 11; step S1140 and col. 22, lines 43-45 and thereinafter, it is further disclosed the user equipment can report the measured CSI to the base station. Or claim 3*),

wherein, K antenna port groups are used to transmit the first wireless signal (**PDSCH signal**) (*col. 20, lines 8-14 and thereinafter, antenna port set for a transmission of PDSCH signal is discussed in reference to TABLE 7*); the first signaling (**CSI-RS Configuration IE**) is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K

channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values (*CSI configuration IE is discussed in col. 18, 17 and thereinafter, in reference to TABLE 6*); the first information (**measured CSI**) is used to determine the K1 antenna port groups and the first proportional sequence (*col,. 22, line 46 to col. 23, line 56 and in reference with TABLEs 10 and 11, CSI-RS subframe configuration parameters are discussed*). It appears that Kim fails to further explicitly disclose the claimed limitation of "[wherein] *the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold*." However, such limitation lacks thereof from Kim is well-known in the art and taught by Nam.

In an analogous art in the same field of endeavor, Nam teaches method and apparatus for transmitting and receiving reference signal comprising, among other things, the limitation of "[wherein] the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal

to the target threshold" (*Nam; para [0222] and thereinafter, it is disclosed UE initiated or requested measurement reference signal (MRS) configurations are discussed to include the UE is configured with K cell-specific MRS patterns and/or N UE-specific MRS patterns … the condition is that the UE measured delay spread or Doppler has exceed a certain threshold. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention. A motivation for doing so would be to provide improvements in radio interface efficiency and coverage (*Nam; para [0003] and thereinafter*).

Regarding **claim 7**, in addition to features recited in base claim 6 (see rationales discussed above), Kim in view of Nam also discloses wherein the K channel quality values are broadband channel quality values; **or**

the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; **or**

the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; **or**

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

the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s) (*Nam, para [0023] and thereinafter, it is disclosed in verbatim that One purpose of QCL is for a* ***UE to associate large scale channel properties for improving channel estimation quality****. Due to varying UE capabilities, dynamically changing UE propagation conditions as well as different quality-of-service (QoS), an UE may need different support of QCL during its channel estimation. Therefore, it may be advantageous for a UE to request the network to configure MRS according to its needs. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention for the same rationales as discussed above.

Regarding **claim 8**, in addition to features recited in base claim 6 (see rationales discussed above), Kim in view of Nam also discloses wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second

proportional sequence (*Nam; para [0159] and thereinafter, it is also disclosed narrow analog beam can be configured to sweep across a wider range of angles by varying the phase shifter bank across symbols or subframes. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention for the same rationales as discussed above.

Regarding **claim 9**, in addition to features recited in base claim 8 (see rationales discussed above), Kim in view of Nam also discloses wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); **or**

any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; **or**

the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality (*Nam, para [0023] and thereinafter, it is disclosed in verbatim that*

One purpose of QCL is for a ***UE to associate large scale channel properties for improving channel estimation quality****. Due to varying UE capabilities, dynamically changing UE propagation conditions as well as different quality-of-service (QoS), an UE may need different support of QCL during its channel estimation. Therefore, it may be advantageous for a UE to request the network to configure MRS according to its needs. Such disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition*).

Thus, it would have been obvious to a person having ordinary skill in the art to which the claimed invention pertains before the effective filing date of the claimed invention to incorporate/combine Nam's teaching into Kim's to arrive the claimed invention for the same rationales as discussed above.

Regarding **claim 10**, in addition to features recited in base claim 8 (see rationales discussed above), Kim in view of Nam also discloses transmitting a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, **or** the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence (*Kim; col. 22, lines 46-53 and thereinafter, it is further disclosed in verbatim that the base station can differently set a CSI-RS transmission period of a logical antenna port which is mapped to a vertical physical antenna or used for a vertical beamforming. Parameters for setting a transmission period different per antenna port may be included in the CSI-RS configuration information element of the step S1110 shown in FIG. 11. To this end, a configuration for each antenna port should be individually defined. Such*

disclosure, given the broadest reasonable interpretation in consisting with the specification, reads on the claimed limitation in the present condition).

As per group **claims 11-15**, the claims call for an apparatus (user equipment) having limitations variously and essentially mirrored method steps of method claims 1-5, respectively. Thus, they are deemed obvious over Kim in view of Nam for the same rationales applied to method claims 1-5 as discussed above.

As per group **claims 16-20**, the claims call for an apparatus (base station) having limitations variously and essentially mirrored method steps of method claims 6-10, respectively. Thus, they are deemed obvious over Kim in view of Nam for the same rationales applied to method claims 6-10 as discussed above.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Onggosanusi et al (US 10,484,064).

Kim et al (US 10,218,478).

Cai (US 9,780,856).

Han et al, Large-Scale Antenna Systems with Hybrid Analog and Digital Beamforming for Millimeter Wave 5G, IEEE, 9 pages, January 2015.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to FRANK DUONG whose telephone number is (571)272-3164. The examiner can normally be reached on 7:00AM-3:30PM.

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, MICHAEL THIER can be reached on 571-272-2832. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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9. Applicant is encouraged to submit a written authorization for Internet communications (PTO/SB/439, http://www.uspto.gov/sites/default/files/documents/sb0439.pdf) in the instant patent

application to authorize the examiner to communicate with the applicant via email. The authorization will allow the examiner to better practice compact prosecution. The written authorization can be submitted via one of the following methods only: (1) Central Fax which can be found in the Conclusion section of this Office action; (2) regular postal mail; (3) EFS WEB; or (4) the service window on the Alexandria campus. EFS web is the recommended way to submit the form since this allows the form to be entered into the file wrapper within the same day (system dependent). Written authorization submitted via other methods, such as direct fax to the examiner or email, will not be accepted. See MPEP § 502.03.

/FRANK DUONG/
Primary Examiner, Art Unit 2474
June 25, 2020

Notice of References Cited	Application/Control No. 16/454,075	Applicant(s)/Patent Under Reexamination ZHANG, Xiaobo	
	Examiner FRANK DUONG	Art Unit 2474	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-9520973-B2	12-2016	Kim; Jinmin	H04B7/0667	1/1
*	B	US-20170288743-A1	10-2017	Nam; Young-Han	H04L5/0035	1/1
*	C	US-9780856-B2	10-2017	Cai; Khiem Van	H04B7/0617	1/1
*	D	US-10218478-B2	02-2019	Kim; Kitae	H04B7/0617	1/1
*	E	US-10484064-B2	11-2019	Onggosanusi; Eko	H04L5/0053	1/1
	F					
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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
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	Q					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Han et al, Large-Scale Antenna Systems with Hybrid Analog and Digital Beamforming for Millimeter Wave 5G, IEEE, 9 pages, January 2015.
	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
	16/454,075	ZHANG, Xiaobo
	Examiner	**Art Unit**
	FRANK DUONG	2474

✓	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	06/25/2020								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
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	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	Art Unit
	FRANK DUONG	2474

CPC - Searched*		
Symbol	Date	Examiner
H04B1/0064 H04B7/024 H04B7/04 H04B7/0404 H04B7/0408 H04B7/0413 H04B7/0452 H04B7/0456 H04B7/0495 H04B7/06 H04B7/0617 H04B7/0491 H04B7/0695 H04L5/0023 H04L5/0048 H04W52/40 H04W72/085	06/24/2020	FD

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
EAST Search (see printout)	06/24/2020	FD
Inventorship Search (see printout)	06/24/2020	FD
IEEE/Internet Search using terms from the specification (see printout)	06/24/2020	FD
H04B1/0064 H04B7/024 H04B7/04 H04B7/0404 H04B7/0408 H04B7/0413 H04B7/0452 H04B7/0456 H04B7/0495 H04B7/06 H04B7/0617 H04B7/0491 H04B7/0695 H04L5/0023 H04L5/0048 H04W52/40 H04W72/085 (text search only-see printout)	06/24/2020	FD

/FRANK DUONG/ Primary Examiner, Art Unit 2474	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/454,075	ZHANG, Xiaobo
	Examiner	Art Unit
	FRANK DUONG	2474

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

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16454075
Filing Date	2019-06-27
First Named Inventor	XiaoBo ZHANG
Art Unit	2464
Examiner Name	NGO, RICKY QUOC
Attorney Docket Number	20160102-PCT-US

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	1	2016047505	WO	A1	2016-03-31	NTT DOCOMO INC	English Abstract	☓
	2	102170335	CN	A	2011-08-31	ZTE CORPORATION	English Abstract	☒
	3	103918195	CN	A	2014-07-09	MOTOROLA MOBILITY LLC	English Abstract	☒

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16454075
	Filing Date	2019-06-27
	First Named Inventor	XiaoBo ZHANG
	Art Unit	2464
	Examiner Name	NGO, RICKY QUOC
	Attorney Docket Number	20160102-PCT-US

	4	104170272	CN	A1	2014-11-26	MOTOROLA MOBILITY LLC	English Abstract	☒

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	1	ISR received in application no. PCT/CN2017/094209 dated October 23, 2017	

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Examiner Signature	/FRANK DUONG/	Date Considered	06/24/2020

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16454075
	Filing Date	2019-06-27
	First Named Inventor	XiaoBo ZHANG
	Art Unit	2464
	Examiner Name	NGO, RICKY QUOC
	Attorney Docket Number	20160102-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/XiaoBo ZHANG/	Date (YYYY-MM-DD)	2019-08-22
Name/Print	XiaoBo ZHANG	Registration Number	

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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.

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	9,297	(massive near3 (MIMO or (multiple adj input adj multiple adj output))) or mMIMO or ((large adj scale) near3 (MIMO or (multiple adj input adj multiple adj output))) or ("large-scale MIMO" or "massive MIMO" or "large-scale antenna systems" or "large-scale antenna" or "very large MIMO" or "very large multi-user-MIMO" or "full-dimensional MIMO" or "FD-MIMO" or "Scaling up MIMO" or "hyper MIMO" or "3-D MIMO" or "LS-MIMO")	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/06/24 13:53
L2	157	1 and ((antenna near3 port near4 group) or (antenna near3 group)) and (beam near3 sweep$4)	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/06/24 13:54
L3	62	2 and ((antenna near3 virtualiz$8) or ((beamform$4 or ("beam-form"$4)) near3 vector))	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/06/24 13:54
L4	109	2 and (((analog near3 (beamform$4 or (beam adj form$4))) and (digital near3 (beamform$4 or (beam adj form$4)))) or (hybrid near3 (beamform$4 or (beam adj form$4))))	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/06/24 13:55
L5	74	4 and (H04B1/0064 H04B7/024 H04B7/04 H04B7/0404 H04B7/0408 H04B7/0413 H04B7/0452 H04B7/0456 H04B7/0495 H04B7/06 H04B7/0617 H04B7/0491 H04B7/0695 H04L5/0023 H04L5/0048 H04W52/40 H04W72/085).CPC.	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/06/24 13:57

6/24/2020 1:57:09 PM

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	297	Zhang-Xiaobo.in.	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/06/24 07:36
L2	1	"16454075"	US-PGPUB; USPAT; EPO; DERWENT	OR	ON	2020/06/24 07:36

6/24/2020 7:37:22 AM
C:\Users\fduong\Documents\EAST\Workspaces\Default EAST Workspace 1600x1200.wsp

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
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2019-06-27
First Named Inventor	XiaoBo ZHANG
Art Unit	-
Examiner Name	Not Yet Assigned
Attorney Docket Number	20160102-PCT-US

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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	106034360	CN	A	2016-10-19	LONGBO COMMUNICATION TECHNICAL CO LTD		☒
	2	106209195	CN	A	2016-12-07	CHINA ACADEMY TELECOMMUNICATIONS TECHNOLOGY		☒
	3	105474556	CN	A	2016-04-06	INTEL CORPORATION		☒

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-06-27
	First Named Inventor	XiaoBo ZHANG
	Art Unit	-
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	20160102-PCT-US

	4	105580468	CN	A	2016-05-11	NTT DOCOMO INC		☒
	5	106211338	CN	A	2016-12-07	ZTE WAVETONE SCINECE&TECHNOLOGY LTD		☒

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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]
	1	CN 1st Search Report received in application no. 201611236923.2 dated November 30, 2018	
	2	CN 1st Office Action received in application no. 201611236923.2 dated December 10, 2018	
	3	CN Notice of Allowance received in application no. 201611236923.2 dated January 14, 2019	

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Examiner Signature	/FRANK DUONG/	Date Considered	06/24/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-06-27
	First Named Inventor	XiaoBo ZHANG
	Art Unit	-
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	20160102-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/XiaoBo ZHANG/	Date (YYYY-MM-DD)	2019-06-27
Name/Print	XiaoBo ZHANG	Registration Number	

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CONFIRMATION NO. 3768

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
16/454,075	06/27/2019	370	2474	20160102-PCT-US

APPLICANTS

INVENTORS

Xiaobo ZHANG, Shanghai, CHINA;

**** CONTINUING DATA ***************************

This application is a CON of PCT/CN2017/094209 07/25/2017

**** FOREIGN APPLICATIONS ***************************

CHINA 201611236923.2 12/28/2016

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **

07/09/2019

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☑ Yes ☐ No	☑ Yes ☐ No	/FRANK DUONG/ Examiner's Signature	☐ Initials	CHINA	10	20	4

ADDRESS

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

TITLE

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

FILING FEE RECEIVED		
1015	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Main Concept Document
==========
US20190319680
Title: Method and Device for Multi-Antenna Transmission in UE and Base Station
Abstract: A method and a device for multi-antenna transmission in a user equipment and a base station are disclosed in the present disclosure. The user equipment first receives a first signaling, receives a first wireless signal, and transmits first information. K antenna port groups are used to transmit the first wireless signal. The first signaling is used to determine the K antenna port groups. The K antenna port groups respectively correspond to K channel quality values. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. The K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

(No Concept Modifiers)
==========

Filters (6)
==========
Title+Abstract+Body Text+Related Terms limited to: analog beamform; analog beam-form; analog beamformer; analog beamforming; analog beam-former; analog beam-forming

Title+Abstract+Body Text+Related Terms limited to: digital beamform; digital beam-form; digital beamformer; digital beamforming; digital beam-former; digital beam-forming

Title+Abstract+Body Text+Related Terms limited to: Scaling up MIMO; Massive MIMO; large-scale antenna; large-scale MIMO; large-scale antenna system; very large MIMO; very large multi-user-MIMO; full-dimensional MIMO; hyper MIMO; 3-D MIMO; LS-MIMO

Title+Abstract+Body Text+Related Terms limited to: antenna port virtualization; antenna virtualization; port virtualization

Title+Abstract+Body Text+Related Terms limited to: Analog beam-forming vector; Analog beamforming vector; digital beam-forming vector; digital beamforming vector; beam-forming vector; beamforming vector

Title+Abstract+Body Text+Related Terms limited to: beam sweep; beam sweeping

Options
=======

De-dup: None
Cut-off: None
Sort: Relevance

Content: Non-Patent Literature (25)
==========
IEEE Xplore Publications: IEEE Periodicals
IEEE Xplore Publications: IEEE Conferences
IEEE Xplore Publications: IEEE Standards
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Main Concept Document
==========
US20190319680
Title: Method and Device for Multi-Antenna Transmission in UE and Base Station

(No Concept Modifiers)
==========

Filters (6)
==========
Title+Abstract+Description+Claims+Related Terms limited to: analog beamform; analog beam-form; analog beamformer; analog beamforming; analog beam-former; analog beam-forming

Title+Abstract+Description+Claims+Related Terms limited to: digital beamform; digital beam-form; digital beamformer; digital beamforming; digital beam-former; digital beam-forming

Title+Abstract+Description+Claims+Related Terms limited to: Scaling up MIMO; Massive MIMO; large-scale antenna; large-scale MIMO; large-scale antenna system; very large MIMO; very large multi-user-MIMO; full-dimensional MIMO; hyper MIMO; 3-D MIMO; LS-MIMO

Title+Abstract+Description+Claims+Related Terms limited to: antenna port virtualization; antenna virtualization; port virtualization

Title+Abstract+Description+Claims+Related Terms limited to: Analog beam-forming vector; Analog beamforming vector; digital beam-forming vector; digital beamforming vector; beam-forming vector; beamforming vector

Title+Abstract+Description+Claims+Related Terms limited to: beam sweep; beam sweeping

Options
==========
De-dup: None
Cut-off: None
Sort: Relevance

Content: Patent Publications (164)
==========
US Patents
US Designs

US Applications
EPO Patents
EPO Applications
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China Applications
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Republic of Moldova Applications
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San Marino Applications

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New Zealand Patents
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/454,075	06/27/2019	Xiaobo ZHANG	20160102-PCT-US

CONFIRMATION NO. 3768

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

PUBLICATION NOTICE



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

Publication No.US-2019-0319680-A1
Publication Date:10/17/2019

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16454075
Filing Date	2019-06-27
First Named Inventor	XiaoBo ZHANG
Art Unit	2464
Examiner Name	NGO, RICKY QUOC
Attorney Docket Number	20160102-PCT-US

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	1	20160143055	A1	2016-05-19	TELEFONAKTIEBOLAGET L M ERICSSON	

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	1	2016047505	WO	A1	2016-03-31	NTT DOCOMO INC	English Abstract	☒
	2	102170335	CN	A	2011-08-31	ZTE CORPORATION	English Abstract	☒
	3	103918195	CN	A	2014-07-09	MOTOROLA MOBILITY LLC	English Abstract	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Attorney Docket Number	20160102-PCT-US

	4	104170272	CN	A1	2014-11-26	MOTOROLA MOBILITY LLC	English Abstract	☒

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	1	ISR received in application no. PCT/CN2017/094209 dated October 23, 2017	

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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	16454075
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	Examiner Name	NGO, RICKY QUOC
	Attorney Docket Number	20160102-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/XiaoBo ZHANG/	Date (YYYY-MM-DD)	2019-08-22
Name/Print	XiaoBo ZHANG	Registration Number	

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EFS ID:	36945264
Application Number:	16454075
International Application Number:	
Confirmation Number:	3768
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	157297
Filer:	Qi Zhou
Filer Authorized By:	
Attorney Docket Number:	20160102-PCT-US
Receipt Date:	22-AUG-2019
Filing Date:	27-JUN-2019
Time Stamp:	05:47:40
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	IDS_R1_WO2016047505A1.pdf	1428274 57c52721e6b1d7dfd408e59e592aeb942bbdcb56	no	38

Warnings:

Information:					
2	Foreign Reference	IDS_R2_CN102170335A.pdf	998460 f319e12ab7109f8f6e0aa952b845dca0a563405c	no	15
Warnings:					
Information:					
3	Foreign Reference	IDS_R3_CN103918195A.pdf	5131084 9f676eba77c23a3821f91e40b9d8c1bbfc8c2e72	no	47
Warnings:					
Information:					
4	Foreign Reference	IDS_R4_CN104170272A.pdf	1387029 f76b0374876964db0da47dfbb7d48106e76c8c48	no	20
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	20160102-PCT-US_APP_Official_Info_PCTCN2017094209_ISR.pdf	173324 dc5d426376fb96340609404273cd58f8211023c	no	4
Warnings:					
Information:					
6	Information Disclosure Statement (IDS) Form (SB08)	20160102-PCT-US_APP_IDS.pdf	612395 0496c17db84280f4bd03bdeeb6e0ce8aea6e8703	no	4
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Espacenet

Bibliographic data: WO2016047505 (A1) — 2016-03-31

BASE STATION AND USER DEVICE

Inventor(s): KAKISHIMA YUICHI [JP]; NAGATA SATOSHI [JP]; NA CHONGNING [CN]; HOU XIAOLIN [CN]; JIANG HUILING [CN] ± (柿島　佑一, ; 永田　聡, ; ナ　スウネイ, ; コウ　ギョウリン, ; ジャン　ホイリン)

Applicant(s): NTT DOCOMO INC [JP] ± (株式会社ＮＴＴドコモ)

Classification: - international: ***H04B7/04; H04J99/00; H04W16/28***
- cooperative: **H04B7/04**; **H04B7/0478**; **H04B7/0617**; **H04B7/0619**; **H04B7/0626**; **H04L5/0014**; **H04W16/28**; **H04W24/10**; H04B7/0639; H04L5/0082; H04W72/0406

Application number: WO2015JP76172 20150915 Global Dossier

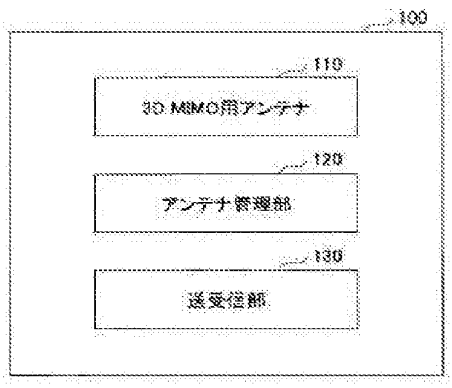
Priority number(s): JP20140195882 20140925

Also published as: CN107079308 (A) CN107079308 (B) EP3200497 (A1) EP3200497 (A4) JP6185188 (B2) more

Abstract of WO2016047505 (A1)

Provided is a technology for implementing highly accurate channel-state estimation and efficient channel-state feedback in three-dimensional multiple-input multiple-output (3D MIMO). One embodiment of the present invention is related to a user device which implements 3D MIMO communication, and which is provided with: a channel-state-information generation unit which uses reference signals transmitted from antenna ports of a 3D MIMO antenna of a base station, to measure the channel states of the antenna ports, and generates channel state information on the basis of the measured channel states; and a channel-state-information feedback unit which uses different channel-state-information feedback means for antenna ports in each dimension of the antenna, to feed back, to the base station, the generated channel state information.

(図7)



110: 3D MIMO antenna
120: Antenna management unit
130: Transmission/reception unit

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特願 2014-195882 2014 年 9 月 25 日(25.09.2014) JP

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(74) 代理人: 伊東　忠重, 外 (ITOH, Tadashige et al.); 〒1000005 東京都千代田区丸の内二丁目１番１号　丸の内　ＭＹ　ＰＬＡＺＡ　（明治安田生命ビル）　１６階 Tokyo (JP).

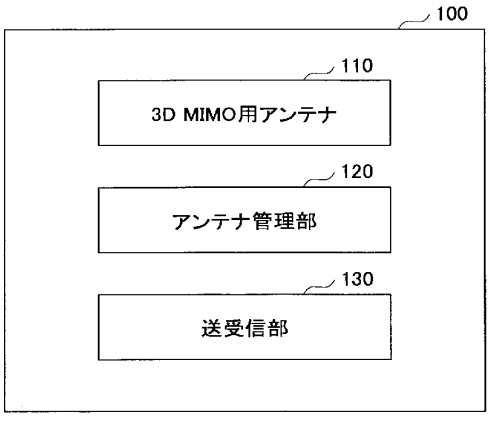
(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX,

[続葉有]

(54) **Title**: BASE STATION AND USER DEVICE

(54) 発明の名称 : 基地局及びユーザ装置

[図7]



110 3D MIMO antenna
120 Antenna management unit
130 Transmission/reception unit

(57) **Abstract**: Provided is a technology for implementing highly accurate channel-state estimation and efficient channel-state feedback in three-dimensional multiple-input multiple-output (3D MIMO). One embodiment of the present invention is related to a user device which implements 3D MIMO communication, and which is provided with: a channel-state-information generation unit which uses reference signals transmitted from antenna ports of a 3D MIMO antenna of a base station, to measure the channel states of the antenna ports, and generates channel state information on the basis of the measured channel states; and a channel-state-information feedback unit which uses different channel-state-information feedback means for antenna ports in each dimension of the antenna, to feed back, to the base station, the generated channel state information.

(57) 要約: ３Ｄ　ＭＩＭＯにおける高精度のチャネル状態の推定と効率的なチャネル状態のフィードバックとを実現するための技術が開示される。本発明の一態様は、３Ｄ　ＭＩＭＯ（３－Ｄｉｍｅｎｓｉｏｎａｌ　Ｍｕｌｔｉｐｌｅ－Ｉｎｐｕｔ　Ｍｕｌｔｉｐｌｅ－Ｏｕｔｐｕｔ）通信を実現するユーザ装置であって、基地局の３Ｄ　ＭＩＭＯ用のアンテナのアンテナポートから送信されたリファレンス信号により前記アンテナポートのチャネル状態を測定し、前記測定したチャネル状態に基づきチャネル状態情報を生成するチャネル状態情報生成部と、前記アンテナの各次元におけるアンテナポートについて異なるチャネル状態情報フィードバック手段を用いて、前記生成されたチャネル状態情報を前記基地局にフィードバックするチャネル状態情報フィードバック部とを有するユーザ装置に関する。

WO 2016/047505 A1

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) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, RU, TJ, TM), ヨーロッパ (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).

添付公開書類:

— 国際調査報告（条約第 21 条(3)）

明　細　書

発明の名称 ： 基地局及びユーザ装置

技術分野

[0001] 本発明は、無線通信システムに関する。

背景技術

[0002] 従来の水平方向のビーム制御に加えて、垂直方向のビーム制御を行う３Ｄ　ＭＩＭＯ（Ｔｈｉｒｄ　Ｄｉｍｅｎｓｉｏｎａｌ　Ｍｕｌｔｉｐｌｅ－Ｉｎｐｕｔ　Ｍｕｌｔｉｐｌｅ－Ｏｕｔｐｕｔ）が現在議論されている。３Ｄ　ＭＩＭＯは、アンテナポートの個数に応じてＥｌｅｖａｔｉｏｎ　ｂｅａｍｆｏｒｍｉｎｇ（ＢＦ）とＦｕｌｌ　ｄｉｍｅｎｓｉｏｎ（ＦＤ）－ＭＩＭＯとに分類されることもある。図１に示されるように、８アンテナポートまでの３Ｄ　ＭＩＭＯはＥｌｅｖａｔｉｏｎ　ｂｅａｍｆｏｒｍｉｎｇと呼ばれ、それより多くのアンテナポートの３Ｄ　ＭＩＭＯはＦｕｌｌ　ｄｉｍｅｎｓｉｏｎ－ＭＩＭＯ又はＭａｓｓｉｖｅ　ＭＩＭＯと呼ばれる。Ｆｕｌｌ　ｄｉｍｅｎｓｉｏｎ－ＭＩＭＯでは、図示されるように、多数のアンテナポートを有する２次元平面アンテナだけでなく、円筒状に配置した複数のアンテナや立方体面上に配置したアンテナなどの３次元アンテナなども利用される。

[0003] このような多次元アンテナを備えた基地局が水平方向と垂直方向との２つの方向に対してビーム制御を行う３Ｄ　ＭＩＭＯでは、セル間干渉へのインパクトを考慮しながら垂直方向に正確なビームを形成するために、キャリブレーションを行ったアクティブアンテナシステム（ＡＡＳ）に基づく運用が想定されている。ＬＴＥ（Ｌｏｎｇ　Ｔｅｒｍ　Ｅｖｏｌｕｔｉｏｎ）規格のリリース１３では、最大で６４個の送受信機（Ｔｒａｎｓｃｅｉｖｅｒ　ｕｎｉｔ：ＴＸＲＵ）を用いることが想定され、これらの送受信機がアクティブアンテナシステムの下で制御される。

[0004] ３Ｄ　ＭＩＭＯの効果としては以下のものがあげられる。まず、従来の水

平方向に加えて垂直方向のビーム制御（プリコーディング）を実現することによって、より高いビームフォーミング利得を実現することが可能になる。例えば、図２に示されるように、高層ビル内のユーザ装置に対するビーム吹き上げが可能になる。また、より多くのアンテナを使用することによって、より高いビームフォーミング利得を実現することが可能になる。例えば、ビームをシャープにすることによって、より高い送信電力により対象となるユーザ装置に無線信号を送信することが可能になると共に、他のビームからの干渉電力を低減することが可能になる。さらに、大量のアンテナ素子を用いることによって、送信ダイバーシチ利得を実現することが可能になると共に、フレキシブルなビーム制御による干渉制御やトラフィックオフローディングが可能になる。

[0005] ３Ｄ ＭＩＭＯ用アンテナは、典型的には、図３に示されるような構成を有する。すなわち、Ｖ×Ｈ個のアンテナ素子は複数のサブアレイにグループ化される。図示されたサブアレイは垂直方向に配置されたアンテナ素子から構成されているが、これに限定されることなく、水平方向又は２または３次元に配置されたアンテナ素子から構成されてもよい。また、サブアレイは必ずしも連続するアンテナ素子により構成されなくてもよい。一般に、サブアレイの個数とＴＸＲＵの個数とは同一になるが、必ずしもこれに限定されるものでない。１つのサブアレイが１つのアンテナ素子から構成される場合（Ｋ＝１）、伝送特性は最も良くなる一方、必要となるＴＸＲＵの個数が多くなり、同様に付随するベースバンド（ＢＢ）処理部の負荷が増大する。ここで、サブアレイ内のアンテナ素子は固定のチルトが適用されることがある。また、図示された３Ｄ ＭＩＭＯ用アンテナでは、単一偏波アンテナが利用されているが、これに限定されるものでなく、直交偏波アンテナが利用されてもよい。

[0006] Ｆｕｌｌ ｄｉｍｅｎｓｉｏｎ－ＭＩＭＯ又はＭａｓｓｉｖｅ ＭＩＭＯでは、ビームが細くなるためビーム追従誤差の影響が大きくなり、カバレッジに穴が生じやすくなる。このため、適切なビームフォーミングが重要とな

り、各種ビーム形成法が検討されている。すなわち、３Ｄ　ＭＩＭＯでは、複数のアンテナポートから基地局がどのようにしてチャネル状態測定用のリファレンス信号を送信するか、また、測定したチャネル状態をユーザ装置がどのようにフィードバックするかを規定する必要がある。

[0007] 更なる詳細については、例えば、３ＧＰＰ　ＴＲ　３７．８４０　Ｖ１２．１．０（２０１３－１２）３ＧＰＰ　ＴＳ　３６．２１３　Ｖ１２．２．０（２０１４－０６）を参照されたい。

発明の概要

発明が解決しようとする課題

[0008] すなわち、基地局の各アンテナポートから送信されたリファレンス信号に対して、ユーザ装置がチャネル状態を推定し、チャネル状態情報（ＣＳＩ）として基地局にフィードバックする。リファレンス信号のオーバヘッドを削減するため、いくつかのリファレンス信号系列を用いて水平方向のチャネル、垂直方向のチャネル及び偏波素子間のチャネルを推定する方法が考えられている。例えば、図４に示されるように、３通りのＣＳＩリファレンス信号（ＣＳＩ－ＲＳ）を用いて当該推定が実行されることが提案されている。水平方向、垂直方向及び偏波間のＣＳＩ－ＲＳがそれぞれ、コンフィギュレーション１，２，３により通知され、図示されるような送信タイミングで送信される。すなわち、コンフィギュレーション１により、ＣＳＩ－ＲＳが通知された送信タイミングで水平方向の単一偏波アンテナから送信される。コンフィギュレーション２により、ＣＳＩ－ＲＳが通知された送信タイミングで垂直方向の単一偏波アンテナから送信される。コンフィギュレーション３により、ＣＳＩ－ＲＳが通知された送信タイミングで直交偏波アンテナから送信される。なお、ＣＳＩ－ＲＳの送信パターンは、これに限定されるものでなく、図５に示されるような各種送信パターンが使用されてもよい。図５の左上の送信パターンに示されるように、全てのアンテナポートからリファレンス信号を送信することも考えられる。しかしながら、当該送信に伴うオーバヘッドと共に、ユーザ装置からのフィードバック量も大きくなってしまう

。このため、リファレンス信号を間引いて、すなわち、サンプリングしたアンテナポートから送信する図示されるような他の送信パターンの利用が想定される。

[0009] 現在の仕様では、アンテナ構成に関して、基地局はユーザ装置にＣＲＳ（Ｃｅｌｌ ｓｐｅｃｉｆｉｃ Ｒｅｆｅｒｅｎｃｅ Ｓｉｇｎａｌ）ポート数やＣＳＩ－ＲＳポート数などのトータルのアンテナポート数しか通知しない。３Ｄ ＭＩＭＯにおいてより精度の高いＣＳＩフィードバックを実現するためには、ユーザ装置は、アンテナ構成に関するより詳細な情報を取得し、より詳細なアンテナ構成を利用した補間処理などに基づき、各種パターンにより送信されるＣＳＩ－ＲＳから全アンテナのチャネル状態を推定し、推定したチャネル状態を効率的に基地局にフィードバックすることができると考えられる。

[0010] 上述した問題点を鑑み、本発明の課題は、３Ｄ ＭＩＭＯにおける高精度のチャネル状態の推定と効率的なチャネル状態のフィードバックとを実現するための技術を提供することである。

課題を解決するための手段

[0011] 上記課題を解決するため、本発明の一態様は、３Ｄ ＭＩＭＯ（３－Ｄｉｍｅｎｓｉｏｎａｌ Ｍｕｌｔｉｐｌｅ－Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ－Ｏｕｔｐｕｔ）通信を実現する基地局であって、３Ｄ ＭＩＭＯ用のアンテナと、前記アンテナを管理するアンテナ管理部と、前記アンテナを介しユーザ装置との間で無線信号を送受信する送受信部とを有し、前記アンテナ管理部は、前記アンテナの構成を示すアンテナコンフィギュレーション情報を有し、前記送受信部は、前記アンテナコンフィギュレーション情報を前記ユーザ装置に通知する基地局に関する。

[0012] 本発明の他の態様は、３Ｄ ＭＩＭＯ（３－Ｄｉｍｅｎｓｉｏｎａｌ Ｍｕｌｔｉｐｌｅ－Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ－Ｏｕｔｐｕｔ）通信を実現するユーザ装置であって、基地局の３Ｄ ＭＩＭＯ用のアンテナのアンテナポートから送信されたリファレンス信号により前記アンテナポートのチャ

ネル状態を測定し、前記測定したチャネル状態に基づきチャネル状態情報を生成するチャネル状態情報生成部と、前記アンテナの各次元におけるアンテナポートについて異なるチャネル状態情報フィードバック手段を用いて、前記生成されたチャネル状態情報を前記基地局にフィードバックするチャネル状態情報フィードバック部とを有するユーザ装置に関する。

発明の効果

[0013] 本発明によると、３Ｄ　ＭＩＭＯにおける高精度のチャネル状態の推定と効率的なチャネル状態のフィードバックとを実現することが可能になる。

図面の簡単な説明

[0014] [図1]図１は、３Ｄ　ＭＩＭＯのアンテナタイプを示す概略図である。

[図2]図２は、３Ｄ　ＭＩＭＯのビーム制御を示す概略図である。

[図3]図３は、一例となる３Ｄ　ＭＩＭＯ用アンテナの構成を示す概略図である。

[図4]図４は、一例となるリファレンス信号系列を示す概略図である。

[図5]図５は、リファレンス信号の各種送信パターンを示す概略図である。

[図6]図６は、本発明の一実施例による無線通信システムを示す概略図である。

[図7]図７は、本発明の一実施例による基地局の構成を示すブロック図である。

[図8]図８は、本発明の一実施例によるアンテナポートのインデックス付けの具体例を示す図である。

[図9]図９は、本発明の一実施例によるリファレンス信号の送信パターンの具体例を示す図である。

[図10]図１０は、本発明の一実施例によるユーザ装置の構成を示すブロック図である。

[図11]図１１は、本発明の一実施例によるＣＳＩフィードバック例を示す図である。

[図12]図１２は、本発明の一実施例による他のＣＳＩフィードバック例を示

す図である。

[図13]図１３は、本発明の一実施例によるランクインジケータの組み合わせを示す図である。

発明を実施するための形態

[0015] 以下、図面に基づいて本発明の実施の形態を説明する。

[0016] 以下の実施例では、３Ｄ　ＭＩＭＯ通信を実現するユーザ装置及び基地局が開示される。本発明を概略すると、基地局は、２次元平面アンテナなどの３Ｄ　ＭＩＭＯ用アンテナの構成を示すアンテナコンフィギュレーション情報と、チャネル状態測定用に各アンテナポートから送信されるＣＳＩ－ＲＳなどのリファレンス信号のシグナリングパターンを示すリファレンス信号コンフィギュレーション情報とをユーザ装置に通知すると共に、当該シグナリングパターンによってユーザ装置にリファレンス信号を送信する。ユーザ装置は、通知されたシグナリングパターンにより基地局から送信されたリファレンス信号を受信し、２次元平面アンテナの各次元のアンテナポートから送信されたリファレンス信号について異なるチャネル状態情報フィードバック手段を用いて、推定したチャネル状態情報を基地局にフィードバックする。例えば、相対的にビーム制御の伝送特性に与える効果の低い垂直方向のアンテナポートからのリファレンス信号については、ユーザ装置は、相対的にシンプルなチャネル状態情報フィードバック手段によりプリコーディングマトリックスインジケータをフィードバックする。他方、相対的にビーム制御の伝送特性に与える効果の高い水平方向のアンテナポートからのリファレンス信号については、ユーザ装置は、相対的に精細なプリコーディングを可能にするチャネル状態情報フィードバック手段によりプリコーディングマトリックスインジケータをフィードバックする。

[0017] まず、図６を参照して、本発明の一実施例による無線通信システムを説明する。図６は、本発明の一実施例による無線通信システムを示す概略図である。

[0018] 図６に示されるように、無線通信システム１０は、基地局１００及びユー

ザ装置２００を有する。無線通信システム１０は、ＬＴＥシステム又はＬＴＥ－Ａｄｖａｎｃｅｄ（ＬＴＥ－Ａ）システムであるが、これに限定されることなく、３Ｄ　ＭＩＭＯ通信をサポートする何れかの無線通信システムであってもよい。

[0019] 基地局１００は、ユーザ装置２００との３Ｄ　ＭＩＭＯ通信を実現し、搭載された２次元平面アンテナや３次元アンテナなどの多次元アンテナにおける複数のアンテナポートを介しユーザ装置２００と無線接続する。具体的には、基地局１００は、コアネットワーク（図示せず）上に通信接続された上位局やサーバなどのネットワーク装置から受信したダウンリンク（ＤＬ）パケットを複数のアンテナポートを介しユーザ装置２００に送信すると共に、複数のアンテナポートを介しユーザ装置２００から受信したアップリンク（ＵＬ）パケットをネットワーク装置に送信する。

[0020] 基地局１００は、典型的には、ユーザ装置２００との間で無線信号を送受信するための３Ｄ　ＭＩＭＯ用アンテナ、隣接する基地局１００と通信するための通信インタフェース（Ｘ２インタフェースなど）、コアネットワークと通信するための通信インタフェース（Ｓ１インタフェースなど）、ユーザ装置２００との送受信信号を処理するためのプロセッサや回路などのハードウェアリソースにより構成される。後述される基地局１００の各機能及び処理は、メモリ装置に格納されているデータやプログラムをプロセッサが処理又は実行することによって実現されてもよい。しかしながら、基地局１００は、上述したハードウェア構成に限定されず、他の何れか適切なハードウェア構成を有してもよい。一般には、無線通信システム１０のサービスエリアをカバーするよう多数の基地局１００が配置される。

[0021] ユーザ装置２００は、基地局１００との３Ｄ　ＭＩＭＯ通信を実現し、基地局１００の複数のアンテナポートを介し基地局１００との間で各種データ信号及び制御信号などの無線信号を送受信する。適切な３Ｄ　ＭＩＭＯ通信を実現するため、ユーザ装置２００は、各アンテナポートとの間のチャネル状態を推定し、推定したチャネル状態をチャネル状態情報（ＣＳＩ）として

基地局１００にフィードバックする。当該チャネル状態情報を受信すると、基地局１００は、受信したチャネル状態情報に基づき各アンテナポートから送信されるビームを制御する。

[0022] ユーザ装置２００は、典型的には、スマートフォン、携帯電話、タブレット、モバイルルータ、ウェアラブル端末などの無線通信機能を備えた何れか適切な情報処理装置であってもよい。ユーザ装置２００は、プロセッサなどのＣＰＵ（Ｃｅｎｔｒａｌ Ｐｒｏｃｅｓｓｉｎｇ Ｕｎｉｔ）、ＲＡＭ（Ｒａｎｄｏｍ Ａｃｃｅｓｓ Ｍｅｍｏｒｙ）やフラッシュメモリなどのメモリ装置、基地局１００との間で無線信号を送受信するための無線通信装置などから構成される。例えば、後述されるユーザ装置２００の各機能及び処理は、メモリ装置に格納されているデータやプログラムをＣＰＵが処理又は実行することによって実現されてもよい。しかしながら、ユーザ装置２００は、上述したハードウェア構成に限定されず、後述する処理の１以上を実現する回路などにより構成されてもよい。

[0023] 次に、図７～９を参照して、本発明の一実施例による基地局を説明する。図７は、本発明の一実施例による基地局の構成を示すブロック図である。

[0024] 図７に示されるように、基地局１００は、３Ｄ ＭＩＭＯ用のアンテナ１１０、アンテナ管理部１２０及び送受信部１３０を有する。

[0025] ３Ｄ ＭＩＭＯ用のアンテナ１１０は、２次元平面アンテナ、円筒形に配置したアンテナや立方体面上に配置したアンテナなどの３次元アンテナなど、複数のアンテナ素子から構成される多次元アンテナから構成される。図３に示されるように、アンテナ１１０は、１以上のアンテナ素子から構成されるアンテナポートを含み、各アンテナポートから送信されるビームが、ユーザ装置２００と３Ｄ ＭＩＭＯ通信を実行するため制御される。

[0026] アンテナ管理部１２０は、アンテナ１１０を管理し、アンテナ１１０の構成を示すアンテナコンフィギュレーション情報を有する。一実施例では、アンテナコンフィギュレーション情報は、アンテナ１１０の各次元におけるアンテナポート数と、アンテナ１１０の偏波種別とを示すものであってもよい

。例えば、アンテナコンフィギュレーション情報は、垂直方向におけるアンテナポートの個数（Ｖ＿ａｐ）、水平方向におけるアンテナポートの個数（Ｈ＿ａｐ）及び単一偏波か直交偏波などを示すアンテナポートの偏波種別（Ｐ＿ａｐ）を示すものであってもよい。しかしながら、アンテナコンフィギュレーション情報は、これに限定されるものでなく、例えば、アンテナポートの構成、アンテナ素子の構成、ＴＸＲＵの構成、アンテナ素子間隔、サブアレイの構成を示す情報又はこれらの情報の何れかの組み合わせに関するものであってもよい。

[0027] 一実施例では、アンテナ管理部１１０は、アンテナ１１０の各次元と偏波種別とに基づきアンテナポートをインデックス付けしてもよい。図８は、本発明の一実施例によるアンテナポートのインデックス付けの具体例を示す図である。例えば、アンテナ１１０が単一偏波アンテナである場合、図８（ａ）に示されるように、アンテナポートはまず水平方向に関してインデックス付けされ、次に垂直方向に関してインデックス付けされてもよい。同様に、図示しないが、アンテナポートはまず垂直方向に関してインデックス付けされ、次に水平方向に関してインデックス付けされてもよい。また、図８（ｂ）に示されるように、アンテナポートは水平方向と垂直方向とに関して独立してインデックス付けされてもよい。一方、アンテナ１１０が直交偏波アンテナである場合、図８（ｃ）に示されるように、アンテナポートはまず水平方向に関してインデックス付けされ、次に偏波方向に関してインデックス付けされ、さらに垂直方向に関してインデックス付けされてもよい。同様に、図示しないが、アンテナポートはまず水平方向に関してインデックス付けされ、次に垂直方向に関してインデックス付けされ、さらに偏波方向に関してインデックス付けされてもよい。また、アンテナポートは水平方向、垂直方向及び偏波方向に関して独立してインデックス付けされてもよい。

[0028] 一実施例では、アンテナ管理部１２０は更に、アンテナ１１０のアンテナポートから送信されるリファレンス信号のシグナリングパターンを示すリファレンス信号コンフィギュレーション情報を有しても良い。当該シグナリン

グパターンは、アンテナ１１０の何れのアンテナポートからリファレンス信号が送信されるかを規定する。図４及び５に関連して説明したように、ユーザ装置２００が各アンテナポートとの間のチャネル状態を測定するのに利用されるリファレンス信号は、所定のシグナリングパターンにより基地局１００から送信される。このシグナリングパターンをユーザ装置２００に通知するため、アンテナ管理部１２０は、アンテナコンフィギュレーション情報と共にリファレンス信号コンフィギュレーション情報を有してもよい。

[0029] 一実施例では、リファレンス信号コンフィギュレーション情報は、シグナリングパターンに関するアンテナ１１０の各次元におけるサンプリングファクタ、オフセット及び偏波種別を示すものであってもよい。例えば、リファレンス信号コンフィギュレーション情報は、水平方向及び垂直方向のそれぞれにおけるサンプリングファクタ（Ｈ＿ｓｆ，Ｖ＿ｓｆ）及びオフセット（Ｈ＿ｏｆ，Ｖ＿ｏｆ）を示すものであってもよい。具体的には、サンプリングファクタは各次元におけるサンプリング間隔を示し、オフセットは各次元における原点からのサンプリング開始位置を示すものであってもよい。

[0030] また、アンテナ１１０が直交偏波アンテナである場合、リファレンス信号コンフィギュレーション情報は、クロス偏波インデックス（ＣＰＩ）を有してもよい。クロス偏波インデックスは、例えば、水平方向において２つの偏波によりリファレンス信号が送信される場合には００を示し、垂直方向において２つの偏波によりリファレンス信号が送信される場合には０１を示し、単一偏波によりリファレンス信号が送信される場合には１０を示すよう構成され、また、リザーブ用に１１が割り当てられてもよい。また、偏波方向に関してサンプリングが行われる場合、リファレンス信号コンフィギュレーション情報は、偏波方向のサンプリングファクタ（Ｐ＿ｓｆ）を有してもよい。

[0031] 図９は、本発明の一実施例によるリファレンス信号の送信パターンの具体例を示す図である。図示された例では、水平方向に８個（Ｈ＿ａｐ＝８）と垂直方向に４個（Ｖ＿ａｐ＝４）の３２個のアンテナポートからのリファレ

ンス信号の送信パターンが示される。

[0032] 図９（ａ）に示される送信パターンは、Ｈ＿ｓｆ＝１，Ｖ＿ｓｆ＝１，Ｈ＿ｏｆ＝０，Ｖ＿ｏｆ＝０，ＣＰＩ＝０１のリファレンス信号コンフィギュレーション情報により規定される。水平方向に関してはＨ＿ｓｆ＝１，Ｈ＿ｏｆ＝０であるため、水平方向に関して先頭の行に配置された全てのアンテナポートからリファレンス信号が送信される。また、垂直方向に関してはＶ＿ｓｆ＝１，Ｖ＿ｏｆ＝０であるため、垂直方向に関して先頭の列に配置された全てのアンテナポートからリファレンス信号が送信される。また、偏波種別に関してＣＰＩ＝０１であるため、垂直方向に関しては２つの偏波によりリファレンス信号が送信される。

[0033] また、図９（ｂ）に示される送信パターンは、Ｈ＿ｓｆ＝２，Ｖ＿ｓｆ＝１，Ｈ＿ｏｆ＝１，Ｖ＿ｏｆ＝３，ＣＰＩ＝０１のリファレンス信号コンフィギュレーション情報により規定される。水平方向に関してはＨ＿ｓｆ＝２，Ｈ＿ｏｆ＝１であるため、水平方向に関して２番目の行に配置された半数のアンテナポートからリファレンス信号が送信される。また、垂直方向に関してはＶ＿ｓｆ＝１，Ｖ＿ｏｆ＝３であるため、垂直方向に関して４番目の列に配置された全てのアンテナポートからリファレンス信号が送信される。また、偏波種別に関してＣＰＩ＝０１であるため、垂直方向に関しては２つの偏波によりリファレンス信号が送信される。

[0034] 送受信部１３０は、アンテナ１１０を介しユーザ装置２００との間で無線信号を送受信すると共に、アンテナコンフィギュレーション情報をユーザ装置２００に通知する。上述したように、アンテナコンフィギュレーション情報は、アンテナ１１０の構成を示し、例えば、アンテナ１１０の各次元におけるアンテナポート数とアンテナ１１０の偏波種別とを示す。

[0035] 一実施例では、送受信部１３０は、各次元におけるアンテナポート数及び偏波種別を示す各パラメータを組み合わせてユーザ装置２００に通知してもよい。例えば、送受信部１３０は、水平方向におけるアンテナポート数（Ｈ＿ａｐ）と偏波種別（Ｐ＿ａｐ）とを組み合わせてジョイント情報としてユ

ーザ装置２００に送信し、垂直方向におけるアンテナポート数（Ｖ＿ａｐ）を付加情報としてユーザ装置２００に送信してもよい。このようにパラメータを送信することによって、ＬＴＥ規格の以前のリリースとの後方互換性を維持することが可能になる。しかしながら、これに限定されることなく、送受信部１３０は、例えば、Ｈ＿ａｐとＶ＿ａｐとを組み合わせ、Ｐ＿ａｐを付加情報として送信してもよいし、あるいは、Ｖ＿ａｐとＰ＿ａｐとを組み合わせ、Ｈ＿ａｐを付加情報として送信してもよい。なお、単一偏波と二重偏波とを示す偏波種別は、フラグ（Ｐ＿ｆｌａｇ）として通知されてもよい。

[0036] 上述した実施例では、送受信部１３０は、水平方向のアンテナポート数と垂直方向のアンテナポート数とを規定したアンテナコンフィギュレーション情報をユーザ装置２００に通知している。しかしながら、本発明はこれに限定されることなく、送受信部１３０は、ユーザ装置２００にフィードバックさせる第１ＣＳＩフィードバックセットのためのアンテナポート数と、第２ＣＳＩフィードバックセットのためのアンテナポート数とを規定したアンテナコンフィギュレーション情報をユーザ装置２００に通知してもよい。また、上述した実施例では、送受信部１３０は、アンテナポートの配置に関するアンテナコンフィギュレーション情報をユーザ装置２００に通知しているが、これに限定されることなく、例えば、アンテナポートの構成、アンテナ素子の構成、ＴＸＲＵの構成、サブアレイの構成を示す情報又はこれらの情報の何れかの組み合わせに関するアンテナコンフィギュレーション情報をユーザ装置２００に通知してもよい。

[0037] 一実施例では、送受信部１３０は、アンテナコンフィギュレーション情報をＰＢＣＨ（Ｐｈｙｓｉｃａｌ Ｂｒｏａｄｃａｓｔ Ｃｈａｎｎｅｌ）又はＲＲＣ（Ｒａｄｉｏ Ｒｅｓｏｕｒｃｅ Ｃｏｎｔｒｏｌ）シグナリングにより通知してもよいし、それらの組合わせで通知しても良い。例えば、トータルのアンテナポート数をＰＢＣＨで通知し、ＰＢＣＨの情報をもとにより詳細なアンテナ構成を通知できても良い。なお、ＲＲＣシグナリングによ

る通知において、送受信部１３０は、アンテナコンフィギュレーション情報をＬＴＥ規格のリリース１１において規定されたＣＳＩプロセスに含めて通知してもよい。ＣＳＩプロセスは、ＣＳＩ－ＲＳリソースコンフィギュレーションとＣＳＩ－ＩＭ（ＣＳＩ－Ｉｎｔｅｒｆｅｒｅｎｃｅ　Ｍｅａｓｕｒｅｍｅｎｔ）リソースコンフィギュレーションとを含み、ユーザ装置２００は、基地局１００から通知されたＣＳＩプロセス毎にチャネル状態を測定し、測定したチャネル状態に基づきＣＳＩを生成する。ここで、ユーザ装置２００は、ＣＳＩ－ＲＳリソースコンフィギュレーションに基づき３Ｄ　ＭＩＭＯ通信を実行するのに必要な電力を算出し、ＣＳＩ－ＩＭリソースコンフィギュレーションに基づき３Ｄ　ＭＩＭＯ通信における他のビームからの干渉電力を算出する。このとき、複数のＣＳＩ－ＲＳリソースが１つのＣＳＩプロセスに含まれてもよい。また、アンテナコンフィギュレーション情報は、ＣＳＩ－ＲＳリソースに含まれてもよい。更に、ＣＳＩプロセスのより上位な概念を用いて複数のＣＳＩプロセス（またはＣＳＩ－ＲＳリソースコンフィグレーション）を含んでいても良い。

[0038] また、Ｒｅｌ．１１の下りリンクＣｏＭＰでは、複数のＣＳＩプロセスを用いる事で、複数の地理的に離れた最大８アンテナのセルのＣＳＩを推定する事が可能となっている。３Ｄ　ＭＩＭＯでは、８より大きいアンテナを具備する基地局に対して、複数のＣＳＩプロセスを設定することで８より大きいＣＳＩを推定する事が可能である。ＣｏＭＰでは、基本的には地理的に離れたセルのＣＳＩ推定を想定していたが、３Ｄ　ＭＩＭＯでは複数のＣＳＩプロセスやＣＳＩ－ＲＳリソースコンフィグレーションが地理的に離れているか、同一かを示す情報を含めても良い。

[0039] 例えば、ＣＳＩ－ＲＳリソースコンフィグレーションにコロケーション情報を含めても良い。更に、複数のＣＳＩプロセスはＣＳＩ－ＲＳリソースコンフィギュレーションの物理的な関係性をシグナリングしてもよい。

[0040] 一実施例では、送受信部１３０は更に、リファレンス信号コンフィギュレーション情報をユーザ装置２００に通知してもよい。すなわち、送受信部１

３０は、アンテナコンフィギュレーション情報に加えて、アンテナ１１０のアンテナポートから送信されるリファレンス信号のシグナリングパターンを示すリファレンス信号コンフィギュレーション情報をユーザ装置２００に通知してもよい。

[0041] 上述したように、リファレンス信号コンフィギュレーション情報は、例えば、シグナリングパターンに関するアンテナ１１０の各次元におけるサンプリングファクタ、オフセット及び偏波種別を示すが、これに限定されることなく、アンテナ１１０のどのアンテナポートからリファレンス信号がどの偏波種別により送信されるかを示す他の何れか適切なパラメータを含むものであってもよい。例えば、各次元において送信されるリファレンス信号の個数とサンプリングファクタとが通知されてもよい。

[0042] また、説明の便宜上、アンテナコンフィギュレーション情報とリファレンス信号コンフィギュレーション情報とを異なる情報要素として説明したが、本発明は、これに限定されるものでなく、アンテナコンフィギュレーション情報のパラメータとリファレンス信号コンフィギュレーション情報のパラメータとを１つの情報要素としてユーザ装置２００に通知してもよい。上述したパラメータに基づき、コードブック又は最大ランクを選択することが可能である。

[0043] また、一実施例では、送受信部１３０は更に、ＣＳＩ－ＲＳリソースコンフィギュレーションに関連するパラメータを通知してもよい。ＣＳＩ－ＲＳリソースコンフィギュレーションに関連するパラメータとして、ＣＳＩ－ＲＳリソースコンフィギュレーションアイデンティティ、ＣＳＩ－ＲＳポートの個数、ＣＳＩ　ＲＳコンフィギュレーション、ＣＳＩ　ＲＳサブフレームコンフィギュレーション、ＣＳＩフィードバック情報算出時のＰＤＳＣＨ送信電力に関するユーザ装置２００の仮定、擬似乱数列生成パラメータ、ユーザ装置２００が送信モード１０に設定されている場合における各種コロケーション情報があげられる。送受信部１３０は、１つのＣＳＩ－ＲＳリソースコンフィギュレーションに複数のエレメントを含めることによって、あるい

は、１つのＣＳＩコンフィギュレーションに複数のＣＳＩ－ＲＳリソースコンフィギュレーションを含めることによって、これらのパラメータを通知してもよい。

[0044] なお、ＣＳＩ－ＲＳリソースコンフィギュレーションアイデンティティは、ＣＳＩ－ＲＳリソースコンフィギュレーションのインデックスである。ＣＳＩ－ＲＳポートの個数は、ＣＳＩ－ＲＳの送信アンテナポート数（２、４又は８など）である。ＣＳＩ－ＲＳコンフィギュレーションは、サブフレーム内におけるＣＳＩ－ＲＳの多重位置（サブキャリア番号、シンボル番号）を示す。ＣＳＩ－ＲＳサブフレームコンフィギュレーションI_{CSI-RS}は、時間的なＣＳＩ－ＲＳの多重位置（送信周期、オフセット）を示す。ＣＳＩフィードバック情報算出時のＰＤＳＣＨ送信電力P_Cは、ＣＳＩ－ＲＳとＰＤＳＣＨとの電力比を示す。擬似乱数列生成パラメータn_{ID}は、ＣＳＩ－ＲＳ系列生成用のパラメータである。上位レイヤパラメータｑｃｌ－ＣＲＳ－Ｉｎｆｏ－ｒ１１は、当該ＣＳＩ－ＲＳがどのＣＲＳとコロケーションしているかを通知する情報である。ＣＳＩ－ＲＳは非常に疎であるため、単体では周波数同期ができず、ＣＲＳを用いて周波数同期を行う。このため、当該ＣＳＩ－ＲＳがどのＣＲＳを用いるかを通知する必要がある。

[0045] 次に、図１０～１３を参照して、本発明の一実施例によるユーザ装置を説明する。図１０は、本発明の一実施例によるユーザ装置の構成を示すブロック図である。

[0046] 図１０に示されるように、ユーザ装置２００は、チャネル状態情報生成部２１０及びチャネル状態情報フィードバック部２２０を有する。

[0047] チャネル状態情報生成部２１０は、基地局１００の３Ｄ　ＭＩＭＯ用のアンテナ１１０のアンテナポートから送信されたリファレンス信号によりアンテナポートのチャネル状態を測定し、測定したチャネル状態に基づきチャネル状態情報を生成する。具体的には、チャネル状態情報生成部２１０は、基地局１００のアンテナポートから送信されたリファレンス信号（ＣＳＩ－ＲＳ）を受信し、受信したリファレンス信号に基づき送信元のアンテナポート

との間のチャネル状態を測定すると共に、測定したチャネル状態に基づきリファレンス信号を送信していないアンテナポートとの間のチャネル状態も推定する。その後、チャネル状態情報生成部２１０は、推定したチャネル状態に基づき、３Ｄ　ＭＩＭＯ通信に使用されるべきランクインジケータ（ＲＩ）、ＣＱＩ（Ｃｈａｎｎｅｌ　Ｑｕａｌｉｔｙ　Ｉｎｄｉｃａｔｏｒ）及びプリコーディングマトリックスインジケータ（ＰＭＩ）を算出し、チャネル状態情報（ＣＳＩ）として基地局１００にフィードバックする。

[0048] 一実施例では、チャネル状態情報生成部２１０は、基地局１００のアンテナ１１０の構成を示すアンテナコンフィギュレーション情報とアンテナ１１０のアンテナポートから送信されるリファレンス信号のシグナリングパターンを示すリファレンス信号コンフィギュレーション情報とを基地局１００から受信し、受信したアンテナコンフィギュレーション情報とリファレンス信号コンフィギュレーション情報とに基づきアンテナポートのチャネル状態を測定してもよい。アンテナコンフィギュレーション情報とリファレンス信号コンフィギュレーション情報とを利用することによって、チャネル状態情報生成部２１０は、リファレンス信号を送信したアンテナポートについて測定したチャネル状態に基づき、リファレンス信号を送信していないアンテナポートとのチャネル状態をより高精度に推定することが可能になる。

[0049] また、チャネル状態情報生成部２１０は、複数のＣＳＩリソースに基づきチャネル状態情報を生成してもよい。３Ｄ　ＭＩＭＯのためのＰＭＩは、２つの異なるＣＳＩプロセスに基づきフィードバックされてもよい。同様に、ＲＩ及びＣＱＩは、複数のＣＳＩプロセスに基づきフィードバックされてもよい。

[0050] チャネル状態情報フィードバック部２２０は、アンテナ１１０の各次元におけるアンテナポートについて異なるチャネル状態情報フィードバック手段を用いて、生成されたチャネル状態情報を基地局１００にフィードバックする。具体的には、基地局１００は、上述したように、水平方向及び垂直方向のそれぞれにおけるアンテナポートからリファレンス信号をユーザ装置２０

０に送信する。このため、チャネル状態情報フィードバック部２２０もまた、図１１に示されるように、水平方向及び垂直方向のそれぞれにおけるアンテナポートから受信したリファレンス信号に対応して水平方向のＰＭＩ１及び垂直方向のＰＭＩ２を基地局１００にフィードバックする。

[0051] また、他の実施例では、図１２に示されるように、チャネル状態情報フィードバック部２２０は、ＣＳＩ－ＲＳ１及びＣＳＩ－ＲＳ２について、ＲＩ、ＰＭＩ及びＣＱＩのチャネル状態情報を様々な方法によりフィードバックしてもよい。例えば、図１２（ａ）に示されるように、チャネル状態情報フィードバック部２２０は、ＣＳＩ－ＲＳ１及びＣＳＩ－ＲＳ２に対して推定したＲＩ、ＰＭＩ及びＣＱＩをジョイント情報として基地局１００にフィードバックしてもよい。また、図１２（ｂ）に示されるように、チャネル状態情報フィードバック部２２０は、ＣＳＩ－ＲＳ１に対して推定したＲＩ１、ＰＭＩ１及びＣＱＩ１と、ＣＳＩ－ＲＳ２に対して推定したＲＩ２、ＰＭＩ２及びＣＱＩ２とを別々のチャネル状態情報フィードバック手段により基地局１００にフィードバックしてもよい。同様に、図１２（ｃ）に示されるように、チャネル状態情報フィードバック部２２０は、ＣＳＩ－ＲＳ１に対して推定したＲＩ１及びＰＭＩ１と、ＣＳＩ－ＲＳ２に対して推定したＲＩ２及びＰＭＩ２とを別々のチャネル状態情報フィードバック手段により基地局１００にフィードバックし、ＣＱＩをジョイント情報として基地局１００にフィードバックしてもよい。

[0052] 一実施例では、チャネル状態情報フィードバック部２２０は、アンテナ１１０の水平方向におけるアンテナポートについて第１チャネル状態情報フィードバック手段を用いて、生成されたチャネル状態報情報を基地局１００にフィードバックし、アンテナ１１０の垂直方向におけるアンテナポートについて第２チャネル状態情報フィードバック手段を用いて、生成されたチャネル状態情報を基地局１００にフィードバックしてもよく、第１チャネル状態情報フィードバック手段は、第２チャネル状態情報フィードバック手段より精細なプリコーディングを可能にするものであってもよい。一般に、３Ｄ

ＭＩＭＯでは、垂直方向に複数のデータストリームを多重することには向いておらず、ビームの上下方向のみの制御がメインで想定される一方、水平方向に関してはより精細なビーム制御が効果的であると考えられる。フィードバックのためのシグナリング量を低減するため、チャネル状態情報フィードバック部２２０は、粒度の異なる２つのタイプのチャネル状態情報フィードバック手段を用いて水平方向のＰＭＩ１と垂直方向のＰＭＩ２とを基地局１００にフィードバックしてもよい。

[0053] 例えば、第１チャネル状態情報フィードバック手段は、ＬＴＥ規格リリース１２の４－Ｔｘコードブックであり、第２チャネル状態情報フィードバック手段は、ＤＦＴ（Ｄｉｓｃｒｅｔｅ Ｆｏｕｒｉｅｒ Ｔｒａｎｓｆｏｒｍ）コードブックであってもよい。ＤＦＴコードブックは、ＬＴＥ規格リリース１２の４－Ｔｘコードブックよりシンプルであり、上下方向のビーム制御を実現するのに好適である。また、第１チャネル状態情報フィードバック手段は、ＬＴＥ規格リリース１２の４－Ｔｘコードブックであり、第２チャネル状態情報フィードバック手段は、ＰＭＩではなく、ビームセレクションにおけるビームインデックスであってもよいし、ビーム追従を行う場合のフィードバック情報であってもよい。すなわち、チャネル状態情報フィードバック部２２０は、基地局１００の各アンテナポートから送信されたビームのうち最適なビームを選択し、選択したビームのビームインデックスを基地局１００に第２チャネル状態情報フィードバック手段として通知してもよい。より一般には、チャネル状態情報フィードバック部２２０は、基地局１００からＣＳＩ－ＲＳプロセスを受信すると、第１ＣＳＩ－ＲＳプロセスについてビームトラッキングによるビームインデックスを通知し、第２ＣＳＩ－ＲＳプロセスについて選択したＰＭＩを通知してもよい。

[0054] また、チャネル状態情報フィードバック部２２０は、ＣＳＩプロセス毎にコードブックなどのチャネル状態情報フィードバック手段を設定するなど、ＣＳＩフィードバック単位毎にチャネル状態情報フィードバック手段を設定してもよい。

[0055] また、チャネル状態情報フィードバック部２２０は、アンテナ１１０の各次元のランクインジケータを結合して基地局１００にフィードバックしてもよい。具体的には、チャネル状態情報フィードバック部２２０は、水平方向と垂直方向との各チャネル状態情報をジョイント情報として基地局１００に通知してもよい。このとき、選択された水平方向のＰＭＩは選択された垂直方向のＰＭＩに依存することになる。例えば、ランクインジケータに関して、第１ＰＭＩの第１ＲＩと第２ＰＭＩの第２ＲＩなどの複数のＲＩがフィードバックされてもよい。例えば、ユーザ装置２００の受信アンテナの個数が４である場合、最大ランクは４に限定される。このとき、チャネル状態情報フィードバック部２２０は、水平方向のランクと垂直方向のランクとを結合して、図１３に示されるようなランクインジケータの組み合わせにより基地局１００にフィードバックしてもよい。なお、本例ではランク４に関する結合されたランクを通知する方法を示したが、それに加えて複数のランク（例えばランク１から８）にまたがった結合されたランクを通知しても良い。なお、垂直方向のビーム制御は相対的にシンプルなチャネル状態情報フィードバック手段により指示することが想定されるため、相対的に高い（またはマルチランクの）垂直方向のランクインジケータに関する組み合わせは、含めなくてもよいかもしれない。すなわち、ランクインジケータは水平方向のＣＳＩのみに関連付ける（または水平方向のＣＳＩフィードバックに含める）事がメリットとなるかもしれない。

[0056] また、ＰＭＩに関して、水平方向及び偏波種別の第１ＰＭＩと垂直方向の第２ＰＭＩなどの複数のＰＭＩがフィードバックされてもよい。ユーザ装置２００は、第２ＰＭＩを選択するため、最新のＲＩと第１ＰＭＩとを利用し、また、第１ＰＭＩを選択するため、最新のＲＩと第２ＰＭＩとを利用してもよい。このため、基地局１００は、第２ＰＭＩを選択するため、最新のＲＩと第１ＰＭＩとをユーザ装置２００に通知し、第１ＰＭＩを選択するため、最新のＲＩと第２ＰＭＩとをユーザ装置２００に通知してもよい。

[0057] また、ＣＱＩに関して、ＣＱＩは、各ＣＱＩプロセスについて選択されて

もよい。また、２つの異なるＣＳＩプロセスに基づき１つのＣＱＩが選択されてもよい。

[0058] 以上、本発明の実施例について詳述したが、本発明は上述した特定の実施形態に限定されるものではなく、特許請求の範囲に記載された本発明の要旨の範囲内において、種々の変形・変更が可能である。

[0059] 本国際出願は、２０１４年９月２５日に出願した日本国特許出願２０１４－１９５８８２号に基づく優先権を主張するものであり、２０１４－１９５８８２号の全内容を本国際出願に援用する。

符号の説明

[0060] １０ 無線通信システム

１００ 基地局

２００ ユーザ装置

請求の範囲

[請求項1] ３Ｄ ＭＩＭＯ（３－Ｄｉｍｅｎｓｉｏｎａｌ Ｍｕｌｔｉｐｌｅ－Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ－Ｏｕｔｐｕｔ）通信を実現する基地局であって、

３Ｄ ＭＩＭＯ用のアンテナと、

前記アンテナを管理するアンテナ管理部と、

前記アンテナを介しユーザ装置との間で無線信号を送受信する送受信部と、

を有し、

前記アンテナ管理部は、前記アンテナの構成を示すアンテナコンフィギュレーション情報を有し、

前記送受信部は、前記アンテナコンフィギュレーション情報を前記ユーザ装置に通知する基地局。

[請求項2] 前記アンテナコンフィギュレーション情報は、前記アンテナの各次元におけるアンテナポート数と、前記アンテナの偏波種別とを示す、請求項１記載の基地局。

[請求項3] 前記アンテナ管理部は、前記アンテナの各次元と偏波種別とに基づきアンテナポートをインデックス付けする、請求項２記載の基地局。

[請求項4] 前記アンテナ管理部は更に、前記アンテナのアンテナポートから送信されるリファレンス信号のシグナリングパターンを示すリファレンス信号コンフィギュレーション情報を有し、

前記送受信部は更に、前記リファレンス信号コンフィギュレーション情報を前記ユーザ装置に通知する、請求項１乃至３何れか一項記載の基地局。

[請求項5] 前記リファレンス信号コンフィギュレーション情報は、前記シグナリングパターンに関する前記アンテナの各次元におけるサンプリングファクタ、オフセット及び偏波種別を示す、請求項４記載の基地局。

[請求項6] ３Ｄ ＭＩＭＯ（３－Ｄｉｍｅｎｓｉｏｎａｌ Ｍｕｌｔｉｐｌｅ

－Ｉｎｐｕｔ　Ｍｕｌｔｉｐｌｅ－Ｏｕｔｐｕｔ）通信を実現するユーザ装置であって、

基地局の３Ｄ　ＭＩＭＯ用のアンテナのアンテナポートから送信されたリファレンス信号により前記アンテナポートのチャネル状態を測定し、前記測定したチャネル状態に基づきチャネル状態情報を生成するチャネル状態情報生成部と、

前記アンテナの各次元におけるアンテナポートについて異なるチャネル状態情報フィードバック手段を用いて、前記生成されたチャネル状態情報を前記基地局にフィードバックするチャネル状態情報フィードバック部と、

を有するユーザ装置。

[請求項7] 前記チャネル状態情報生成部は、前記基地局のアンテナの構成を示すアンテナコンフィギュレーション情報と前記アンテナのアンテナポートから送信されるリファレンス信号のシグナリングパターンを示すリファレンス信号コンフィギュレーション情報とを前記基地局から受信し、前記受信したアンテナコンフィギュレーション情報とリファレンス信号コンフィギュレーション情報とに基づき前記アンテナポートのチャネル状態を測定する、請求項６記載のユーザ装置。

[請求項8] 前記チャネル状態情報フィードバック部は、前記アンテナの水平方向におけるアンテナポートについて第１チャネル状態情報フィードバック手段を用いて、前記生成されたチャネル状態報情報を前記基地局にフィードバックし、前記アンテナの垂直方向におけるアンテナポートについて第２チャネル状態情報フィードバック手段を用いて、前記生成されたチャネル状態情報を前記基地局にフィードバックし、

前記第１チャネル状態情報フィードバック手段は、前記第２チャネル状態情報フィードバック手段より精細なプリコーディングを可能にする、請求項６又は７記載のユーザ装置。

[請求項9] 前記第１チャネル状態情報フィードバック手段は、ＬＴＥ規格リリ

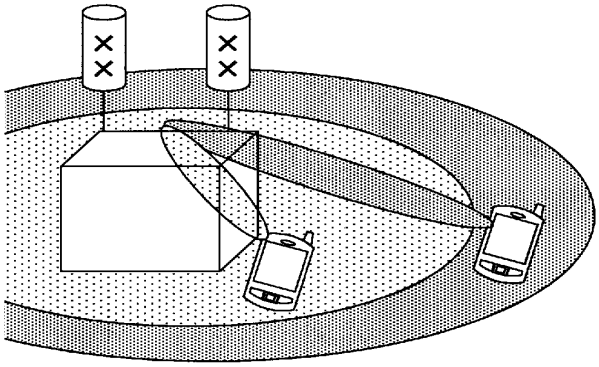
ース１２の４－Ｔｘコードブックであり、

前記第２チャネル状態情報フィードバック手段は、ＤＦＴ（Ｄｉｓｃｒｅｔｅ　Ｆｏｕｒｉｅｒ　Ｔｒａｎｓｆｏｒｍ）コードブックである、請求項８記載のユーザ装置。

[請求項10] 前記チャネル状態情報フィードバック部は、前記アンテナの各次元のランクインジケータを結合して前記基地局にフィードバックする、請求項６乃至９何れか一項記載のユーザ装置。

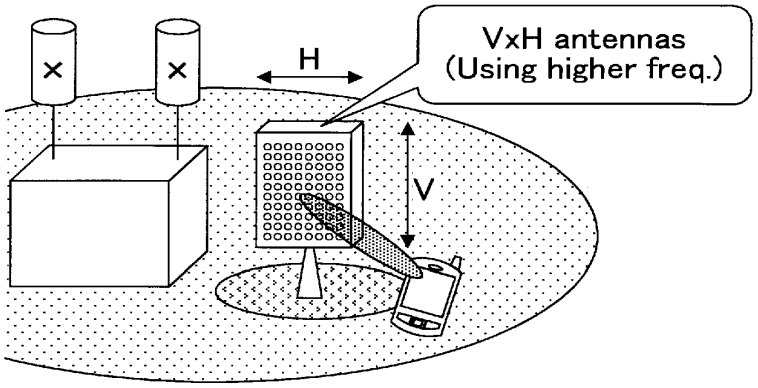
[図1]

(a) Elevation beam forming



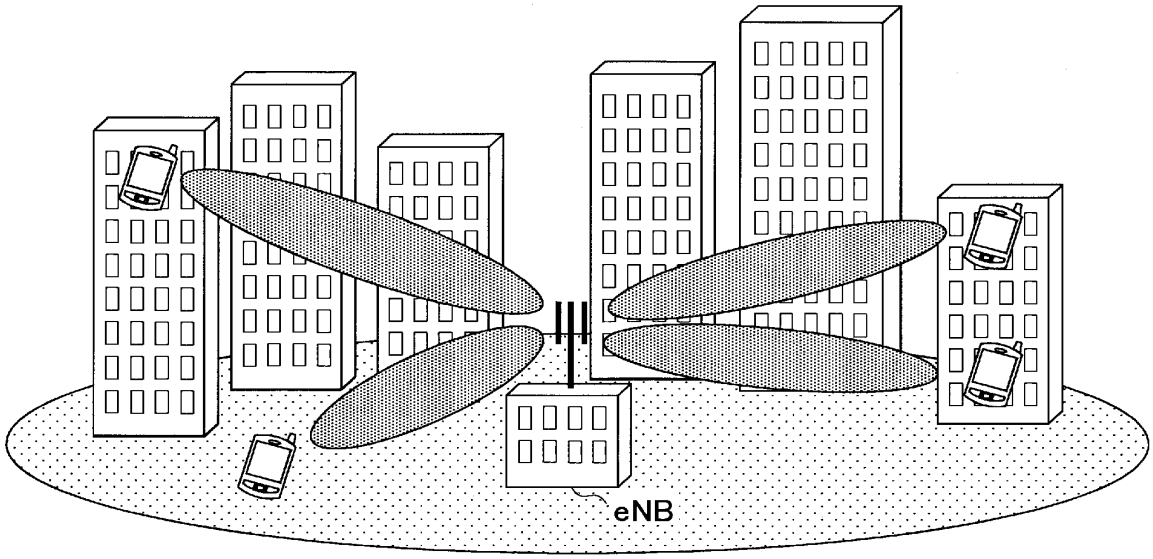
•Up to 8-Tx

(b) Full dimension-MIMO

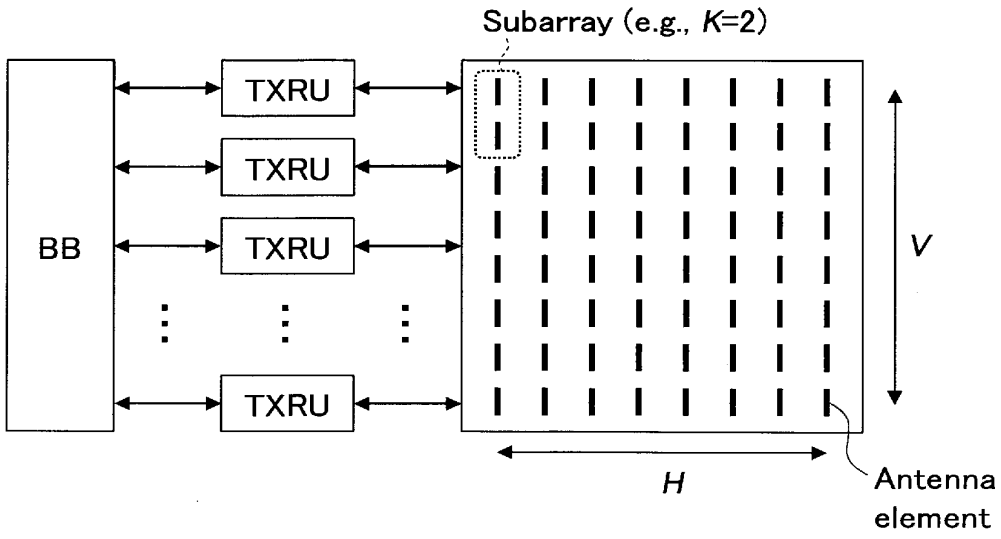


•More than 8-Tx (e.g., 16, 32 and 64)

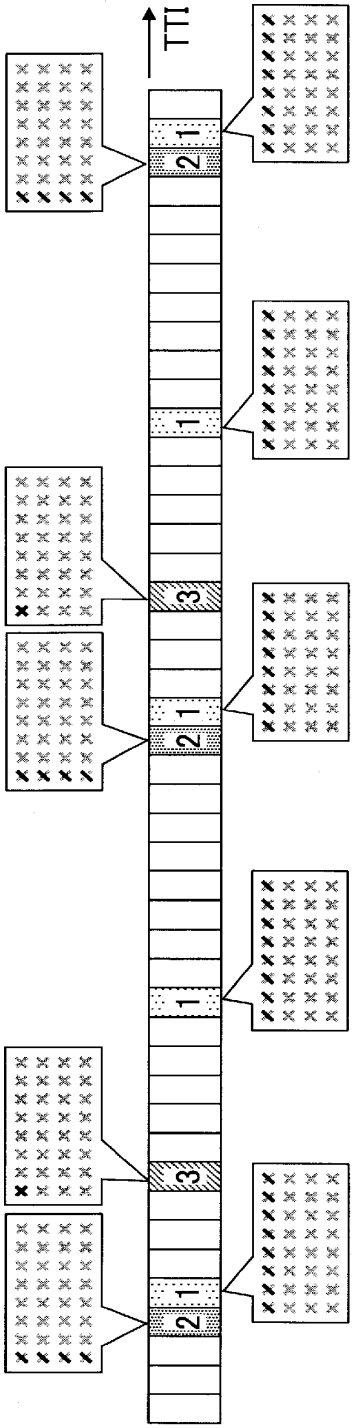
[図2]



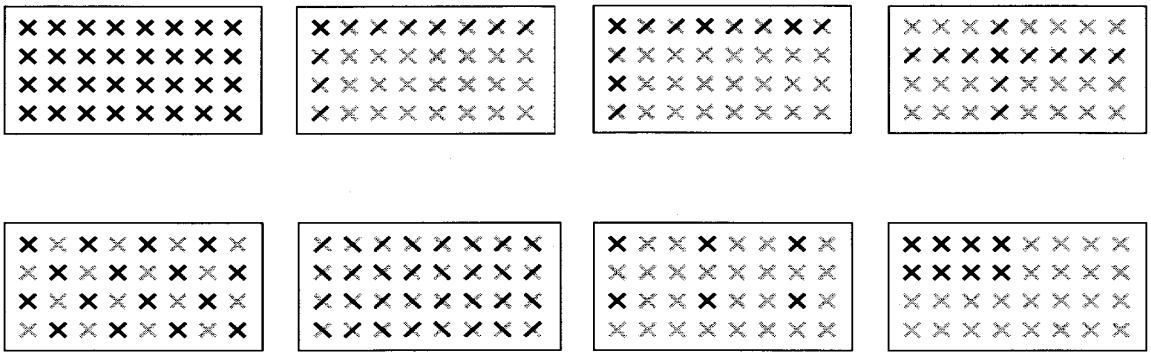
[図3]



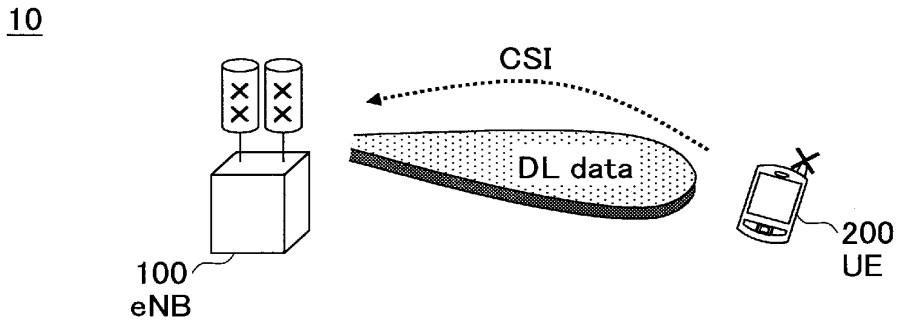
[図4]



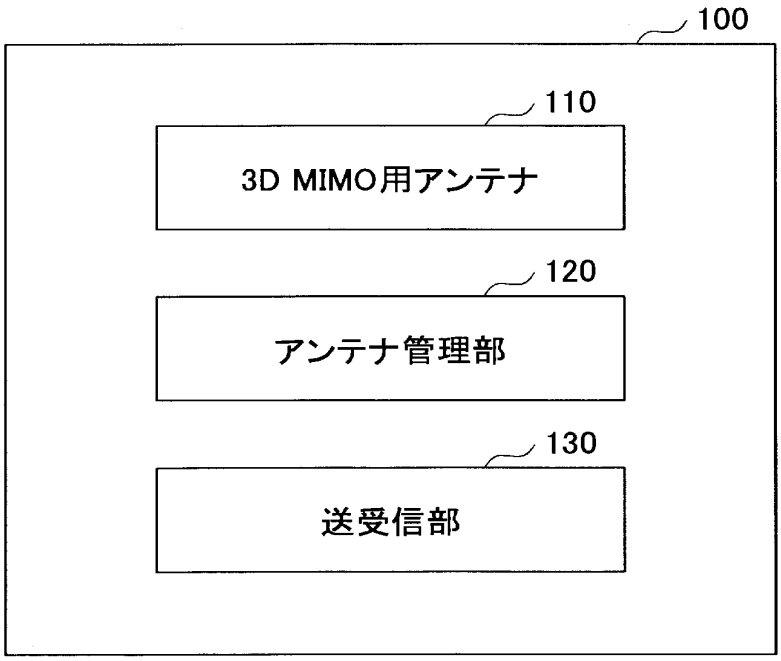
[図5]



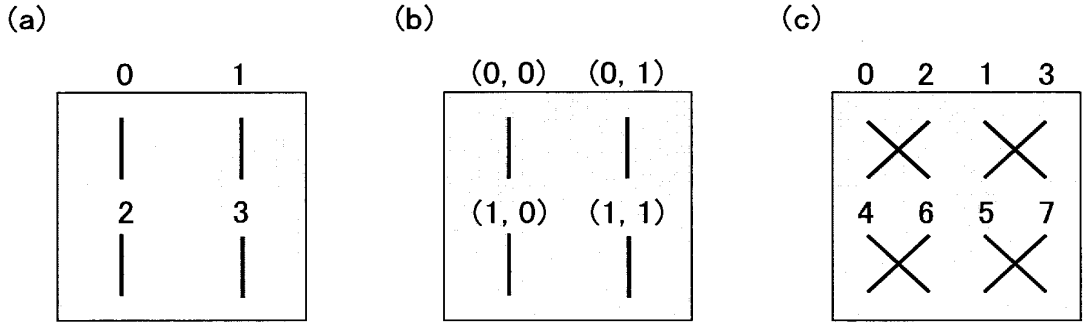
[図6]



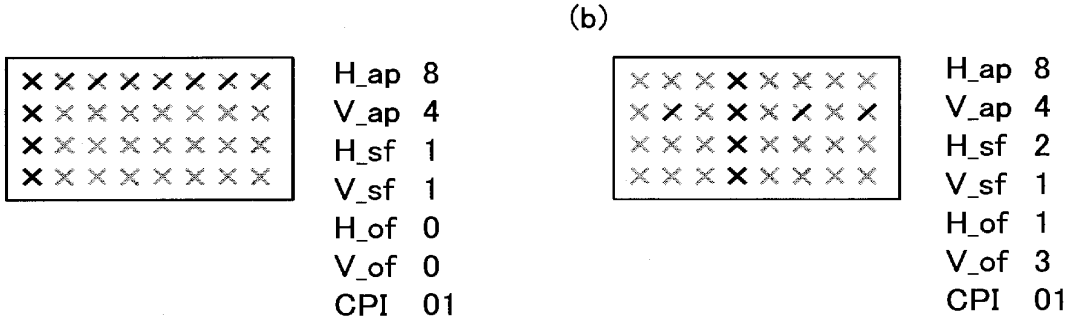
[図7]


100
110
3D MIMO用アンテナ
120
アンテナ管理部
130
送受信部

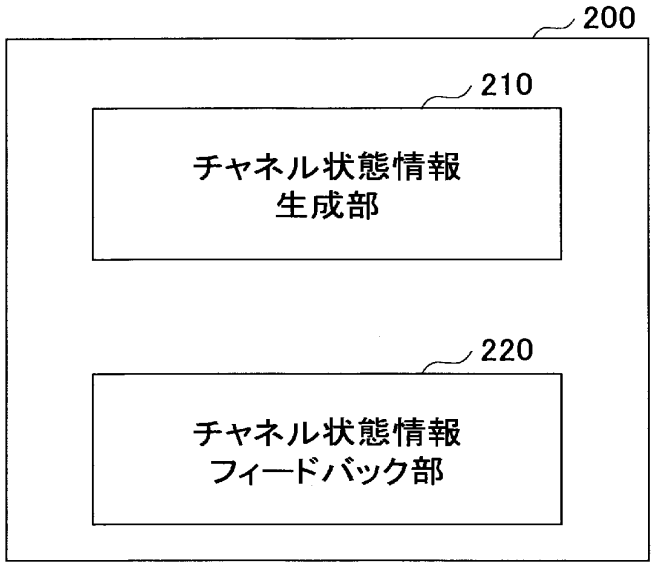
[図8]


(a)
0
1
2
3
(b)
(0, 0)
(0, 1)
(1, 0)
(1, 1)
(c)
0 2 1 3
4 6 5 7

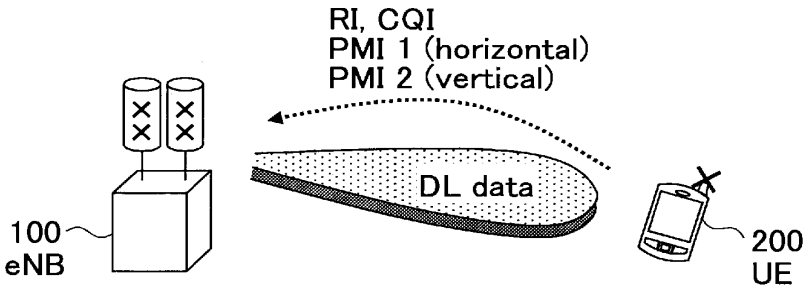
[図9]


(a)
H_ap 8
V_ap 4
H_sf 1
V_sf 1
H_of 0
V_of 0
CPI 01
(b)
H_ap 8
V_ap 4
H_sf 2
V_sf 1
H_of 1
V_of 3
CPI 01

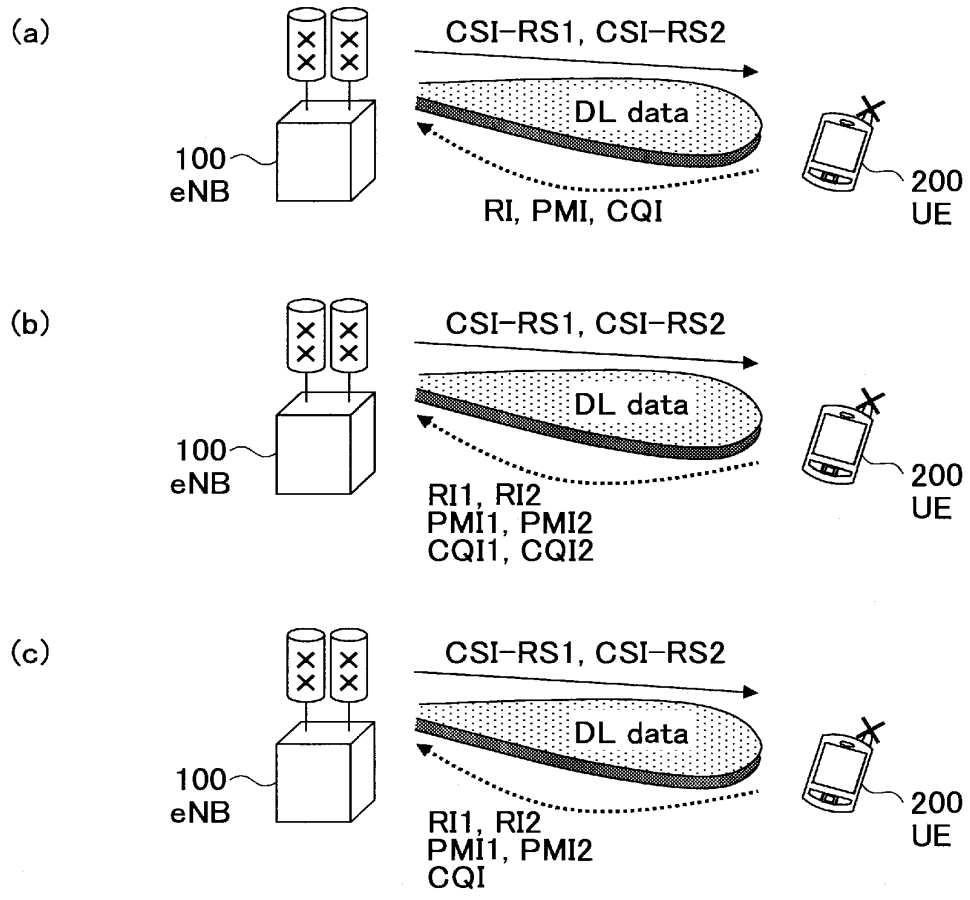
[図10]


200
210
チャネル状態情報
生成部
220
チャネル状態情報
フィードバック部

[図11]


RI, CQI
PMI 1 (horizontal)
PMI 2 (vertical)
DL data
100
eNB
200
UE

[図12]


(a)
CSI-RS1, CSI-RS2
DL data
RI, PMI, CQI
100
eNB
200
UE
(b)
CSI-RS1, CSI-RS2
DL data
RI1, RI2
PMI1, PMI2
CQI1, CQI2
100
eNB
200
UE
(c)
CSI-RS1, CSI-RS2
DL data
RI1, RI2
PMI1, PMI2
CQI
100
eNB
200
UE

[図13]

Joint RI		H-rank			
		1	2	3	4
V-rank	1	0	1	2	3
	2	4	5		
	3	6			
	4	7			

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/076172

A. CLASSIFICATION OF SUBJECT MATTER
H04W16/28(2009.01)i, *H04B7/04*(2006.01)i, *H04J99/00*(2009.01)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)
H04B7/24-7/26, H04W4/00-99/00, H04B7/04, H04J99/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2014-053811 A (NTT Docomo Inc.), 20 March 2014 (20.03.2014), paragraphs [0026], [0041], [0048] & US 2015/0222340 A1 paragraphs [0043], [0058], [0065] & WO 2014/038321 A1	1,4,6-8 2,3,9,10 5
X Y A	US 2013/0329664 A1 (SAMSUNG ELECTRONICS CO., LTD.), 12 December 2013 (12.12.2013), paragraphs [0076], [0090], [0099], [0109] & WO 2013/187669 A1 paragraphs [76], [88], [98], [109]	1,4,6-8 2,3,9,10 5
Y	Qualcomm Incorporated, Discussion on Simulation Assumptions for 3D Channel Model Calibration, R1-134621, 3GPP, 2013.09.28, paragraph 2	2,3

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"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
13 November 2015 (13.11.15)	24 November 2015 (24.11.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/076172

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Fujitsu, Discussion on Feedback Design for LTE-A, R1-103221, 3GPP, 2010.05.04, paragraph 3	9
Y	US 2013/0308714 A1 (QUALCOMM INC.), 21 November 2013 (21.11.2013), paragraph [0162] & WO 2013/173679 A1 paragraph [0074]	10

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１５／０７６１７２

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　H04W16/28(2009.01)i, H04B7/04(2006.01)i, H04J99/00(2009.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　H04B7/24-7/26, H04W4/00-99/00, H04B7/04, H04J99/00

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１５年
日本国実用新案登録公報	１９９６－２０１５年
日本国登録実用新案公報	１９９４－２０１５年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
X Y A	JP 2014-053811 A (株式会社ＮＴＴドコモ) 2014.03.20, 第 26,41,48 段落 & US 2015/0222340 A1, 第 43,58,65 段落 & WO 2014/038321 A1	1,4,6-8 2,3,9,10 5
X Y A	US 2013/0329664 A1 (SAMSUNG ELECTRONICS CO., LTD.) 2013.12.12, 第 76,90,99,109 段落 & WO 2013/187669 A1, 第 76,88,98,109 段落	1,4,6-8 2,3,9,10 5

☑　Ｃ欄の続きにも文献が列挙されている。

☐　パテントファミリーに関する別紙を参照。

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国際調査を完了した日 １３．１１．２０１５	国際調査報告の発送日 ２４．１１．２０１５
国際調査機関の名称及びあて先 日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　５Ｊ　３５７１ 松野　吉宏 電話番号　０３－３５８１－１１０１　内線　３５３４

様式ＰＣＴ／ＩＳＡ／２１０（第２ページ）（２００９年７月）

Ｃ（続き）．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
Y	Qualcomm Incorporated, Discussion on Simulation Assumptions for 3D Channel Model Calibration, R1-134621, 3GPP, 2013.09.28, paragraph 2	2,3
Y	Fujitsu, Discussion on Feedback Design for LTE-A, R1-103221, 3GPP, 2010.05.04, paragraph 3	9
Y	US 2013/0308714 A1 (QUALCOMM INCORPORATED) 2013.11.21, 第162段落 & WO 2013/173679 A1, 第74段落	10

Espacenet

Bibliographic data: CN102170335 (A) — 2011-08-31

Method and apparatus for reporting channel state information

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Applicant(s): ZTE CORP ± (ZTE CORPORATION, ; 中兴通讯股份有限公司)

Classification: - international: ***H04L1/06***
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Application number: CN20111112862 20110503 Global Dossier

Priority number(s): CN20111112862 20110503

Also published as: CN102170335 (B) WO2012149892 (A1)

Abstract of CN102170335 (A)

The invention discloses a method and an apparatus for reporting channel state information. The method comprises the steps that: UE determines the channel state information of paths between the UE and all sending antenna port sets; and the UE reports the channel state information to the predetermined sending antenna port sets of all the sending antenna port sets. The method and the device raise the applicability of the channel state information and reduce the cost.

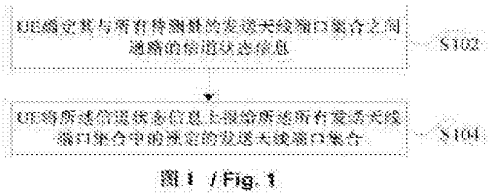


图 1 / Fig. 1

S102 A UE determines channel state information of paths between all the transmission antenna ports set to be measured and the UE;
S104 The UE reports the channel state information to a predetermined transmission antenna ports set of all the transmission antenna ports set

(19)中华人民共和国国家知识产权局

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代理人 余刚 吴孟秋

(51)Int.Cl.
H04L 1/06(2006.01)

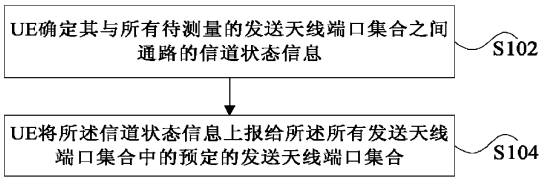
权利要求书 2 页 说明书 9 页 附图 2 页

(54)发明名称

信道状态信息上报方法及装置

(57)摘要

本发明公开了一种信道状态信息上报方法及装置，该方法包括：UE确定其与所有发送天线端口集合之间通路的信道状态信息；UE将信道状态信息上报给所有发送天线端口集合中的预定的发送天线端口集合。本发明提高了信道状态信息的适用性，降低了开销。



CN 102170335 A

1. 一种信道状态信息上报方法，其特征在于，包括：

用户设备 UE 确定其与所有待测量的发送天线端口集合之间通路的信道状态信息；

所述 UE 将所述信道状态信息上报给所述所有发送天线端口集合中的预定的发送天线端口集合。

2. 根据权利要求 1 所述的方法，其特征在于，所述信道状态信息包括：所述 UE 到第一类发送天线端口集合之间通路的第一信道状态信息和所述 UE 到第二类发送天线端口集合之间通路的第二信道状态信息，其中所述第一类发送天线端口集合是所述预定的发送天线端口集合，所述第二类发送天线端口集合是所述所有发送节点中除所述预定的发送天线端口集合之外的其它的发送天线端口集合。

3. 根据权利要求 1 所述的方法，其特征在于，所述信道状态信息包括：两个或者两个以上发送天线端口集合的联合信道状态信息。

4. 根据权利要求 2 所述的方法，其特征在于，所述第一信道状态信息包括：M1 个第一类预编码矩阵索引信息 PMI 和 N1 个信道质量指示信息 CQI，其中，M1、N1 均是大于等于 1 的正整数。

5. 根据权利要求 2 所述的方法，其特征在于，所述第二信道状态信息包括：M2 个第二类 PMI 和 N2 个 CQI，其中，M2、N2 均是大于等于 1 的正整数。

6. 根据权利要求 5 所述的方法，其特征在于，所述 M2 个第二类 PMI 对应于 N-1 个所述 UE 到所述第二类发送天线端口集合之间通路的信道状态信息，其中 M2 = N-1，其中 N 是所述所有发送天线端口集合的数量。

7. 根据权利要求 6 所述的方法，其特征在于，所述 M2 个第二类 PMI 包括 N-1 个最好伴随预编码矩阵索引 BCI 或者 N-1 个信道预编码矩阵索引 cPMI。

8. 根据权利要求 7 所述的方法，其特征在于，所述 BCI 用一个预编码矩阵索引 i1 表示，其中，i1 为使得 $\min_{w_j \in C_{BCI}^{(k)}} \left\| H_c^k w_j \right\|_F$ 取得最小值的 i 值，$C_{BCI}^{(K)}$ 是对应第 k 个发送节点的 BCI 对应的预定义码本，wj 是码本 $C_{BCI}^{(K)}$ 中索引为 j 对应的码字，H_c^k 为所述 UE 到第 k 个第二类发送天线端口集合之间通路的信道矩阵。

9. 根据权利要求 7 所述的方法，其特征在于，所述 BCI 用一个预编码矩阵索引 i1 表示，其中，i1 为使得 $\max_{w_j \in C_{PMI}^{(k)}} \left\| H_c^k w_j \right\|$ 取得最大值的 i 值，$C_{PMI}^{(k)}$ 是对应第 k 个发送节点的 PMI 对应的预定义码本，wj 是码本 $C_{PMI}^{(k)}$ 中索引为 j 对应的码字，H_c^k 为所述 UE 到第 k 个第二类发送天线端口集合之间通路的信道矩阵。

10. 根据权利要求 5 所述的方法，其特征在于，所述 M2 个第二类 PMI 对应于 2(N-1) 个所述 UE 到所述第二类发送天线端口集合之间通路的信道状态信息，其中 M2 = 2(N-1)，其中 N 是所述所有发送天线端口集合的数量。

11. 根据权利要求 10 所述的方法，其特征在于，所述 M2 个第二类 PMI 包括 2(N-1) 个最好伴随预编码矩阵索引 BCI 或者 2(N-1) 个信道预编码矩阵索引 cPMI。

12. 根据权利要求 11 所述的方法，其特征在于，所述 BCI 用一对预编码矩阵索引 (i1, i2) 表示，其中，(i1, i2) 为 $\min_{w_{ij} \in C_{BCI}^{(k)}} \left\| H_c^k w_{ij} \right\|_F^2$ 取得最小值的 (i, j)，$C_{BCI}^{(K)}$ 为所述 BCI 对应的预定

义码本，w_{ij} 是码本$C_{BCI}^{(K)}$中第一索引为 i 和第二索引为 j 对应的码字，H_c^k为所述 UE 到第 k 个第二类发送天线端口集合之间通路的信道矩阵。

13. 根据权利要求 11 所述的方法，其特征在于，所述 BCI 用一个预编码矩阵索引 (i1, i2) 表示，其中，(i1, i2) 为使得$\max_{w_{ij}\in C_{PMI}^{(k)}} \left\| H_c^k w_{ij} \right\|_F$取得最大值的 (i, j) 值，$C_{PMI}^{(k)}$是 PMI 对应的预定义码本，wij 是码本$C_{PMI}^{(k)}$中第一索引为 i 和第二索引为 j 对应的码字，$H_c^k$为所述 UE 到第 k 个第二类发送天线端口集合之间通路的信道矩阵。

14. 根据权利要求 5 所述的方法，其特征在于，所述 M2 个第二类 PMI 用于指示 N-1 个所述 UE 到所述第二类发送天线端口集合之间通路的联合信道状态信息，其中 M2 = 1 或 2，其中 N 是所述所有发送天线端口集合的数量。

15. 根据权利要求 5 所述的方法，其特征在于，所述的联合信道状态信息是联合好伴随预编码矩阵索引 BCI 或者联合信道预编码矩阵索引 cPMI。

16. 根据权利要求 15 所述的方法，其特征在于，所述联合的 BCI 用一个预编码矩阵索引 i1 表示，i1 为$\min_{w_{bci}\in C_{BCI}} \left\{ \left\| H_c^1 w_{bci} \right\|_F + \left\| H_c^2 w_{bci} \right\|_F + \cdots \left\| H_c^N w_{bci} \right\|_F \right\}$取得最小值的 j 值，其中，BCI 对应的预定义码本为 C_{BCI}，wj 是码本 C_{BCI} 中索引为 j 对应的码字，H_c^N为所述 UE 到第 N 个第二类发送天线端口集合之间通路的信道矩阵。

17. 根据权利要求 15 所述的方法，其特征在于，所述联合的 BCI 用一对预编码矩阵索引 (i1, i2) 表示，(i1, i2) 为$\min_{w_{ij}\in C_{BCI}} \left\{ \left\| H_c^1 w_{ij} \right\|_F^2 + \left\| H_c^2 w_{ij} \right\|_F^2 + \cdots \left\| H_c^N w_{ij} \right\|_F^2 \right\}$取得最小值的 (ij)，其中 BCI 对应的预定义码本为 C_{BCI}，wij 是码本 C_{BCI} 中第一索引为 i 和第二索引为 j 对应的码字，H_c^N为所述 UE 到第 N 个第二类发送天线端口集合之间通路的信道矩阵。

18. 根据权利要求 1 至 17 中任一项所述的方法，其特征在于，所述 N 个发送天线端口集合的组成方式包括以下之一：

所述 N 个发送天线端口集合中的每一个发送天线端口集合具有相同的小区标识 ID；

所述 N 个发送天线端口集合中每一个发送天线端口集合具有不同的小区 ID；

所述 N 个发送天线端口集合中 L1 个发送天线端口集合具有相同的小区 ID，L2 个发送天线端口集合具有不同的小区 ID，其中，L1 和 L2 之和等于 N。

19. 根据权利要求 1 至 17 中任一项所述的方法，其特征在于，所述发送天线端口集合为基站或分布式天线头 RRH。

20. 一种信道状态信息上报装置，应用于用户设备 UE，其特征在于，包括：

确定模块，用于确定用户设备与所有发送天线端口集合之间通路的信道状态信息；

上报模块，用于将所述信道状态信息上报给所述所有发送天线端口集合中的预定的发送天线端口集合。

信道状态信息上报方法及装置

技术领域

[0001] 本发明涉及通信领域，具体而言，涉及一种信道状态信息上报方法及装置。

背景技术

[0002] 协作多输入多输出 (Multiple Input Multiple Output，简称为 MIMO) 技术，又称为多点协作传输 (COMP) 技术是利用多个小区的发射天线协作传输来提高小区边缘处无线链路的容量和传输的可靠性，可以有效解决小区边缘干扰问题。

[0003] 在无线通信中，如果在发送端 (eNB) 使用了多根天线，可以采取空间复用的方式来提高传输速率，即，在发送端相同的时频资源上的不同天线位置发射不同的数据，在接收端 (用户终端 UE) 也使用多根天线。一般来说，MIMO 存在两种传输形式，一种是单用户 MIMO(Single User-MIMO，简称为 SU-MIMO)，其在单用户的情况下将所有天线的资源都分配给同一用户，另外一种是多用户 MIMO(Multi User-MIMO，简称为 MU-MIMO)，其在多用户的情况下将不同天线空间的资源分配给不同用户，在相同时间和相同载波上通过空间区分来实现对多个用户的服务，通过 MU-MIMO 传输形式可以提高小区内的平均吞吐量。

[0004] 具体来说，SU-MIMO 是指一个用户终端在一个传输间隔内独自占有分配给该用户终端的物理资源。MU-MIMO 是指一个用户终端和至少一个其它用户终端在一个传输间隔内共享分配给该用户终端的物理资源。一个用户终端和其它用户终端通过空分多址或者空分复用方式共享同一物理资源 (包括时频资源)。

[0005] 在第三代合作伙伴计划标准组织的长期演进技术 (Long term Evolution，简称为 LTE) 中，通过高层信令半静态 (semi-statically) 的将用户终端设置为基于以下的一种传输模式 (transmission mode)，对于版本 8，包括以下几种模式 :

[0006] 模式 1 :单天线端口 ;端口 0(Single-antenna port ;port 0)

[0007] 模式 2 :发射分集 (Transmit diversity)

[0008] 模式 3 :开环空间复用 (Open-loop spatial multiplexing)

[0009] 模式 4 :闭环空间复用 (Closed-loop spatial multiplexing)

[0010] 模式 5 :多用户多输入多输出 (Multi-user MIMO)

[0011] 模式 6 :闭环 Rank = 1 预编码 (Closed-loop Rank = 1 precoding)

[0012] 模式 7 :单天线端口 ;端口 5(Single-antenna port ;port 5)

[0013] UE 根据不同的传输模式确认不同的信道状态信息传输格式，然后发送端 (即，eNB) 再根据 UE 所反馈的信道状态信息进行调度，并根据一定的原则 (例如，最大容量原则) 配置新的信道状态信息用于实际传输。其中，UE 所反馈的信道状态信息包括 :

[0014] 信道质量指示信息 (Channel quality indication，简称为 CQI)，是衡量下行信道质量好坏的一个指标。在 36-213 协议中 CQI 用 0 ～ 15 的整数值来表示，分别代表了不同的 CQI 等级，不同 CQI 对应着各自的调制方式和编码码率 (MCS)。

[0015] 预编码矩阵指示符 (Precoding Matrix Indicator，简称为 PMI)，是 UE 反馈的预编码码本的索引号。在闭环空间复用、MU-MIMO、RI = 1 的闭环这 3 种模式下，需要反馈 PMI

信息，其他发射模式下不需要反馈PMI信息。PMI的反馈粒度可以是整个带宽反馈一个PMI，也可以根据 subband 来反馈PMI。

[0016] 秩指示符(Rank Indicator，简称为RI)，用于描述空间独立信道的个数，对应信道响应矩阵的秩。在开环空间复用和闭环空间复用模式下，需要UE反馈RI信息，其他模式下不需要反馈RI信息。信道矩阵的秩和层数对应。

[0017] 由于信道状态信息的反馈传输方法对反馈信息的开销和精度影响很大，因此，其对发送端进行正确的资源调度和提高无线系统传输性能有重要作用。然而，现有技术中对于信道状态信息携带的内容的定义仅仅适用于单小区的单用户MIMO或者多用户MIMO的情况下，而在协作MIMO系统的传输模式下不太适用，反馈开销和反馈精度的矛盾非常突出。

发明内容

[0018] 针对相关技术中信道状态信息所提供的内容不适用于多点协作传输的问题而提出本发明，为此，本发明的主要目的在于提供一种信道状态信息上报方法及装置，以解决上述问题。

[0019] 为了实现上述目的，根据本发明的一个方面，提供了一种信道状态信息上报方法。

[0020] 根据本发明的一种信道状态信息上报方法包括：UE确定其与所有发送天线端口集合之间通路的信道状态信息；UE将信道状态信息上报给所有发送天线端口集合中的预定的发送天线端口集合。

[0021] 为了实现上述目的，根据本发明的另一个方面，提供了一种信道状态信息上报装置，应用于UE。

[0022] 根据本发明的信道状态信息上报装置包括：确定模块，用于确定用户设备与所有发送天线端口集合之间通路的信道状态信息；上报模块，用于将信道状态信息上报给所有发送天线端口集合中的预定的发送天线端口集合。

[0023] 通过本发明，确定了UE的多种的信道状态信息的格式，并将该信道状态信息发送至发送天线端口集合，提高了信道状态信息的适用性，降低了开销。

附图说明

[0024] 此处所说明的附图用来提供对本发明的进一步理解，构成本申请的一部分，本发明的示意性实施例及其说明用于解释本发明，并不构成对本发明的不当限定。在附图中：

[0025] 图1是根据本发明实施例的信道状态信息上报方法的流程图；

[0026] 图2是根据本发明实施例的信道状态信息的反馈传输方法的流程图；

[0027] 图3是根据本发明实施例的信道状态信息上报装置的结构框图。

具体实施方式

[0028] 需要说明的是，在不冲突的情况下，本申请中的实施例及实施例中的特征可以相互组合。下面将参考附图并结合实施例来详细说明本发明。

[0029] 本发明实施例提供了一种信道状态信息上报方法。图1是根据本发明实施例的信道状态信息上报方法的流程图，如图1所示，包括如下的步骤S102至步骤S104。

[0030] 步骤S102，UE确定其与所有发送天线端口集合之间通路的信道状态信息。

[0031] 步骤 S104，UE 将信道状态信息上报给所有发送天线端口集合中的预定的发送天线端口集合。

[0032] 相关技术中，信道状态信息所提供的内容不适用于多点协作传输。本发明实施例中，确定了 UE 的多种的信道状态信息的格式，并将该信道状态信息发送至发送天线端口集合，提高了信道状态信息的适用性，降低了开销。

[0033] 优选地，信道状态信息包括：UE 到第一类发送天线端口集合之间通路的第一信道状态信息和 UE 到第二类发送天线端口集合之间通路的第二信道状态信息，其中第一类发送天线端口集合是预定的发送天线端口集合，第二类发送天线端口集合是所有发送节点中除预定的发送节点之外的其它的发送天线端口集合。通过该优选实施例，对信道状态信息中的内容根据第一类协作节点与终端之间的通路和第二类协作节点与终端之间的通路进行分类，有利于按照第一类协作节点和第二类协作节点实现协作发送的效率公平。

[0034] 优选地，所述的预定可以是基站配置的也可以是终端指示的。

[0035] 优选地，所述信道状态信息至少包括：两个或者两个以上天线发送天线端口的联合信道状态信息。

[0036] 优选地，第一信道状态信息包括：M1 个第一类预编码矩阵索引信息 PMI 和 N1 个信道质量指示信息 CQI，其中，M1、N1 均是大于等于 1 的正整数。通过该优选实施例，使用第一类 PMI 和 CQI 作为第一类发送天线端口集合与终端之间通路的信道状态信息，提高了第一类发送天线端口集合至终端之间通路信道状态信息的准确性。

[0037] 优选地，第二信道状态信息包括：M2 个第二类 PMI 和 N2 个 CQI，其中，M2、N2 均是大于等于 1 的正整数。通过该优选实施例，采用第二类 PMI 和 CQI 作为第二类发送天线端口集合至终端之间通路的信道状态信息，提高了第二类发送天线端口集合至终端之间通路的信道状态信息的准确性。

[0038] 优选地，M2 个第二类 PMI 对应于 N-1 个 UE 到第二类发送天线端口集合之间通路的信道状态信息，其中 M2 = N-1，其中 N 是所有发送天线端口集合的数量。通过该优选实施例，每个从 UE 到第二类发送天线端口集合之间通路的信道状态信息均与 PMI 对应，提高了第二类发送天线端口集合至终端之间通路的信道状态信息的准确性。

[0039] 优选地，对应于 UE 到第 k 个第二类发送天线端口集合之间通路的状态信息的第二类 PMI 为以下方式之一：用一个预编码矩阵索引 i1 表示，其中，i1 为 $\max_{w_{bci}\in C_{BCI}} \left\| H_c^k w_{bci} \right\|$ 取得最小值的 i 值，第 k 个发送节点的 PMI 对应的预定义码本为 $C_{PMI}^{(k)}$，wj 是码本 $C_{PMI}^{(k)}$ 中索引为 j 对应的码字，H_c^k 为 UE 到第 k 个第二类发送天线端口集合之间通路的信道矩阵；用一对预编码矩阵索引 (i1, i2) 表示，其中，(i1, i2) 为 $\min_{w_{ij}\in C_{BCI}^{(k)}} \left\| H_c^k w_{ij} \right\|_F^2$ 取得最小值的 (i, j)，C_{BCI} 为预定义码本，wij 是码本 C_{BCI} 中第一索引为 i 和第二索引为 j 对应的码字，H_c^k 为 UE 到第 k 个第二类发送天线端口集合之间通路的信道矩阵。通过该优选实施例，采用现有确定码字的方法，降低了研发成本。

[0040] 优选地，M2 个第二类 PMI 为 M2 个 BCI。通过该优选实施例，采用 BCI 实现，提高了信道状态信息的确定精度。

[0041] 优选地，M2 个第二类 PMI 使用 1 个或者 2 个联合的 BCI 标识，其中，BCI 用于指示

N-1 个发送天线端口集合到终端的信道状态信息。通过该优选实施例，采用联合的 BCI 标识，降低了传输信道状态信息的所需要的比特负荷。

[0042] 优选地，联合的 BCI 用一个预编码矩阵索引 i1 表示，i1 为 $\min_{w_{bci}\in C_{BCI}}\left\{\left\|H_c^1 w_{bci}\right\|_F+\left\|H_c^2 w_{bci}\right\|_F+\cdots\left\|H_c^N w_{bci}\right\|_F\right\}$ 取得最大值的 j 值，其中，BCI 对应的预定义码本为 C_{BCI}，wj 是码本 C_{BCI} 中索引为 j 对应的码字，H_c^N 为 UE 到第 N 个第二类发送天线端口集合之间通路的信道矩阵。

[0043] 优选地，联合的 BCI 用一对预编码矩阵索引 (i1, i2) 表示，(i1, i2) 为 $\min_{w_{ij}\in C_{BCI}}\left\{\left\|H_c^1 w_{ij}\right\|_F^2+\left\|H_c^2 w_{ij}\right\|_F^2+\cdots\left\|H_c^N w_{ij}\right\|_F^2\right\}$ 取得最大值的 (i, j)，其中 BCI 对应的预定义码本为 C_{BCI}，wij 是码本 C_{BCI} 中第一索引为 i 和第二索引为 j 对应的码字，H_c^N 为 UE 到第 N 个第二类发送天线端口集合之间通路的信道矩阵。通过该优选实施例，采用上述公式确定联合的 BCI 标识，提高了 BCi 确定的精度。

[0044] 优选地，N 个发送天线端口集合的组成方式包括以下之一：N 个发送天线端口集合中的每一个发送天线端口集合具有相同的小区标识 ID；N 个发送天线端口集合中每一个发送天线端口集合具有不同的小区 ID；N 个发送天线端口集合中 L1 个发送天线端口集合具有相同的小区 ID，L2 个发送天线端口集合具有不同的小区 ID，其中，L1 和 L2 之和等于 N。通过该优选实施例，实现了 N 个发送天线端口集合的的多种组成方式。

[0045] 优选地，发送天线端口集合为基站或 RRH。通过该优选实施例，丰富了本实施例的应用场景。

[0046] 优选地，对于该 N 个发送天线端口集合，每个发送节点都有一个不同的小区 ID。

[0047] 优选地，对于该 N 个发送天线端口集合，每个发送节点都有相同的小区 ID。

[0048] 优选地，对于该 N 个发送天线端口集合，一部分 L1 个发送节点具有相同的小区 ID，另一部分 L2 个发送节点具有不同的小区 ID，其中 L1 和 L2 是大于等于 1 的正整数，并且 L1+L2 = N。

[0049] 优选地，第一类发送天线端口集合是服务小区 (serving cell)。

[0050] 下面分别描述第一类发送天线端口集合的信道状态信息和第二类发送天线端口集合的信道状态信息。

[0051] (1) 第一类发送天线端口集合的信道状态信息

[0052] 第一类发送天线端口集合的信道状态信息至少包括：M1 个预编码矩阵索引信息 PMI，N1 个信道质量指示信息，其中 M1 是大于等于 1 的正整数，N1 是大于等于 1 的正整数。所述 M1 个预编码矩阵索引 PMI 信息可以确定一个子带、多个子带或子带集合上预编码矩阵。所述 N1 个信道质量指示 CQI 信息可以确定一个子带、多个子带或子带集合上道质量指示信息。

[0053] (2) 第二类发送天线端口集合的信道状态信息

[0054] 第二类发送天线端口集合的信道状态信息至少包括：M2 个预编码矩阵索引信息 PMI，N2 个信道质量指示信息，其中，M2、N2 是大于等于 1 的正整数。其中，M2 = 1、2、N-1 或者 2(N-1)，下面分别对其进行描述。

[0055] ①、当 M2 = 1 时，这个预编码矩阵索引指示一个最好伴随预编码矩阵索引 BCI(Best companion precoding matrix index)，并且这个 BCI 对应所有第二类发送天线

端口集合的联合 BCI，这个 BCI 用一个索引表示即可。

[0056] ②、当 M2 = 2 时，这个预编码矩阵索引指示一个最好伴随预编码矩阵索引 BCI(Best companion precoding matrix index)，并且这个 BCI 对应所有第二类发送天线端口集合的联合 BCI，这个 BCI 用一对索引表示即可。

[0057] ③、当 M2 = N-1 时，包括如下的情况一和情况二。

[0058] 情况一：每个预编码矩阵索引指示一个最好伴随预编码矩阵索引 BCI(Best companion precoding matrix index)，并且每一个 BCI 对应一个第二类发送天线端口集合，每一个 BCI 用一个索引表示即可。

[0059] 情况二：每个预编码矩阵索引指示一个信道预编码矩阵索引 cPMI(channel precoding matrix index)，并且每一个 cPMI 对应一个第二类发送天线端口集合，每一个 cPMI 用一个索引表示即可。

[0060] ④、当 M2 = 2(N-1) 时，包括如下的情况三和情况四。

[0061] 情况三：每个预编码矩阵索引指示一个最好伴随预编码矩阵索引 BCI(Best companion precoding matrix index)，并且每一个 BCI 对应一个第二类发送天线端口集合，每一个 BCI 用一对索引表示即可。

[0062] 情况四：每个预编码矩阵索引指示一个信道预编码矩阵索引 cPMI(channel precoding matrix index)，并且每一个 cPMI 对应一个第二类发送天线端口集合，每一个 cPMI 用一对索引表示即可。

[0063] 本发明确定了 UE 的多种的信道状态信息的格式，并将该信道状态信息发送至发送天线端口集合，解决了信道状态信息所提供的内容不适用于多点协作传输的问题，特别是协作调度协作波束赋形的传输的问题，提高了信道状态信息的适用性，降低了开销。

[0064] 下面将结合实例对本发明实施例的实现过程进行详细描述。

[0065] 本发明实施例提供了一种信道状态信息的反馈传输方法，图 2 是根据本发明实施例的信道状态信息的反馈传输方法的流程图，如图 2 所示，包括如下的步骤 S202 至步骤 S206。

[0066] 步骤 S202，在一种多点协作传输的传输模式下，UE 确定支持该模式的信道状态信息。

[0067] 步骤 S204，UE 向单个或者多个发送天线端口集合发送所述的信道状态信息。

[0068] 步骤 S206，发送天线端口集合根据上报信道状态信息决定发送权值，进行协作多点传输，将数据发送到协作终端 UE。

[0069] 相关技术中的信道状态信息中携带的内容主要适用于单小区 MIMO 传输，对于多点协作传输的缺少足够的支持，本发明就是给出开销尽量小和性能尽量好的信道状态信息格式。

[0070] 通过上述方法，用户终端可以根据不同的发送天线端口集合灵活地选择信道状态信息携带的内容，从而能够适用于多小区协作 MIMO，以便支持单小区 MIMO 和多小区 MIMO 之间进行切换的传输模式。

[0071] 下面将结合实施例对上述信道状态信息的反馈传输方法的实现过程进行详细描述。

[0072] 优选实施例一

[0073] UE 上报 N 个发送天线端口集合到所述的终端的信道状态信息给 N 个协作发送点中一个发送天线端口集合。

[0074] M 个发送天线端口集合通过协作多点传输发送数据到所述的终端，其中 M 个发送发送天线端口集合是 N 个发送天线端口集合的子集。

[0075] 其中，N 是大于等于 2 的正整数，M 是大于等于 2 的正整数且小于等于 N。

[0076] 优选地，发送天线端口集合是基站或者 RRH。

[0077] 优选地，对于用户终端，N 发送天线端口集合中有一个第一类发送天线端口集合，其余的是第二类发送天线端口集合。其中，第一类发送天线端口集合就是接收所述终端上报的信道状态信息的发送节点，第二类发送天线端口集合就是非终端上报的信道状态信息的发送节点。

[0078] 优选地，第一类发送天线端口集合是服务小区 (serving cell)。

[0079] 优选地，信道状态信息至少包括以下内容：一个第一类发送天线端口集合到所述用户终端的信道状态信息，M2 个第二类发送节点到所述用户终端的信道状态信息。

[0080] 下面分别描述第一类发送天线端口集合的信道状态信息和第二类发送天线端口集合的信道状态信息。

[0081] (1) 第一类发送天线端口集合的信道状态信息

[0082] 第一类发送天线端口集合的信道状态信息至少包括：M1 个预编码矩阵索引信息 PMI，N1 个信道质量指示信息，其中 M1 是大于等于 1 的正整数，N1 是大于等于 1 的正整数。所述 M1 个预编码矩阵索引 PMI 信息可以确定一个子带、多个子带或子带集合上预编码矩阵。所述 N1 个信道质量指示 CQI 信息可以确定一个子带、多个子带或子带集合上道质量指示信息。

[0083] (2) 第二类发送天线端口集合的信道状态信息

[0084] 第二类发送天线端口集合的信道状态信息至少包括：M2 个预编码矩阵索引信息 PMI，N2 个信道质量指示信息，其中，M2、N2 是大于等于 1 的正整数。其中，M2 = 1、2、N-1 或者 2(N-1)，下面分别对其进行描述。

[0085] 对应于上述情况一，本优选实施例一中，M2 = N-1，M2 个预编码矩阵索引 PMI 包括 N-1 个最好伴随预编码矩阵索引 BCI(Best Companion Indcator)，每一个 BCI 对应一个第二类发送天线端口集合到所述终端的信道状态信息，并且每一个 BCI 用一个索引表示。并且，每个 BCI 对应一个发送天线端口集合，在这里，M2 = N-1。

[0086] 优选地，所述的最好伴随预编码矩阵索引 BCI 可以用一个预编码矩阵索引 i1 表示，通过找到一个 j 使得下式取最小值来定义 i1。其中，对应第 k 个发送节点的 BCI 对应的预定义码本为$C_{BCI}^{(k)}$，wj 是码本$C_{BCI}^{(k)}$中索引为 j 对应的码字

[0087] $\min_{w_j \in C_{BCI}^{(k)}} \left\| H_c^k w_j \right\|_F$。

[0088] 这里的$C_{BCI}^{(k)}$有不同的维度，所以 BCI 包含的信息也可以是 1 维矢量或多维空间。其中，对于 N-1 第二类发送天线端口集合，第一发送天线端口集合到所述终端的空间信道为H_c^1，第二发送天线端口集合到所述终端的空间信道为H_c^2，依次类推，第 N-1 发送天线端口集合到所述终端的空间信道为H_c^{N-1}。

[0089] 优选实施例二

[0090] 本优选实施例二与优选实施例一的区别在于第二类发送天线端口集合的信道状态信息反馈不同，所以本优选实施例二只描述了第二类发送天线端口集合的信道状态信息内容，其它与优选实施例一相同。

[0091] 第二类发送天线端口集合的信道状态信息至少包括：M2 个预编码矩阵索引信息 PMI，N2 个信道质量指示信息，其中，M2、N2 是大于等于 1 的正整数。

[0092] 对应于上述情况二，本优选实施例二中，M2 = N-1，M2 个预编码矩阵索引 PMI 包括 N-1 个信道预编码矩阵索引 cPMI，每一个 cPMI 对应一个第二类发送天线端口集合到所述终端的信道状态信息。并且，每个 cPMI 对应一个发送天线端口集合，在这里，M2 = N-1。

[0093] 优选地，所述的信道预编码矩阵索引 cPMI 可以用一个预编码矩阵索引 i1 表示，通过找到一个 j 使得下式取最大值来定义 i1。其中，对应第 k 个发送节点的 PMI 对应的预定义码本为$C_{PMI}^{(k)}$，wj 是码本$C_{PMI}^{(k)}$中索引为 j 对应的码字

[0094] $$\max_{w_j \in C_{PMI}^{(k)}} \left\| H_c^k w_j \right\|$$。

[0095] 这里的$C_{PMI}^{(k)}$有不同的维度，所以 PMI 包含的信息也可以是 1 维矢量或多维空间。其中，对于 N-1 第二类发送天线端口集合，第一发送天线端口集合到所述终端的空间信道为H_c^1，第二发送天线端口集合到所述终端的空间信道为H_c^2，依次类推，第 N-1 发送天线端口集合到所述终端的空间信道为H_c^{N-1}。

[0096] 优选实施例三

[0097] 本优选实施例三与优选实施例一的区别在于第二类发送天线端口集合的信道状态信息反馈不同，所以本优选实施例三只描述了第二类发送天线端口集合的信道状态信息内容，其它与优选实施例一相同。

[0098] 对应于上述情况三，本优选实施例三中，M2 = 2 * (N-1)，M2 个预编码矩阵索引 PMI 包括 N-1 个最好伴随预编码矩阵索引 BCI(Best companion indcator)，每一个 BCI 对应一个第二类发送天线端口集合到所述终端的信道状态信息，并且每一个 BCI 用一对索引表示。并且，每个 BCI 对应一个发送天线端口集合，在这里，M2 = 2 * (N-1)。

[0099] 优选地，所述的最好伴随预编码矩阵索引 BCI 可以用一对预编码矩阵索引 (i1, i2) 表示，通过找到一组 (i, j) 使得下式取最小值来定义 (i1, i2)。其中，BCI 对应的预定义码本为$C_{BCI}^{(k)}$，wij 是码本$C_{BCI}^{(k)}$中第一索引为 i 和第二索引为 j 对应的码字。

[0100] $$\min_{w_{ij} \in C_{BCI}^{(k)}} \left\| H_c^k w_{ij} \right\|_F^2$$

[0101] 这里的$C_{BCI}^{(k)}$有不同的维度，所以 BCI 包含的信息也可以是 1 维矢量或多维空间。其中，对于 N-1 第二类发送天线端口集合，第一发送天线端口集合到所述终端的空间信道为H_c^1，第二发送天线端口集合到所述终端的空间信道为H_c^2，依次类推，第 N-1 发送天线端口集合到所述终端的空间信道为H_c^{N-1}。

[0102] 优选实施例四

[0103] 本优选实施例四与优选实施例一的区别在于第二类发送天线端口集合的信道状态信息反馈不同，所以本优选实施例四只描述了第二类发送天线端口集合的信道状态信息内容，其它与优选实施例一相同。

[0104] 对应于上述情况四，本优选实施例四中，M2 = 2 * (N-1)，M2 个预编码矩阵索引 PMI 包括 N-1 个信道预编码矩阵索引 cPMI，每一个 cPMI 对应一个第二类发送天线端口集合到所述终端的信道状态信息，并且每一个 cPMI 用一对索引表示。并且，每个 cPMI 对应一个发送天线端口集合，在这里，M2 = 2 * (N-1)。

[0105] 优选地，所述的最好伴随预编码矩阵索引 PMI 可以用一对预编码矩阵索引 (i1, i2) 表示，通过找到一组 (i, j) 使得下式取最大值来定义 (i1, i2)。其中，PMI 对应的预定义码本为$C_{PMI}^{(k)}$，wij 是码本$C_{PMI}^{(k)}$中第一索引为 i 和第二索引为 j 对应的码字。

[0106] $$\max_{w_{ij}\in C_{PMI}^{(k)}} \left\| H_c^k w_{ij} \right\|_F$$

[0107] 这里的$C_{PMI}^{(k)}$有不同的维度，所以 PMI 包含的信息也可以是 1 维矢量或多维空间。其中，对于 N-1 第二类发送天线端口集合，第一发送天线端口集合到所述终端的空间信道为H_c^1，第二发送天线端口集合到所述终端的空间信道为H_c^2，依次类推，第 N-1 发送天线端口集合到所述终端的空间信道为H_c^{N-1}。

[0108] 优选实施例五

[0109] 本优选实施例五与优选实施例一的区别在于第二类发送天线端口集合的信道状态信息反馈不同，所述信道状态信息至少包括：两个或者两个以上天线发送天线端口的联合信道状态信息。所以本优选实施例五只描述了第二类发送天线端口集合的信道状态信息内容，其它与优选实施例一相同。

[0110] 本优选实施例五中，M2 = 1，M2 预编码矩阵索引 PMI 包括 1 个联合的最好伴随预编码矩阵索引 BCI(Best companion indcator)，所述的 1 个 BCI 用于指示 N-1 个发送天线端口集合到所述终端的信道状态信息，其中 M2 等于 1。

[0111] 优选地，所述的联合的最好伴随预编码矩阵索引 BCI 可以用一个预编码矩阵索引 i1 表示，通过找到一个 j 使得下式取最小值来定义 i1。其中，BCI 对应的预定义码本为$C_{BCI}^{(k)}$，wj 是码本$C_{BCI}^{(k)}$中索引为 j 对应的码字

[0112] $$\min_{w_j\in C_{BCI}} \left\{ \left\| H_c^1 w_j \right\|_F^2 + \left\| H_c^2 w_j \right\|_F^2 + \cdots \left\| H_c^N w_j \right\|_F^2 \right\}$$

[0113] 这里的$C_{BCI}^{(k)}$有不同的维度，所以 BCI 包含的信息也可以是 1 维矢量或多维空间。其中，对于 N-1 第二类发送天线端口集合，第一发送天线端口集合到所述终端的空间信道为H_c^1，第二发送天线端口集合到所述终端的空间信道为H_c^2，依次类推，第 N-1 发送天线端口集合到所述终端的空间信道为H_c^{N-1}。

[0114] 优选地，所述的 M2 预编码矩阵索引 PMI 包括 1 个联合的最好伴随预编码矩阵索引 BCI(Best companion indcator)，所述的 1 个 BCI 用于指示 N-1 个发送天线端口集合到所述终端的信道状态信息，1 个 BCI 用两个索引表示，其中 M2 等于 2。

[0115] 优选地，所述的联合的最好伴随预编码矩阵索引 BCI 可以用一对预编码矩阵索引 (i1, i2) 表示，通过找到一组 (i, j) 使得下式取最小值来定义 (i1, i2)。其中，BCI 对应的预定义码本为$C_{BCI}^{(k)}$，w_{ij} 是码本$C_{BCI}^{(k)}$中第一索引为 i 和第二索引为 j 对应的码字。

[0116] $$\min_{w_{ij}\in C_{BCI}^{k}} \left\{ \left\| H_c^1 w_{ij} \right\|_F^2 + \left\| H_c^2 w_{ij} \right\|_F^2 + \cdots \left\| H_c^N w_{ij} \right\|_F^2 \right\}$$

[0117] 这里的$C_{BCI}^{(k)}$有不同的维度，所以 BCI 包含的信息也可以是 1 维矢量或多维空间。其中，对于 N-1 第二类发送天线端口集合，第一发送天线端口集合到所述终端的空间信道为H_c^1，第二发送天线端口集合到所述终端的空间信道为H_c^2，依次类推，第 N-1 发送天线端口集合到所述终端的空间信道为H_c^{N-1}。

[0118] 需要说明的是，在附图的流程图示出的步骤可以在诸如一组计算机可执行指令的计算机系统中执行，并且，虽然在流程图中示出了逻辑顺序，但是在某些情况下，可以以不同于此处的顺序执行所示出或描述的步骤。

[0119] 本发明实施例提供了一种信道状态信息上报装置，应用于 UE，该信道状态信息上报装置可以用于实现上述信道状态信息上报方法。图 3 是根据本发明实施例的信道状态信息上报装置的结构框图，如图 3 所示，包括确定模块 32 和上报模块 34，下面对其结构进行详细描述。

[0120] 确定模块 32，用于确定其与所有发送天线端口集合之间通路的信道状态信息；上报模块 34，连接至确定模块 32，用于将确定模块 32 确定的信道状态信息上报给所有发送天线端口集合中的预定的发送天线端口集合。

[0121] 需要说明的是，装置实施例中描述的信道状态信息上报装置对应于上述的方法实施例，其具体的实现过程在方法实施例中已经进行过详细说明，在此不再赘述。

[0122] 综上所述，根据本发明的上述实施例，提供了一种信道状态信息上报方法及装置。通过本发明，确定了 UE 的多种的信道状态信息的格式，并将该信道状态信息发送至发送天线端口集合，提高了信道状态信息的适用性，降低了开销。具体地，借助本发明实施例提供的技术方案，通过向发送天线端口集合反馈不同的信道状态信息，可以灵活准确的反馈信道状态信息，通过发送第一类 PMI 和第二类 PMI，使得接收端可以充分获得各个发送天线端口集合到终端的信道状态信息。该方法适用于协作多点传输，特别是协作调度协作波束赋形 (CS/CB)，使得基站根据实际信道条件较好地抑制相邻小区的干扰，提高信号的传输质量，从而达到显著地提高系统性能的目的，同时可以保证反馈的信道状态信息具有较小的开销，以达到最佳的反馈效果。

[0123] 显然，本领域的技术人员应该明白，上述的本发明的各模块或各步骤可以用通用的计算装置来实现，它们可以集中在单个的计算装置上，或者分布在多个计算装置所组成的网络上，可选地，它们可以用计算装置可执行的程序代码来实现，从而，可以将它们存储在存储装置中由计算装置来执行，或者将它们分别制作成各个集成电路模块，或者将它们中的多个模块或步骤制作成单个集成电路模块来实现。这样，本发明不限制于任何特定的硬件和软件结合。

[0124] 以上所述仅为本发明的优选实施例而已，并不用于限制本发明，对于本领域的技术人员来说，本发明可以有各种更改和变化。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。

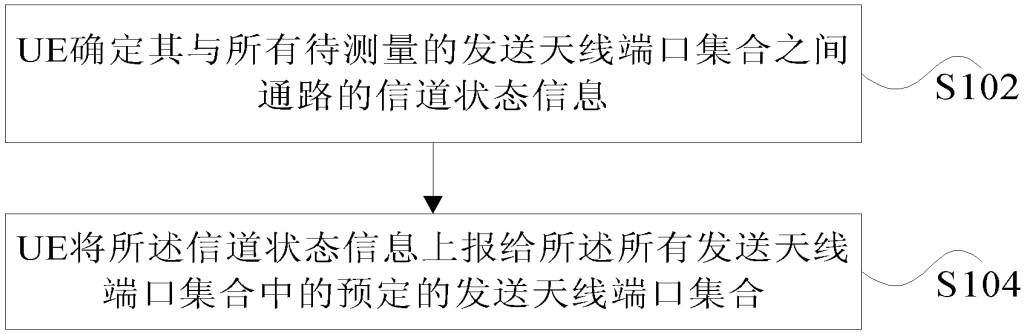

UE确定其与所有待测量的发送天线端口集合之间通路的信道状态信息
S102
UE将所述信道状态信息上报给所述所有发送天线端口集合中的预定的发送天线端口集合
S104

图 1

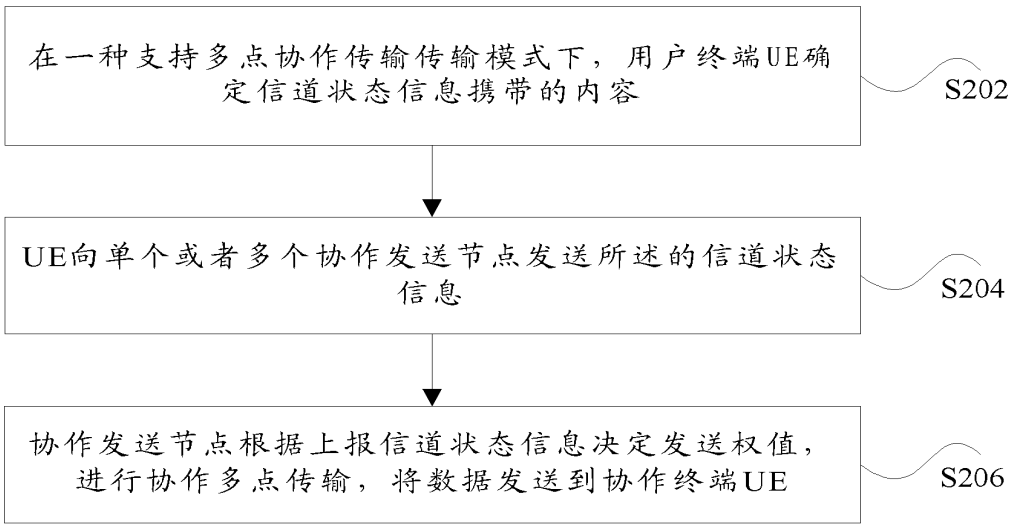

在一种支持多点协作传输传输模式下，用户终端UE确定信道状态信息携带的内容
S202
UE向单个或者多个协作发送节点发送所述的信道状态信息
S204
协作发送节点根据上报信道状态信息决定发送权值，进行协作多点传输，将数据发送到协作终端UE
S206

图 2



图 3

Espacenet

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Method and apparatus for CSI feedback for joint processing schemes in an orthogonal frequency division multiplexing communication system with coordinated multi-point transmission

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Classification: - international: ***H04B7/02***
- cooperative: **H04B7/024**; H04B7/0632; H04B7/0634; H04B7/0639

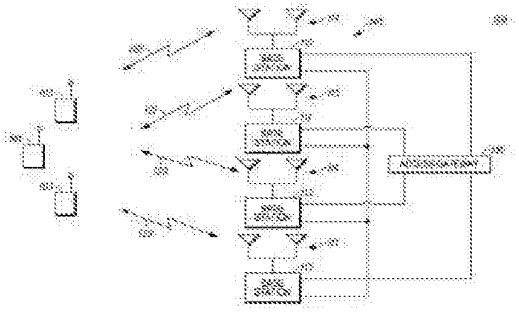
Application number: CN20128054715 20121106 Global Dossier

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Abstract of CN103918195 (A)

Methods in a wireless terminal are described for supporting co-ordinated multipoint transmissions including joint transmissions from two or more transmission points, specifically the method of receiving indication of two or more CSI reference signal configurations, each CSI reference signal configuration representing one or more antenna ports comprising a set of antenna ports; determining a first set of transmission parameters corresponding to a first set of antenna ports corresponding to a first CSI reference signal configuration and a second set of transmission parameters corresponding to a second set of antenna ports corresponding to a second CSI reference signal configuration; the first set and second set of transmission parameters determined to maximize the sum data rate for simultaneous transmission from the first set and the second set of antenna ports; conveying, to the base station, information pertaining to the first set of transmission parameters and the second set of transmission parameters.



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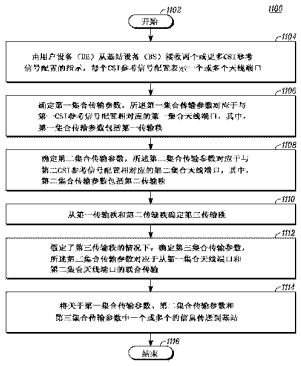
权利要求书4页 说明书27页 附图14页

(54)发明名称

在具有协作多点传输的正交频分复用通信系统中联合处理方案的CSI反馈的方法和装置

(57)摘要

无线终端中的方法被描述用于支持包括从两个或更多传输点的联合传输的协作多点传输，特别是接收两个或更多CSI参考信号配置的指示的方法，每个CSI参考信号配置表示包括天线端口的集合的一个或多个天线端口；确定对应于与第一CSI参考信号配置相对应的第一集合天线端口的第一集合传输参数、以及对应于与第二CSI参考信号配置相对应的第二集合天线端口的第二集合传输参数；第一集合传输参数和第二集合传输参数被确定以最大化用于从第一集合天线端口和第二集合天线端口的同时传输的总和数据速率；将关于第一集合传输参数和第二集合传输参数的信息传送到基站。



CN 103918195 A

1. 一种在与基站单元通信的无线通信终端中的方法，包括：

接收两个或更多信道状态信息 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口；

确定第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口；

假定从所述第一集合天线端口和所述第二集合天线端口同时传输的情况下，所述第一集合传输参数和第二集合传输参数被确定为使总和数据速率最大化；以及

将关于所述第一集合传输参数和所述第二集合传输参数的信息传送至所述基站。

2. 根据权利要求 1 所述的方法，进一步包括：

假定从所述第一集合天线端口的第一单个码字传输和从所述第二集合天线端口的第二单个码字传输。

3. 根据权利要求 2 所述的方法，其中，与所述第二码字相对应的信道质量索引与和所述第一码字的信道质量索引相对应地被不同地编码。

4. 根据权利要求 1 所述的方法，其中，所述传输参数对应于下述中的一个或多个：预编码矩阵索引、秩指示符、信道质量指示。

5. 根据权利要求 1 所述的方法，其中，所述第一集合传输参数和第二集合传输参数对应于重叠的下行链路时间频率资源的集合。

6. 根据权利要求 1 所述的方法，进一步其中，所述第一 CSI 参考信号配置和第二 CSI 参考信号配置每个跨越所述时间频率资源的子集，所述时间频率资源的子集跨越所述下行链路系统带宽，其中，跨越所述下行链路系统带宽的所述时间频率资源的所述子集重叠。

7. 根据权利要求 1 所述的方法，进一步包括：

确定用于与所述第二集合天线端口上的一个或多个传输参数的固定假设一起使用的所述第一集合传输参数。

8. 一种在无线终端中的方法，包括：

接收两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口；

确定第一集合传输参数，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，其中，第一集合传输参数包括第一传输秩；

确定第二集合传输参数，所述第二集合传输参数对应于与第二 CSI 参数信号配置相对应的第二集合天线端口，其中，第二集合传输参数包括第二传输秩；

从所述第一传输秩和第二传输秩导出第三传输秩；以及

假定所述第三传输秩的情况下，确定第三集合传输参数，所述第三集合传输参数对应于从所述第一集合天线端口和第二集合天线端口的联合传输；

将关于所述第一集合传输参数、所述第二集合传输参数和所述第三集合传输参数中一个或多个的信息传送至所述基站。

9. 一种在无线通信设备中的方法，包括：

接收两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口；

基于从与第一 CSI 参考信号配置相对应的第一集合天线端口和与第二 CSI 参考信号配置相对应的第二集合天线端口的传输，确定传输参数 ；

其中，所述传输参数包括码本，所述码本指示从所述第一集合天线端口和所述第二集合天线端口的传输权重向量 ；

其中，所述码本包括第一集合的一个或多个对角元素，所述第一集合的一个或多个对角元素对应于从第一集合天线端口的第一集合空间层和从所述第二集合天线端口的第二集合空间层的传输 ；以及

其中，基于用于传输的固定假设，对于从所述第一集合天线端口的所述一个或多个空间层的传输、以及对于所述第二集合天线端口没有发射或发射，所述码本包括第二集合元素 ；以及

将优选码本索引传送回所述基站。

10. 根据权利要求 9 所述的方法，其中，假定一个或多个空间层传输的情况下，所述码本进一步包括第三集合元素，从所述第一集合天线端口和第二集合天线端口两者同时发射每个空间层。

11. 根据权利要求 9 所述的方法，其中，所述码本隐含地包括在每个集合的天线端口上发射的空间层数目的信息。

12. 根据权利要求 9 所述的方法，其中，在每个集合的天线端口上发射的空间层数目的信息在一个报告中被反馈，并且条件码本索引在另一个报告中被反馈，其中，所述条件码本索引是其中所述码本基于以所述空间层数目为基础的码本。

13. 一种在无线终端中的方法，包括 ：

接收两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口 ；

选择第一集合子带和第二集合子带，所述第一集合子带对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合子带对应于与第二 CSI 参考信号配置相对应的第二集合天线端口 ；

确定第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于所述第一集合子带上的所述第一集合天线端口，所述第二集合传输参数对应于所述第二集合子带上的第二集合天线端口 ；

将关于所述第一集合传输参数和所述第二集合传输参数以及所述第一集合子带和所述第二集合子带的信息传送至所述基站。

14. 根据权利要求 13 所述的方法，其中，所述确定与第一集合子带相对应的第一集合传输参数的步骤是基于信道质量，所述信道质量是针对固定假设而在用于从第二集合天线端口传输的每个子带上被计算的。

15. 一种在无线基站中的方法，所述方法包括 ：

发送两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口 ；

接收关于所述第一集合传输参数和第二集合传输参数的信息，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口 ；

假定在第一下行链路时间频率资源上从所述第一集合天线端口的第一单个码字传输和在第二下行链路时间频率资源上从所述第二集合天线端口的第二单个码字传输是同时的情况下，确定所述第一集合传输参数和第二集合传输参数，其中，所述第一时间频率资源和第二时间频率资源重叠。

16. 根据权利要求 15 所述的方法，进一步包括：

基于关于所述第一集合天线端口和所述第二集合天线端口的所述信息，从所述第一集合天线端口发射第一码字并且从所述第二集合天线端口发射第二码字。

17. 一种在无线基站中的方法，所述方法包括：

发送两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口；

接收关于传输参数的信息，所述传输参数对应于从与第一 CSI 参考信号配置相对应的第一集合天线端口和与第二 CSI 参考信号配置相对应的第二集合天线端口的传输；

其中，所述传输参数包括码本，所述码本指示从所述第一集合天线端口和第二集合天线端口的传输权重向量；

其中，所述码本包括第一集合的一个或多个对角元素，所述第一集合的一个或多个对角元素对应于从所述第一集合天线端口的所述第一集合空间层和从所述第二集合天线端口的所述第二集合空间层的传输；以及

基于用于传输的固定假设，假定从所述第一集合天线端口的一个或多个空间层传输、以及假定没有在所述第二集合天线端口上传输或者假定在所述第二集合天线端口上传输的情况下，所述码本包括第二集合元素。

18. 一种在无线终端中的方法，包括：

接收两个或更多信道状态信息 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口；

确定第一集合传输参数，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，其中，第一集合传输参数包括第一传输秩；

确定第二集合传输参数，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口，其中，第二集合传输参数包括第二传输秩，所述第二传输秩基于所确定的第一传输秩；

将关于所述第一集合传输参数和所述第二集合传输参数中一个或多个的信息传送到所述基站。

19. 一种在无线通信设备中的方法，包括：

接收两个或更多信道状态信息 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示一个或多个天线端口；

基于第一码本子集限制值，从第一码本接收用于第一子集的码本元素的指示，所述第一子集的码本元素指示可能的传输权重向量，所述可能的传输权重向量对应于与所述第一 CSI 参考信号配置相对应的第一集合天线端口；

基于第二码本子集限制值，从第二码本接收用于第二子集的码本元素的指示，所述第二子集的码本元素指示可能的传输权重向量，所述可能的传输权重向量对应于与所述第二 CSI 参考信号配置相对应的第二集合天线端口；

确定第一集合传输参数，所述第一集合传输参数对应于与所述第一 CSI 参考信号配置相对应的所述第一集合天线端口，其中，所述第一集合传输参数包括第一预编码矩阵索引，所述第一预编码矩阵索引选自所述第一子集的码本元素；

确定第二集合传输参数，所述第二集合传输参数对应于与所述第二 CSI 参考信号配置相对应的所述第二集合天线端口，其中，所述第二集合传输参数包括第二预编码矩阵索引，所述第二预编码矩阵索引选自所述第二子集的码本元素；

将关于所述第一集合传输参数和所述第二集合传输参数中一个或多个的信息传送到所述基站。

在具有协作多点传输的正交频分复用通信系统中联合处理方案的 CSI 反馈的方法和装置

技术领域

[0001] 本公开总体涉及无线通信系统，并且更特别地，涉及具有诸如地理上分离或分布式天线的多传输点的正交频分复用 (OFDM) 通信系统中的秩适配。

背景技术

[0002] 协作多点 (CoMP) 传输 / 接收已被提出作为有前途的技术，以通过改进特别是小区边缘用户设备 (UE) 的性能，满足 3GPP(第三代合作伙伴计划) 高级 LTE(LTE-A) 要求。在 CoMP 操作中，多传输 / 接收点协作发射到一个或多个 UE 或从一个或多个 UE 接收，以改进性能，特别是对于另外在下行链路的情况下，如果传输点不协作，看到从一些传输点的显著干扰的那些 UE。从下行链路角度被称为的传输点 (TP) 通常是指由基站 (在 LTE 中称为演进节点 B 或 eNB) 中的调度器控制的无线电单元。基站可以控制单个 TP，在该情况下，TP 与基站或 eNB 相同。在该情况下，CoMP 操作是指在 eNB 当中存在协作的情况。在另一种网络架构中，基站或 eNB 可以控制多个传输点 (TP)，其通常称为无线电单元或无线电头端。在该情况下，TP 当中的协作将自然地发生，并且更容易实现，这是因为它们由 eNB 内的中央调度器控制。

[0003] 通常，CoMP 技术是指包括干扰避免的协作机制的广泛范围。一种这样的技术是联合传输，其中，从两个或更多 TP 的天线在到 UE 的多天线多输入多输出 (MIMO) 传输中一起被使用。更通常地，人们可以考虑分布式天线类型部署，其中，到终端的传输可以从地理上分布的天线。明显地，与常规 MIMO 操作的不同在于，天线不一定被同位。

[0004] 在一些网络部署中，TP 可以被同位，在该情况下，将它们连接到单个 eNB 是可行的。一个实例是众所周知的三个扇区 / 小区部署，其中，单个 eNB 具有三个服务区，被称为扇区或小区。在一些其他部署中，TP 可以在地理上分离，在该情况下，它们可以由单独 eNB 或单个 eNB 控制。在前者情况下，TP 通常在可以以对等方式协作的单独调度器的控制下。具有可能不同传输功率的不同类型的 eNB 构成所谓的异构网络。在由单个 eNB 控制的地理上分离的 TP 的情况下，通常被称为远程无线电单元 (RRU) 或远程无线电头端 (RRH) 的 TP 经由光纤连接至单个 eNB，并且中央调度器控制 / 协调所有 TP。

[0005] 不管是同位还是地理上分离，每个 TP 都可以形成其本身的逻辑小区，或者多个 TP 可以形成单个逻辑小区。从用户设备 (UE) 角度看，小区被定义为 UE 从其接收数据并且将数据发射至其的逻辑实体，换句话说，“服务”UE。服务 UE 的小区被称为“服务小区”。由逻辑实体覆盖的地理区域有时也被称为小区，诸如，当小区边缘 UE 被提及以描述位于覆盖区域的边缘处的 UE 时。小区通常具有关联小区标识符 (小区 -ID)。小区 -ID 通常用于指定导频信号 (还被称为参考信号)，导频信号对于小区可能是唯一的并且对发射至附着到该小区 (即，由该小区服务) 的 UE 的数据进行加扰。

[0006] 在常规的非 CoMP 多天线 (MIMO) 操作中，作为 UE 的服务小区的单个 TP 基于到 UE 的链路的质量来调整传输参数。在通常在现代无线通信中运用的所谓的“链路适配”中，UE

需要估计传统上从用于非 CoMP 操作的单个小区的假设数据传输的信道质量。信道质量通常被表示为可以由 UE 接收的调制和编译方案 (MCS)，其中误差概率不超过特定阈值。UE 还可以反馈一些推荐的空间传输参数，诸如传输秩指示 (RI)、预编码矩阵索引 (PMI) 等。在 CoMP 操作中，从多点的传输还需要适于由 UE 看到的链路条件。

[0007] UE 依赖于从服务小区发送的导频信号（还被称为参考信号 (RS)），用于信道估计并且用于报告回 eNB 的信道质量测量。通常利用该特定服务小区的小区 -ID 特定的序列对参考信号进行加扰。为了估计信道并且进行信道质量测量，eNB 必须具有使得 UE 能够估计信道并且还测量干扰的机制。实现通过 UE 进行信道估计的普通机制是 eNB 从主要探测该信道的每个发射天线发送导频信号。导频信号是发射器和接收器都已知的波形或序列。在 OFDMA 系统中，导频信号通常对应于关于时间 / 频率网格内的时间频率资源要素 (RE) 集合的导频序列，其中，资源要素是 OFDM 传输中的子载波。然后，UE 使用导频信号，以通过执行内插和噪声抑制来计算每个子载波位置处的信道估计，并且测量信道质量。而且，在 UE 处也需要导频信号，以构造“有效”信道，用于相干解调的目的。与 UE 的一个或多个数据流或层相对应的有效信道是被应用至接收器处的数据调制信号的 UE 的接收器有效地看到的预编码 / 波束形成信道。

[0008] 在 3GPP LTE 标准的 Release8 和 9 中，与 CRS 端口集合（在 Release10 中，是 CRI-RS 端口）相对应的公共或小区特定参考信号 (CRS)（并且在 Release10 中，是信道状态信息参考信号 (CSI-RS)）从 eNB 被发送并且意在用于由 eNB 服务的小区中的所有 UE。CRS 端口可以对应于 eNB 处的该物理天线集合或者在由 eNB 服务的所有 UE 处可观测的虚拟天线集合。这些 RS 可以用于信道质量的信道估计和 / 或用于空间反馈测量。UE 可以计算和报告来自预定义码本的推荐 PMI，以及提供关联 RI 和 CQI（信道质量信息、或指示）反馈，用于最大化在 UE 处的总传输速率（或总 CQI）。

[0009] 广泛地，联合处理 (JP) 方案是指 i) 联合传输 (JT)（其中，数据从两个或更多 TP 被发射至 UE）或者 ii) 动态点选择 (DPS)（其中，数据从两个或更多 TP 之一被动态地发射）。术语联合处理是指两个 TP 应该能够在任何时间处理意在用于 UE 的数据的事实。而且，如果从两个或更多 TP 同时发送至少一个数据流，则其被称作相干联合传输（这要求一些相位对准），并且如果从每个 TP 发送独立数据流，则其被称为非相干 JT。

[0010] 定时问题

[0011] 在由 CRS/CSI-RS 端口表示的天线端口同位的隐含假定下，最初设计 LTE 系统，并且建立测试案例。通常，在那些情况下，可以假定各个天线都被校准。从而，基于这些隐含行为定义码本和 CSI 反馈方法。然而，在 CoMP 通信系统中，被选择用于传输到 UE（例如，两个最接近 RRU/RRH) 的 RRU/RRH 和对应天线端口可以具有不同路径损耗。即，来自每个 RRU/RRH/ 天线端口的信号可以在完全不同的路径上传播，和 / 或 UE 可以比其他更接近一个 RRU/RRH/ 天线端口，结果，与另一个所选天线端口相比，UE 可以从一个所选天线端口看到更大的时间延迟。这在很小的小区或室内部署的情况下通常是真的，其中，UE 可能非常接近天线之一。这样的时间延迟可能在来自不同 eNB 的多组天线之间引入频率选择性相位旋转，在该情况下，从非同位的多组天线的相干联合 MIMO 传输可能具有挑战性。

[0012] 反馈开销

[0013] 而且，在这些系统中，为了支持联合传输，假定从天线的聚合集合的联合传输对应

于传输点的情况下，UE 必须反馈 CSI 信息。这样的 CSI 可以包括涉及主要是发射到 UE 的空间流的数目的传输秩的信息、主要是可以在可以映射至空间流的每个码字上支持的调制和编译方案 (MCS) 的信道质量索引信息、以及作为在天线的聚合集合上使用的预编码权重的预编码矩阵索引。

[0014] CSI 的以上确定是在 LTERelease8/9/10 规范中支持的现有过程的简单扩展。然而，由于像小区加载、业务模式等的实际原因，导致基站可能需要返回到单个 TP 传输（一个集合的同位天线 / 一组天线）的灵活性。在该情况下，需要对关于各个 TP 的 CSI 反馈的访问，另外被称为每 -TP 反馈。所以，例如，如果考虑两个 TP，则总开销可能是支持用于单个 TP 反馈的原始开销的三倍，这是因为假定 i) 从两个 TP 的联合传输，ii) 从第一 TP 的传输，以及 ii) 从第二 TP 的传输，需要支持反馈。这样的三倍增加是不期望的，并且需要进一步优化，以利用反馈开销的更少增加，在基站处实现这样的操作。

[0015] 我们解决优化 CSI 反馈，以支持包括非相干 JT、动态点选择 (DPS) 和可能相干 JT 的 JP。

附图说明

[0016] 图 1 是根据本发明的实施例的无线通信系统的框图。

[0017] 图 2 是根据本发明的另一个实施例的无线通信系统的框图。

[0018] 图 3 是根据本发明的实施例的图 1 和图 2 的通信系统的用户设备的框图。

[0019] 图 4 是根据本发明的实施例的图 1 和图 2 的通信系统的基站的框图。

[0020] 图 5 是根据本发明的实施例的由图 1 和图 2 的通信系统运用并且图示 OFDMA PRB 内的导频信号布置的 OFDMA 物理资源块 (PRB) 的示例性时间频率图。

[0021] 图 6 是根据本发明的另一个实施例的由图 1 和图 2 的通信系统运用并且图示 OFDMA PRB 内的导频信号布置的 OFDMA 物理资源块 (PRB) 的示例性时间频率图。

[0022] 图 7 是根据本发明的另一个实施例的由图 1 和图 2 的通信系统运用并且图示 OFDMA PRB 内的导频信号布置的 OFDMA PRB 的示例性时间频率图。

[0023] 图 8 是 CSI-RS 的示例性配置，特别是与两个传输点 (TP) 相对应的两个 CSI-RS 参考信号配置的配置。

[0024] 图 9 是从两个传输点 (TP) 到无线终端的相干联合传输的示例性视图。

[0025] 图 10 是从两个传输点 (TP) 到无线终端的非相干联合传输的示例性视图。

[0026] 图 11 至图 14 是图示根据本发明的多种实施例的用于支持图 1 和图 2 的通信系统中的协作多点传输的无线终端中的方法的逻辑流程图。

[0027] 图 15 至图 16 是图示根据本发明的多种实施例的用于支持图 1 和图 2 的通信系统中的协作多点传输的无线基站中的方法的逻辑流程图。

[0028] 本领域技术人员将想到，图中的元件被图示用于简单和清楚的目的，并且不一定按比例绘制。例如，图中的一些元件的尺寸和 / 相对定位可以相对于其他元件被放大，以帮助改进对本发明的多个实施例的理解。而且，通常不描述在商业上切实可行的实施例中有用或必需的公知和众所周知的元件，以便于更少地模糊本发明的这些实施例。将进一步想到，可以按照发生的特定顺序描述或示出特定动作和 / 或步骤，同时本领域技术人员将理解，实际上不要求关于顺序的这样的指定。本领域技术人员将进一步认识到，诸如“电路”的

对特定实现实施例的引用可以经由用通用计算装置（例如，CPU）或专用处理装置（例如，DSP）上的软件指令执行代替被等效地实现。还将理解，除了不同特定意义在此被另外阐述之外，在此使用的术语和表达具有符合如上所述的本领域技术人员理解的这样的术语和表达的普通技术意义。

具体实施方式

[0029] 通常，本发明的实施例包括在无线通信终端中与基站单元（base unit）通信的方法，包括：接收两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；确定第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口；假定从第一集合天线端口和第二集合天线端口的同时传输的情况下，第一集合传输参数和第二集合传输参数被确定以最大化总和数据速率；以及将关于第一集合传输参数和第二集合传输参数的信息传送至基站。该方法进一步包括：从第一集合天线端口的第一单个码字传输和从第二集合天线端口的第二单个码字传输，并且第一集合传输参数和第二集合传输参数对应于重叠的下行链路时间频率资源集合。

[0030] 本发明的另一个实施例包括在无线终端中的方法，包括：接收两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；确定第一集合传输参数，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，其中，第一集合传输参数包括第一传输秩；确定第二集合传输参数，所述第二集合传输参数对应于与第二 CSI 参数信号配置相对应的第二集合天线端口，其中，第二集合传输参数包括第二传输秩；从第一传输秩和第二传输秩导出第三传输秩；假定第三传输秩的情况下，确定第三集合传输参数，所述第三集合传输参数对应于从第一集合天线端口和第二集合天线端口的联合传输；将关于第一集合传输参数、第二集合传输参数和第三集合传输参数中的一个或多个的信息传送至基站。

[0031] 本发明的还有的另一个实施例包括无线终端中的方法，包括：接收两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；基于从与第一 CSI 参考信号配置相对应的第一集合天线端口和与第二 CSI 参考信号配置相对应的第二集合天线端口的传输，确定传输参数；传输参数包括指示从第一集合天线端口和第二集合天线端口的传输权重向量的码本；码本包括第一集合一个或多个对角元素（diagonal entry），所述第一集合一个或多个对角元素对应于从第一集合天线端口的第一集合空间层和从第二集合天线端口的第二集合空间层的传输；基于用于传输的固定假设，假定从第一集合天线端口的一个或多个空间层的传输，并且假定第二集合天线端口不发射或发射的情况下，码本包括第二集合元素；以及将优选码本索引传送回基站。在一个实施例中，假定一个或多个空间层的传输的情况下，码本进一步包括第三集合元素，从第一集合天线端口和第二集合天线端口两者同时发射每个空间层。

[0032] 本发明的还有的另一个实施例包括用于在用户设备中与基站通信的方法，所述方法包括：接收两个或更多CSI参考信号配置的指示，每个CSI参考信号配置表示包括天线端口集合的一个或多个天线端口；选择第一集合子带和第二集合子带，所述第一集合子带对

应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合子带对应于与第二 CSI 参考信号配置相对应的第二集合天线端口；确定第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于第一集合子带上的第一集合天线端口，所述第二集合传输参数对应于第二集合子带上的第二集合天线端口；将关于第一集合传输参数和第二集合传输参数以及第一集合子带和第二集合子带的信息传送至基站。

[0033] 本发明的还有的另一个实施例包括在基站中的方法，该方法包括：发送两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；接收关于第一集合传输参数和第二集合传输参数的信息，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口；假定在第一下行链路时间频率资源上从第一集合天线端口的第一单个码字传输和在第二下行链路时间频率资源上从第二集合天线端口的第二单个码字传输是同时的情况下，确定第一集合传输参数和第二集合传输参数，其中，第一时间频率资源和第二时间频率资源重叠。

[0034] 本发明的还有的另一个实施例包括在基站中的方法，该方法包括：发送两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；接收关于传输参数的信息，所述传输参数对应于从与第一 CSI 参考信号配置相对应的第一集合天线端口和与第二 CSI 参考信号配置相对应的第二集合天线端口的传输；传输参数包括码本，码本指示从第一集合天线端口和第二集合天线端口的传输权重向量；码本包括第一集合一个或多个对角元素，所述第一集合一个或多个对角元素对应于从第一集合天线端口的第一集合空间层和从第二集合天线端口的第二集合空间层的传输；基于用于传输的固定假设，假定从第一集合天线端口的一个或多个空间层的传输、以及假定没有在第二集合天线端口上传输或者假定在第二集合天线端口上传输的情况下，码本包括第二集合元素。在一个实施例中，假定一个或多个空间层的传输的情况下，码本进一步包括第三集合元素，从第一集合天线端口和第二集合天线端口同时发射每个空间层。

[0035] 可以参考图 1 至图 16 更全面地描述本发明。图 1 是根据本发明的实施例的无线通信系统 100 的框图。通信系统 100 包括多个用户设备 (UE)101-103(示出三个)，诸如但不限于蜂窝电话、无线电电话、具有射频 (RF) 能力的个人数字助理 (PDA)、或提供对诸如膝上型计算机的数字终端装置 (DTE) 的 RF 访问的无线调制解调器。通信系统 100 进一步包括接入网 140，接入网 140 包括多个基站 (BS)110-113(示出四个)，诸如节点 B、演进节点 B、接入点 (AP)、中继节点 (RN)、或基站收发信机台 (BTS)(术语 BS、演进节点 B、eNB、节点 B 和 BTS 在此可交换地使用)，每个都包括调度器(未示出)和包括多个天线的天线阵列 114-117，支持多输入多输出 (MIMO) 通信，并且经由对应空中接口 120-123 给诸如 UE101-103 的用户设备 (UE) 提供通信服务。

[0036] 每个 BS 都给被称为小区或小区的扇区的地理区域中的 UE 提供通信服务。注意，单个 BS 可以覆盖小区的多个扇区。术语“小区”在该情况下通常用于指扇区。更准确地，从 UE 角度看，小区是 UE 与之通信(即，服务 UE) 的逻辑实体。与“非服务”或潜在干扰小区相反，服务 UE 的小区被称为“服务小区”。小区通常对应于关联小区标识符(小区 -ID)。小区 -ID 通常用于指定导频信号(还称为参考信号 (RS))，并且对发射至附着到该小区(即，由该小区服务)的 UE 的数据加扰。每个小区都可以具有单个传输点 (TP)，在该情况下，术

语小区和 TP 可以交互使用。每个小区都可以具有多个 TP（参考图 2），在该情况下，它们不等同。

[0037] 每个空中接口 120-123 包括相应的下行链路和相应的上行链路。下行链路和上行链路中的每个都包括多个物理通信信道，包括多个控制 / 信令信道和多个业务信道。多个 BS110-113 中的每个 BS 都经由接入网网关 130 和 BS 间接口中的一个或多个与多个 BS 中的其他 BS 通信，BS 间接口可以包括所有 BS 的有线链路和无线链路中的一个或多个，并且经由 BS 间接口，每个 BS 都可以广播到其他 BS。接入网 140 进一步包括接入网网关 130。接入网网关 130 提供用于每个 BS110-113 到通信系统 100 的架构的其他部分和相互之间的接入，并且可以例如但不限于无线电网络控制器 (RNC)、移动交换中心 (MSC)、分组数据服务节点 (PDSN)、或媒体网关中的任何一个或多个。

[0038] 现在参考图 2，提供根据本发明的另一个实施例的无线通信系统 100 的框图。在图 2 中所示的通信系统 100 中，接入网 140 包括 BS200，其功能分布在基带单元 (BBU)201 和耦合至 BBU 的多个远程无线电单元 (RRU)202-205（示出四个）当中。每个 RRU202-205 包括包括一个或多个天线的天线阵列 206-209 并且进一步包括其他功能，并且负责经由对应的空中接口 222-225 从驻留在 RRU 的覆盖区域中的 UE（诸如，UE101-103）接收射频信号并且将射频信号发射至 UE。每个 RRU202-205 还可以被称为连接至相同 BS200 的 TP。每个空中接口 222-225 包括相应的下行链路和相应的上行链路。下行链路和上行链路中的每个包括多个物理通信信道，包括多个控制 / 信令信道和多个业务信道。BBU201 通过对应的回程链路 212-215，例如，无线链路或诸如光纤网络的有线线路，耦合至多个 RRU202-205 中的每个。通常，调度器与 BBU 一起驻留。

[0039] 在本发明的还有的其他实施例中，通信系统 100 可以包括作为图 1 和图 2 中所示的实施例的组合的系统。

[0040] TP 可以同位，在该情况下，将它们连接至单个 BS 是非常切实可行的。一个实例是典型三个扇区部署，其中，单个 BS 控制被称为扇区 / 小区的三个服务区域。TP 可以在地理上分离，因此为术语“远程无线电单元 (RRU)”或“远程无线电头端”(RRH)。地理上分离的 TP 的实例是由具有变化传输功率的不同类型的 BS 构成的异构网络的部署情况。

[0041] UE 可以接收从单个 RRU 或多于一个 RRU 的传输。例如，诸如 UE101 的 UE 可以位于由 RRU 对 203、204 服务的覆盖区域中，并且可以从这两个 RRU 接收联合传输。在该情况下，均仅从 UE101 的观点看，RRU203 和 204 可以称为服务 RRU，并且 RRU205 称为非服务 RRU（或潜在干扰 RRU）。类似地，UE103 可以从 RRU 对 204 和 205 接收传输。但是，UE103 可以更接近 RRU204，并且从而中心调度器可以决定仅使用 RRU204 服务 UE103。BS200 可以基于一些 UE 反馈测量，考虑其控制下的网络 100 的部分的性能，确定用于每个 UE 的服务和非服务 RRU。这样的确定可以是半静态的或动态的。

[0042] 现在参考图 3 和图 4，提供根据本发明的多种实施例的诸如 UE101-103 的 UE300 和诸如 BS110-113 和 200 的 BS400 的框图。UE300 和 BS400 中的每个包括相应的处理器 302、402，诸如一个或多个微信号处理单元、微控制器、数字信号信号处理单元 (DSP)、微处理器、其组合或本领域普通技术人员已知的这样的其他设备。通过存储在与信号处理单元相关联的相应至少一个存储器设备 304、404 中的软件指令和例程的执行来确定处理器 302 和 402 的特定操作 / 功能并且从而 UE300 和 BS400 的特定操作 / 功能，存储器设备 304、404 诸如

随机存取存储器 (RAM)、动态随机存取存储器 (DRAM)、和 / 或只读存储器 (ROM) 或其等同物，存储器设备 304、404 存储可以由对应的处理器执行的数据和程序。处理器 402 还基于存储在 BS 的至少一个存储器设备 404 中的指令和例程实现由 BS 执行的任何调度功能（调度器）。至少一个存储器设备 304、404 中的每个还保持码本，诸如 PMI 码本或扩展 PMI 码本、功率偏移的列表、秩指示、以及对于 UE 和 BS 执行在此描述的它们的功能有用的任何其他参数。

[0043] UE300 和 BS400 中的每个进一步包括耦合至 UE 或 BS 的处理器 302、402 的相应的一个或多个射频 (RF) 收发信机 306、406，并且用于经由中间空中接口分别与 BS 和 UE 无线通信。例如，BS400 可以包括多个收发信机，即，在每个 RRU202-205 处的收发信机。每个收发信机 306、406 包括用于通过诸如空中接口 120-123 和 222-225 的空中接口接收和发射信号的接收电路（未示出）和发射电路（未示出）。UE300 包括一个或多个天线 308，并且在 UE 包括多个天线的情况下，可以支持 MIMO 通信。BS400 进一步包括一个或多个天线阵列 410，例如，BS400 可以包括多个天线阵列，即，在每个 RRU202-205 处的阵列，该阵列中的每个都与对应的收发信机 306 通信，并且该阵列中的每个都包括多个天线 412。通过利用天线阵列将信号发射至位于 BS 的覆盖区域（诸如，由天线阵列服务的小区或扇区）中的 UE，BS 能够利用 MIMO 技术用于信号的传输。

[0044] BS400 进一步包括与一个或多个收发信机 406 中的每个收发信机关联的加权器 408，诸如，预编码器或任何其他类型的信号加权器，加权器 408 与处理器 402 通信并且被插入对应的天线阵列 410 和对应的收发信机 406 之间。在本发明的另一个实施例中，加权器 408 可以由处理器 402 实现。加权器 408 基于由 UE 反馈的信道状态信息 (CSI)，例如，诸如码本索引和秩索引的码本反馈、诸如协方差矩阵或任何其他类型矩阵的统计反馈、特征向量、或信道质量均值和方差、所接收的信号质量信息、信道频率响应、或本领域中已知的任何其他类型的信道反馈，加权器 408 对应用至对应的天线阵列 410 的多个天线 412 的信号进行加权，以便预失真和波束形成用于通过中间空中接口的下行链路传输到 UE 的信号。

[0045] 当加权器 408 包括预编码器时，UE300 和 BS400 中的每个可以将预编码矩阵进一步保持在至少一个存储器设备 304 和 404 中和 / 或加权器 408 中，该预编码矩阵包括多个矩阵集合，并且其中，每个矩阵集合与用于下行链路传输的天线与可应用至每个天线的权重的组合相关联。预编码矩阵在本领域中众所周知，并且将不再更详细地描述。基于由 UE 测量的信道条件，UE 报告回预编码矩阵，优选地预编码矩阵索引 (PMI)，用于一组资源要素 (RE)，其中，RE 是时间频率资源，诸如，在频率上一个 (1) 子载波乘以在时间上一个 (1)OFDM 码元。在确定用于一组 RE 的预编码矩阵中，UE 基于所测量的信道条件计算复数权重集合。该复数权重集合可以是从下行链路参考信号测量导出的本征波束形成向量。复数权重被映射至已经定义的向量集合，即，被映射至已经定义的向量集合的最接近向量，以产生预编码向量。然后，UE 使用上行链路控制信道，传送由 UE 选择的预编码向量的索引。

[0046] 本发明的实施例优选在 UE101-103 和 BS110-113 和 200 内实现，并且更特别地，通过或在存储在至少一个存储器设备 304、404 并且由 UE 和 BS 的处理器 302、402 执行的软件程序和指令中。然而，本领域普通技术人员认识到，本发明的实施例可以替换地在硬件中实现，例如，集成电路 (IC)、专用集成电路 (ASIC) 等，诸如在 UE101-103 和 BS110-113 和 200 中的一个或多个中实现的 ASIC。基于本公开，本领域技术人员将能够容易地产生和实现这

样的软件和 / 或硬件，而不需要试验。

[0047] 通信系统 100 包括用于通过空中接口 206 发射数据的正交频分多址 (OFDMA) 调制方案，其中，频率信道或带宽在给定时间段期间被划分为多个物理资源块 (PRB)。每个物理资源块 (PRB) 包括通过给定数目的 OFDM 码元的多个正交频率子载波，它们是物理层信道，业务和信令信道通过所述物理层信道以时分复用 (TDM) 或 TDM/ 频分复用 (FDM) 方式被发射。通信会话可以被指配一个 PRB 或一组 PRB 以用于承载信息的交换，由此允许多个用户在不同 PRB 上同时发射，使得每个用户的传输与其他用户的传输正交。PRB 还可以被指配给多个用户，在该情况下，用户不再正交，而是它们基于各个发射权重的空间符号被分离。

[0048] 另外，通信系统 100 优选根据第三代合作伙伴计划 (3GPP) 高级长期演进 (LTE-A) 标准操作，该标准指定包括无线电系统参数和呼叫处理过程的无线电信系统操作协议，并且实现从非同位 (或分布式) 天线的协作多点传输 (CoMP) 和 / 或联合 MIMO 传输。然而，本领域普通技术人员认识到，通信系统 100 可以根据运用正交频分复用 (OFDM) 调制方案的任何无线电信标准进行操作，诸如但不限于运用信道估计和信道干扰测量的反馈的其他 3GPP 通信系统、例如 CDMA (码分多址)20001XEV-DV 通信系统的 3GPP2 (第三代合作伙伴计划 2) 演进通信系统、例如通过 IEEE802.xx 标准 (例如，802.11a/HiperLAN2、802.11g、或 802.20 标准) 描述的无线局域网 (WLAN) 通信系统、或根据包括 802.16e 和 802.16m 的 IEEE (电气和电子工程师协会)802.16 标准操作的全球微波互联接入 (WiMAX) 通信系统。

[0049] 被多路复用并且诸如通过多个 BS110-113 和 / 或通过与 BS200 相关联的多个 RRU202-205 从多个覆盖区域中的每个发射至 UE101-103 的信号是可以与其他控制信息和用户数据多路复用的参考或导频信号。从服务 BS 或 RRU 的天线发送导频信号，并且更特别地，信道状态信息参考信号 (CSI-RS)，其可以发射至 UE，以便 UE 确定被反馈回服务 BS 的信道状态信息 (CSI)。另外，关于 CoMP 传输，UE 可能需要确定用于多个 TP 或多个 BS 的 CSI，并且对应的 CSI-RS 还被配置用于该 UE。

[0050] 在 3GPP LTE 标准的 Release8 和 9 中，与 CRS 端口集合 (在 Release10 中的 CSI-RS 端口) 相对应的公共或小区专用参考信号 (CRS) (或在 Release10 中，为信道状态信息参考信号 (CSI-RS)) 从 BS 被发送，并且意在用于由 BS 服务的小区中的所有 UE。CRS 在 UE 处可以被用于解调和信道反馈测量两者。在 Release10 中，限定附加参考信号，即，信道状态信息参考信号 (CSI-RS)，其在 UE 处主要用于信道反馈测量。解调由解调参考信号 (还被称为 UE 特定 RS、解调 RS(DMRS)、专用 RS) 支持，通常在 UE 的数据分配区域中发送解调参考信号。

[0051] 我们现在将描述 CSI-RS (信道状态信息 - 参考信号) 配置的详情，其主要是由 BS 使用以在 UE 处建立信道反馈测量的导频信号。现在参考图 5、图 6 和图 7，分别提供根据本发明的多种实施例的描述导频信号的分布的时间频率图 500、600、700，并且特别是在 OFDMA PRB- 对 540 中并且通过可以由通信系统 100 采用的子帧 530 的 CSI- 参考信号 (CSI-RS)。术语‘导频信号’和‘参考信号’在此被可交换地使用。每个时间频率图 500、600、700 的纵坐标描述可以分配的子帧的频率、或频率门 (bin)、(频率子载波) 的多个块。每个时间频率图 500、600、700 的横坐标描述可以分配的子帧的时间的多个块 (以 OFDM 码元为单位)501-514。在时间频率图 500、600 和 700 中描述的子帧 530 包括物理资源块对 (PRB- 对)540，其中，PRB 包括通过包括七个 (7)OFDM 码元的时隙的 12 个 OFDM 子载波。进

而，PRB 对 540 被划分为多个资源要素 (RE)520，其中，每个 RE 是单个 OFDM 码元上的单个 OFDM 子载波、或频率门。而且，PRB 对 540 可以包括用于控制数据的传输的控制区域 531 和用于用户数据的传输的用户数据区域 532。

[0052] PRB 对 540 包括多个潜在信道状态信息 (CSI) 参考信号配置，该配置限定 PRB 的哪些资源要素 (RE) 被分配给 CSI 参考信号 (CSI-RS)。CSI 参考信号配置被用于指资源集合 (OFDM 系统中的 RE)，其可以用于发射与一组一个或多个发射天线相对应的 CSI-RS 集合。基于 LTE 的 Release10 规范描述示例性操作。在 3GPP LTE 规范的当前 Release10 版本中，对于给定数目（或组）的发射 (BS) 天线端口，限定多个 CSI 参考信号配置，并且 BS 可以选择可用配置之一。如在此使用的，对发射天线端口的引用意在是指用于在下行链路上发射信号的 BS 天线端口。例如，并且现在参考图 5，通过两个发射天线端口的分组来描述示例性 CSI 参考信号配置。每对端口 [0,1] 都通过时域 CDM（码分复用）被多路复用。这样的一对 [0,1] 对应于两个天线端口（例如，‘0’ 和 ‘1’），其与 [1,1] 和 [1,-1] 的简单 CDM 代码共享两个对应的参考要素 (RE)521。如图 5 中所示，潜在 20 个 CSI 参考信号配置（每个都由标记为 (0,1) 的一对资源要素指示，例如，对 521) 中的任何一个都可以被配置用于 UE 处的两个天线端口上的测量。PRB- 对 540 还包括分布在 PRB 对的控制区域 531 和 / 或用户数据区域 532 中的非 CSI-RS 导频信号。例如，PRB 对 540 的阴影 RE 被保留用于（即，被分配给）其他参考码元，公共参考信号 (CRS) 或专用参考信号 (DRS)。那些其他参考信号可以存在但是不一定用于由 LTE-A 通信系统中的 UE 的信道估计或干扰测量。

[0053] 图 5、图 6 和图 7 中所示的 CSI-RS 配置对于分别具有 2、4 或 8 个发射天线端口的 BS 自然有效。例如，图 6 示出具有四个发射天线端口的分组的示例性 CSI-RS 配置。即，在图 6 中，RE 的两个 CDM 对 (0,1) 和 (2,3)（不一定相互临近）通过单个 CSI-RS 配置（配置的重定义集合被用于四个发射天线端口）映射并且对应于四个天线端口。作为另一个实例，图 7 示出具有八个发射天线端口的分组的示例性 CSI-RS 配置。即，在图 7 中，RE 的四个 CDM 对 (0,1)、(2,3)、(4,5) 和 (6,7)（不一定相互临近）通过与八个天线端口相对应的单个 CSI-RS 配置映射。如图 5、图 6 和图 7 中所示，在建立用于对应于两个、四个和八个天线端口的 UE 的 CSI-RS 参考信号时，可以分别使用 20、10 和 5 个可用配置之一。与特定 BS 或特定传输点或多个 BS 或多个传输点相对应的一个或多个 CSI-RS 的信息通常通过较高层信令被传送。如图 5、图 6 和图 7 中所示，与天线端口相对应的 CSI-RS 被分配给用户数据区域 532 中的资源要素 (RE) 对，并且更特别地分配给与 OFDM 码元 506-507、510-511 和 513-514 相关联的 RE 对之一。还如图 5、图 6 和图 7 中所示，一个天线可以通过与 20 个 CSI 参考信号配置相对应的可能 20 个 RE 对中的任何一个发射 CSI-RS。通常，在单个小区传输中，仅多达四个 CSI-RS RE 对，并且从而需要总计 8 个 RE 来支持多达最多八个发射天线。

[0054] 图 5 至图 7 示出可以被建立用于关于单个 TP MIMO 传输的测量的 CSI-RS 配置。可能 CSI-RS 配置之一可以通过基站建立以用于 UE。为了支持 CoMP 或到 UE 的联合 MIMO 传输，与多个 TP 相对应的测量需要在 UE 处实现，以支持多小区反馈。为了将其实现，基站可以建立到 UE 的多个 CSI-RS 参考信号配置，每个这样的配置都潜在地对应于 TP（其可以是同位天线集合）。图 8 中示出一个实例，其中，建立与每个都具有两个发射天线的两个不同 TP 相对应的两种 CSI-RS 配置。这些配置被标记为与具有两个发射天线的第一 TP 相对应的第一 CSI 参考信号配置 852 和与具有两个发射天线的第二 TP854 相对应的第二 CSI-RS 配

置。

[0055] 更通常地，两个或更多 TP 和连接至一个或多个 BS 的对应天线端口可以协作地发射到 UE。在联合传输 (JT) 中，发射天线端口集合联合服务 UE，通常与相同中心基站控制器或 BS 相关联的 TP 或 RRU 可以联合地发射数据和参考码元 (RS)，诸如 CSI-RS，意在用于 UE。

[0056] 例如，将首先描述基于单个 TP 的 MIMO 传输。传输可以由以下信号模型表示

[0057] $$\mathbf{Y}=\mathbf{HV}\begin{bmatrix}s_1\\s_2\\\cdot\\s_r\end{bmatrix}+\eta$$

[0058] 其中，H 是从传输点 (TP) 处的发射天线到 UE 处的接收天线的信道矩阵，并且 η 是每个要素都是具有方差 σ^2 的加性白高斯噪声 (AWGN) 的向量，即，η_i 是包括在在第 i 个 UE 天线处接收到的信号 y_i 中的噪声。UE 基于用于特定 TP 的 CSI-RS 参考信号配置测量信道 H。同样地，由于测量中的误差，导致通常被表示为 $\hat{\mathbf{H}}$ 的所测量的信道不准确地等于实际信道 H。为了方便起见，我们在此不进行该区分，并且当引用信道时，应该理解是指在 UE 处测量的信道。进一步地，UE 基于关于 CSI-RS 的这样的信道测量，导出多种假设传输参数。这样的传输参数是被推荐在基站单元处应用以用于支持到 UE 的传输的参数。

[0059] 在单个 TP 传输中，假定仅从单个 TP(TP1) 的传输的情况下，获得传输参数 PMI V 和秩 r 以及对应的 CQI。在如在此使用的上下文中，不管传输是否从单个 TP，都获得传输参数、秩和 CQI。“假定”被理解为意指系统操作使得条件被满足，而不管那些条件是否已被满足。表示关于每个码字的调制和编译方案的对应信道质量索引 (CQI) 可以对应于如以下进一步描述的单个或两个码字的索引。

[0060] 在 Release10 的当前规范中，所发射的码字的数目基于层的数目（秩），并且单个码字 (CW) 被发射用于秩 (RI)1，并且两个码字被发射用于 RI>1。在两个码字传输的情况下，每个码字都在一个或多个 r 空间流上被编码，并且第二码字在剩余流上被编码。从而，如果 UE 报告 RI = 1，则其仅报告与单个码字相对应的 CQI，而对于秩 >1，其报告两个 CQI，每个码字一个。这些方法是众所周知的并且在 LTE 的 Release-10 规范中被定义。

[0061] 图 9 图示了从两个 TP 到用户的相干联合传输的实例，其与在此呈现的一些实施例相关。两个传输点 TP1935 和 TP2940 由基站 910 控制。基站通过相应的光纤链路 915、920 将两个独立空间层 (s1, s2)925（或 930）发送至 TP935 和 940 中的每个。在每个 TP 处应用预编码之后，TP 每个进而无线地在空中将空间层 (s1, s2) 发射至 UE。空间层通常与在单个资源单元（作为实例，单个资源是先前限定用于 MIMO OFDM 系统的单个 RE）上同时（与同其他层相关联的其他码元一起）发射的对应调制码元相关联。多个这样的资源单元可以被分配为传输的一部分。通常，还可以在以下数学上描述的联合秩 r 传输中从两个 TP 发射所说的 (s1, s2, s3, … sr) 空间层的更大集合。

[0062] 我们现在描述用于这样的系统的数学模型。将从 TP1 到 UE1 的信道表示为 H1 并且将从 TP2 到 UE1 的信道表示为 H2。总信号模型由以下给出

[0063]
$$\mathbf{Y}=\begin{bmatrix}\mathbf{H}_1 & \mathbf{H}_2\end{bmatrix}\mathbf{V}_{agg}\begin{bmatrix}s_1\\ s_2\\ \cdot\\ s_r\end{bmatrix}+\eta$$
$$=\begin{bmatrix}\mathbf{H}_1 & \mathbf{H}_2\end{bmatrix}\begin{bmatrix}\mathbf{V}_{agg,1}\\ \mathbf{V}_{agg,2}\end{bmatrix}\begin{bmatrix}s_1\\ s_2\\ \cdot\\ s_r\end{bmatrix}+\eta$$

[0064] 其表示从天线的聚合集合的秩 -r 的联合 MIMO 传输，具有维度 $2N_t \times r$ 的总预编码器 V_{agg}，其中，N_t 是每 TP 的天线的数目。通过联合传输，UE 可能必须确定联合 PMI V_{agg}、联合秩 r（在以上图中，r ＝＝ 2）和联合 CQI。在各个 RP 处应用的 PMI 是 $V_{agg,1}$ 和 $V_{agg,2}$，其基本是联合 PMI V_{agg} 的子矩阵。在确定用于总联合传输的 V_{agg} 之后，基站引导 TP 在该集合 r 数据流上在每个节点处应用各个预编码器。

[0065] 对于单个流（秩 r ＝ 1）传输的特殊情况，信号模型被如下给出

[0066]
$$\mathbf{Y}=\begin{bmatrix}\mathbf{H}_1 & \mathbf{H}_2\end{bmatrix}\begin{bmatrix}v_{agg,1}\\ v_{agg,2}\end{bmatrix}s_1+\eta$$
$$=\mathbf{H}_1 v_{agg,1}s_1+\mathbf{H}_2 v_{agg,2}s_1+\eta$$

[0067] 以上等式帮助理解与该方法相关联的“相干”联合传输的术语。由于从两个 TP 发射相同流，所以等效信道 $H_1v_{agg,1}S_1$ 和 $H_2v_{agg,2}S_2$ 必须同相，即，相干地相加。如果它们不相干地相加，则信号流被严重衰减（极端情况是相位 $(H_1v_{agg,1}S_1)$ ＝ - 相位 $(H_2v_{agg,2}S_2)$，其中，信号相减）。为了避免这样，聚合 PMI V_{agg} 必须被联合确定，以允许合适同相（同相）。

[0068] 另外，在支持联合传输的系统中，eNB 必须具有退回单个 TP 传输的灵活性，这是因为其可能不一直具有可用于协作传输的 TP 并且其可能在系统级处这样做无效。这要求 JP 反馈应该还包括单个 TP 的关联反馈信息。以下捕捉在用于两个 TP 联合传输 (JT) 的反馈实例中表达的开销。我们在此指出，假定每 -TP 独立传输所导出每 TP PMI V1 和 V2 可能不满足 $V1 = V_{agg,1}$ 和 $V2 = V_{agg,2}$，并且不一定涉及关联 CQI 和 RI。所以，总 CSI 开销可以被关联增加三倍，以反馈以下捕捉的 JT CSI 和单个 TP CSI。

[0069]

反馈参数	RI	PMI	CQI
反馈实例的数目	3	3(每 TP PMI 两个和一个联合 PMI)	3(最多 6 个 CW CQI)

[0070] 我们现在将描述可以通过简单地反馈与每个 TP 相对应的 CSI 实现的另一种机制，这仅要求以上实例中的两个反馈实例。这样的反馈允许基站动态地切换传输，并且考虑其

他网络成本，在给定时间选择两个 TP 之间的最佳 TP。这样的方案被称为动态点选择 (DPS) 方案。清楚地，以上实例中的三个反馈实例将以允许在网络处灵活操作但是以 CSI 的成本增加三倍为代价的动态方式支持 JT 和 DPS 两者。如先前描述的，JT 和 DPS 一起可以被称为联合处理 (JP) 方案。

[0071] 在在此呈现的多种实施例中，我们考虑多个简化以减少开销，而同时引入对 eNB 处的对应 JP 支持的一些限制。

[0072] 具有每 TP PMI 的相干 JT 和同相

[0073] 如果可以基于每 TP PMI 构造用于 JT 的联合 PMI，则可以节省一些反馈开销。这可以通过将以下结构引入 JT-MIMO 信号模型（其中 $V_{agg,1}$ = V1 和 $V_{agg,2}$ = α V2）实现

[0074] $$\mathbf{Y}=\begin{bmatrix}\mathbf{H}_1 & \mathbf{H}_2\end{bmatrix}\begin{bmatrix}V_1\\ \alpha V_2\end{bmatrix}\begin{bmatrix}s_1\\ s_2\\ \cdot\\ s_r\end{bmatrix}+\eta$$

[0075] 其中，相同秩 r（被实现用于联合传输）的每 -TP PMI V1,V2 以及同相因数 α 被用于构造总 PMI V_{agg} = [V1 ; α V_2]^T。然而，假定分别从 TP1 和 TP2r1 和 TP2r2 的单个 TP 传输确定的秩可以不等于联合传输的秩 r。需要使联合传输的秩 r 与单个 TP 传输的秩相关的方法

[0076] 用于具有每 TP PMI 的 JP 的秩定义

[0077] 在多个实施例中，我们将描述联合传输的秩如何必须与各个传输的秩相关。在一些实施例中，JT 的秩可以被约束为各个 TP 的秩的函数。

[0078] 在一个实施例中，r' = max(r1,r2)。这在一些情况下可以是优选的选项。但是如果秩之一，比如 TP1r1<max(r1,r2) 的秩，则与 TP1 相对应的反馈将基于假定其可以最佳支持的更高秩（如果仅假定从 TP1 的单个 TP 传输）。

[0079] 在另一个实施例中，r' = min(r1,r2)，其是简单定义，并且可以用于改进利用 JT 的传输的性能。然而，不是很多空间多路复用增益可以被获得为秩，并且因此速率限于所支持的秩的最小值的速率。

[0080] 在另一个实施例中，秩可以被获得为秩的总和 r' = r1+r2，并且更通常地，为 r' = min(r1+r2,rmax)，其中，rmax 可以是可以由基站配置和 / 或可能涉及（等于）在 UE 处的接收天线的数目的最大支持秩。

[0081] 在更普通实施例中，JT 秩与每 TP 秩的预定义关系可以基于 UE 处的发射天线的数目和接收天线的数目（或最大秩支持）。性能可以被预先确定，并且 (JT 秩的）表可以由以下实例如给定那样限定，其可以被进一步优化。

[0082]

(Nt = 2, rmax = 2)r1\r2	r2 = 1	r2 = 2
r1 = 1	2	2
r1 = 2	2	2

[0083]

(Nt = 2, rmax = 4)r1\r2	r2 = 1	r2 = 2
r1 = 1	2	2
r1 = 2	2	4

[0084] 注意，一旦 JT 秩被确定为在每 TP PMI 的秩与 JT 秩相同（由于 PMI 的堆叠）的预编码中允许 $[V_1 ; \alpha V_2]^T$ 类型分层结构，我们需要建立 r1' = r2' = r'，并且然后每 TP 和联合反馈必须基于对秩关系的该限制，即，r' = r1' = r2'，以使用 PMI 结构。注意，其中，JT-PMI 被独立决定的不具有这样的分层结构的 JT 不需要这样的明确关系（因此要求三个 RI 报告，r、r1、r2）。以下可以捕捉来自之前描述的充分发展 JP 反馈的开销减少。

[0085]

反馈参数	RI	PMI	CQI
反馈实例的数目	1	2 个每 TP PMI+ 同相 α	3（最多 6 个 CW CQI）

[0086] 在一个实施例中，可以由 eNB 半静态地用信号通知每 -TP 秩与 JT 秩的以上关系 / 映射，或者各个秩约束或码本子集约束可以被进一步用于建立约束。

[0087] 在另一个实施例中，秩三联体（r、r1、r2）可以被映射到秩，使得 r' = r1' = r2' = f(r, r1, r2)，其中，这样的功能关系可以被预预定或者通过基站明确地部分或整体指示。

[0088] 然而，以上方法存在特定缺点。首先，秩不被优化用于所有模式，并且可能降低性能。其次，没有减少 CQI 开销。与每个 TP 和 JT CQI 相对应的每 -TP CQI 需要被反馈。当然，可以跳过 JT-CQI 的反馈，并且依赖于在 eNB 处的粗略预测，但是可能很不准确，这是因为具有相干 JT 的 MIMO 信道不同，并且接收器行为可能很难预测，由此丢失大部分增益。

[0089] 现在参考图 11，图 11 示出了根据本发明的多种实施例的用于在与基站通信的无线终端中的联合处理（JP）的秩确定的方法的逻辑流程图。该方法包括：接收（1104）两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；确定（1106）第一集合传输参数，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，其中，第一集合传输参数包括第一传输秩；确定（1108）第二集合传输参数，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口，其中，第二集合传输参数包括第二传输秩；从第一传输秩和第二传输秩导出第三传输秩（1110）；假定第三传输秩的情况下，确定（1112）第三集合传输参数，所述第三集合传输参数对应于从第一集合天线端口和第二集合天线端口的联合传输；以及将关于第一集合传输参数、第二集合传输参数和第三集合传输参数中的一个或多个的信息传

送 (1114) 到基站。

[0090] 利用每 TP PMI 和每 TP CQI 的 JT 反馈

[0091] 我们将描述多个实施例，以进一步利用 JP 减少反馈开销。我们将首先描述如图 10 中所示的非相干联合传输的方法。图 10 图示了从两个 TP 到用户的相干联合传输的实例，这与在此呈现的一些实施例相关。两个传输点 TP11035 和 TP21040 由基站 1010 控制。基站通过相应的光纤链路 1015、1020 将两个空间层 s1(1025) 和 s2(1030) 分别发送至 TP1035 和 1040 中的每个。第一 TP TP1(1035) 在应用预编码 V1 之后发射第一空间层 s1，并且第二 TP 在应用预编码 V2 之后发射第二空间层 s2。更通常地，每个 TP 都可以发射一个或多个空间层，在该情况下，s1 和 s2 每个都可以对应于如以下进一步描述的空间层集合。

[0092] 数学上，非相干 JP 方案可以如下定义，

[0093]
$$\mathbf{Y}=\begin{bmatrix}\mathbf{H}_1 & \mathbf{H}_2\end{bmatrix}\begin{bmatrix}V_1 & 0\\ 0 & V_2\end{bmatrix}\begin{bmatrix}\vec{\mathbf{s}}_1\\ \vec{\mathbf{s}}_2\end{bmatrix}+\eta$$
$$=\mathbf{H}_1V_1\vec{\mathbf{s}}_1+\mathbf{H}_2V_2\vec{\mathbf{s}}_2+\eta$$

[0094] 我们必须注意，聚合 PMI 是各个 PMI 的对角矩阵，没有交叉项。因此，传输对各个传输的相位不敏感。

[0095] 而且，图 10 示出了典型非相干 JP 操作，其中，从每个 TP 发送各个空间层。如果如 Release-10 中的码字映射被应用至用于每个 TP 的现有系统，则可能需要在每个 TP 上发射多达两个码字 (如果 r1>1 和 r2>1，其中，r1、r2 是 V_1 和 V_2 的秩)。在这样的情况下，CQI 还需要允许用于两个码字的 CQI 与每个 TP 相关联，这是不期望的。

[0096] 在一个优选实施例中，仅单个码字传输一直被假定在每个 TP 上，而不管是否需要反馈与每个 TP 相关联的该 TP 上的空间层的数目和单个码字 CQI 以及对应 PMI 和秩索引 RI。

[0097] 在一个实施例中，假定从每个 TP 的单个 CW 的同时联合传输的情况下，确定预编码器对 (V_1, V_2) (或对应的对角矩阵 V = diag(V_1,V_2)) 和秩对 (r_1,r_2) 和 CQI 对 (用于从 TP1 的 CW1 的 CQI1、用于从 TP_2 的 CW_2 的 CQI2)。在这样的情况下，接收器假定从相应的 TP 的 H_1 和 H_2 两者的信道知识，用于计算各个 PMI/CQI/RI。这可以与仅基于用于特定 TP 的信道 (也就是说用于 TP1CSI 的 H_1) 的传统每 -TP 反馈相比较。

[0098] 现在参考图 12，描述了图示根据本发明的多种实施例的支持用于在与基站通信的无线终端中的联合处理 (JP) 的反馈的方法的逻辑流程图。该方法包括 :接收 (1204) 两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口 ;确定 (1206) 第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口，其中，假定从第一集合天线端口和第二集合天线端口的同时传输的情况下，第一集合传输参数和第二集合传输参数被确定 (1208) 以最大化总和数据速率 ;并且将关于第一集合传输参数和第二集合传输参数的信息传送 (1214) 到基站。在本发明的另一个实施例 (1210) 中，第一集合传输参数和第二集合传输参数对应于重叠的下行链路时间频率资源的集合。在本发明的另一个实施例 (1212)

中，假定从第一集合天线端口的第一单个码字传输和从第二集合天线端口的第二单个码字传输的情况下，第一集合传输参数和第二集合传输参数。

[0099] 现在参考图 15，图 15 描述了图示根据本发明的多种实施例的在与无线终端通信的无线基站中的联合处理 (JP) 的方法的逻辑流程图。该方法包括：发送 (1504) 两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；接收 (1506) 关于第一集合传输参数和第二集合传输参数的信息，所述第一集合传输参数对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二 CSI 参考信号配置相对应的第二集合天线端口；假定在第一下行链路时间频率资源上从第一集合天线端口的第一单个码字传输和在第二下行链路时间频率资源上从第二集合天线端口的第二单个码字传输是同时的情况下，第一集合传输参数和第二集合传输参数被确定，其中，第一时间频率资源和第二时间频率资源重叠 (1508)。在另一个实施例中，基站基于关于第一集合天线端口和第二集合天线端口的信息，从第一集合天线端口发射 (1510) 第一码字并且从第二集合天线端口发射第二码字。

[0100] 用于非相干 JP 的 PMI 的单独编码

[0101] 我们现在将利用在每个 TP 处的两个传输天线的实例并且利用非相干 JT 传输来描述用于 PMI 对 (V1、V2) 的单独编码的一些优选实施例。

[0102] 在一个实施例中，这要求两比特开销来报告秩 (当 RI 采取值 1 或 2 时，1 比特 / 秩)。各个 PMI 仅要求 2 比特 /PMI(在用于 2Tx 码本的 Release-10 规范中最多 4 个可能值)，这对于两个 TP 联合传输，每子带四比特，其中，每个子带是必须报告反馈的频带集合的单个实例。反馈可能必须在一个或多个子带上被报告。与两个 CW(每 TP 一个) 相对应的 CQI 也被报告，并且最大开销类似于现有 CQI 开销 (最多支持两个 CW)。而且，通过单独编码，JT 秩简单地为两个秩的总和并且不需要单独用信号通知。

[0103] 在一个实施例中，甚至在该情况下，每 TP 秩还可以被联合编码用于反馈，这是因为由于 UE 处的 NRx(接收天线的数目)，或者当被优化用于最大秩支持时，导致 JT 的最大秩 (rmax) 可以被限制。

[0104] 在一个实例中，以下示出 3 比特被要求用于秩指示，其中 rmax = 4。不要求报告用于相干 JT 传输的 rmax = 2，这是因为在这样的情况下，仅支持秩对 (1,1)。

[0105]

用于 NRx/rmax = 4 的 (RI1,RI2)
1,1
1,2
2,1
2,2
1,3
3,1

[0106] 对于 rmax = 2，秩的一种示例性编码可以如下，包括作为特殊情况的动态点选择(DPS)，在具有噪声抑制的 TP 之一上的零秩传输或者不从其他传输点的传输。

[0107]

用于 NRx/rmax = 2 的联合秩和 DPS 编码(RI1,RI2)
1,1
1,0
0,1

[0108] 元素 (1,0) 可以对应于不从第二 TP 传输的假定。类似编码还可以用于以下所示的 rmax = 4 的情况。

[0109]

用于 NRx/rmax = 4 (4 比特)的联合秩和 DPS 编码 (RI1,RI2)
1,1
1,2
2,1
2,2
1,3
3,1
1,0
0,1
2,0
0,2
3,0
0.3
4,0
0,4

[0110] 在一个实施例中，我们可以用表示第二 TP 正发射 / 活动但是不发射到该用户的 (r,x) 元素代替或添加到 (r,0) 类型元素。在一个实施例中，UE 可以被要求假定在其他 TP 上的非预编码干扰（在不进行预编码的情况下，来自所有发射天线的总和接收功率）。在另一个实施例中，UE 可以假定其他 TP 正使用发射分集模式发射。这样的发射模式可以对应于良好定义的 Alamout 类型空间 - 时间或空间 - 频率传输模式。

[0111] 在另一个实施例中，如果假定其他 TP 发射还用于 CQI 计算目的，则可以使用与用于导出干扰的其他 TP 相对应的特定预编码假定。多个选项可以用于干扰预编码器的假定。换句话说，为了导出用于 TP1 的 CQI1 和 PMI V1 和秩 r1，假定可以被限定用于 TP2 预编码器（比如是 V2'）用于干扰计算的目的。在一个实施例中，干扰可以基于来自码本的随机预编码器。在还有的另一个实施例中，干扰可以基于固定预编码器或与所选每 -TP 预编码器的

固定预编码器关系，即，如果 V1 被用于在 TP1 上预编码，以用于 TP1 的 CSI，则实用固定预编码器 V2' = Vc 或固定函数 V2' = Vc(V1) 的同时传输可以用于从 TP2 导出预编码器假定和对应干扰。更通常地，这样的固定预编码器可能取决于子带索引。而且，干扰预编码器 V2' 可能必须被选择为被最小化或最大化（最好或最差情况 CQI）的 CQI1。

[0112] 以下捕捉应用在此描述的多种实施例的开销，其中，秩和模式 (JT+DPS) 在一个报告中被联合编码，单个 PMI 对被报告，并且两个 CQI 中的最大值被报告。

[0113]

反馈	RI+(模式)	PMI	CQI
反馈实例的数目	1(被联合编码)	1	1(最多 2 个 CW CQI)

[0114] 每 -TP PMI 和 RI(包括 DPS/ 相干 JP 元素）的联合码本编码

[0115] 在上述多种实施例中，可以作出多个简化以减少开销。而且，在说明书中，我们将考虑反馈编码，以支持一些联合编码并且支持用于允许相干和非相干模式两者的混合操作。在一个实施例中，与较早描述的专有非相干编码的反馈相反，我们还可以一起考虑增强码本，以联合编码秩 (RI)、非相干 JT PMI 对和可能 DPS PMI 和基于相干 JT 的 PMI，在以下将对此详细地描述。

[0116] 在一个实施例中，在每 TP PMI 和秩之间可以支持联合编码。作为用于 2Tx/TP 情况的实例，4 个码本元素被支持用于秩 1PMI，并且 3 个码本元素用于秩 2PMI，如以下复制的。

[0117]

Release-10 2Tx 码本		
码本索引	层数 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	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	-

[0118] 以下捕捉联合编码，其中，每个元素捕捉两个秩 (r1,r2) 作为行和列，并且可应用 PMI 对之一在对应表行和列中。

[0119]

每秩对 rmax=4 的联合编码元素		
总计：49	1	2
1	16 (=4x4)	12 (=4x3)
2	12 (=4x3)	9 (=3x3)

[0120] 通过 rmax = 4，要求 49 个元素 (16+12+12+9) 捕捉 (V1、V2、r1、r2)，这要求 6 比特的反馈。另外，对于 rmax = 2，仅需要 16 个元素，其是单独编码的拐角情况。

[0121]

具有 rmax=2 的每秩对的联合编码元素		
总计：16	1	2
1	16	0
2	0	0

[0122] 在一个实施例中，DPS 被组合在秩 +PMI 的以上联合编码中，其中，零秩被视为不传输或到其他用户的传输。附加 14 个元素可以被用于捕捉 DPS（秩＝ 0），如以下被捕捉用于 rmax ＝ 4 和 rmax ＝ 2 的情况，使总元素达到 63 和 30。

[0123]

具有 DPS 和 rmax=4 的每秩对的联合编码元素			
总元素：63	0	1	2
0	0	4	3
1	4	16	12
2	3	12	9

[0124]

具有 DPS 和 rmax=2 的每秩对的联合编码元素			
总元素：30	0	1	2
0	0	4	3
1	4	16	0
2	3	0	0

[0125] 以上实施例中的编码还捕捉动态选择作为 PMI 的一部分（作为用于 TP 之一的秩 0）。如果最大 JT 秩是 4，则表 10 中的码本元素的总数是 63，其可以利用 6 比特有效地支持（具有 6 比特表示的多达 64 个元素）。对于 rmax ＝ 2，我们仅需要 30 个元素，其可以利用 5 比特支持。

[0126] 在一个实施例中，两个码字支持可以被假定用于 RI>1（如在 Rel-10 中，单个 TP 传输），仅用于具有从仅一个 TP 的传输的 DPS 元素（(r,0) 或 (0,r)）。

[0127] 在另一个实施例中，除了上述非相干 PMI(DPS 作为特殊情况），我们还考虑支持相干联合传输。回想起非相干 JT PMI 基本是对角的，其中，块对角基本是每 TP PMI(diag(V1,V2))。

[0128] 我们可以注意，对于 2Rx 情况，UE 可以支持最大秩 2，在该情况下，开销被显著减小，允许同时支持两个对角元素，DPS 元素和非对角元素。在具有 rmax ＝ 2 的以上实例中，需要 30 个元素用于支持非相干 JT（和 DPS）。

[0129] 在一个实施例中，形式 $[V1 ; \alpha V2]^T$ 的附加非对角码本元素可以被添加到对角 PMI，其中，V1/V2 是每个相等秩。对于秩 1，支持用于 α 的两个值 (+1,-1) 将要求约 4x4x2 ＝ 32 个元素 (4 个元素用于 2Tx 传输的秩 1PMI)，仅留下 2(64-30-32) 个用于秩 2。在一个实施例中，固定码本元素可以用于秩 2（例如，码本索引 1），其中 (+1,-1) 用于 α，其使总数达到 34 个元素以用于所包括的秩 1 和秩 2。

[0130] 在另一个实施例中，代替使用与 2Tx 码本相对应的每 -TP 码本元素，可以使用与聚合的 4Tx 相对应的码本元素。版本 -10 中的 4Tx 码本支持 16 个元素用于每个秩，这将产生 16+16 = 32 个元素用于支持秩 1 和秩 2。

[0131] 在以上实例中，如果使用非对角码本元素，则可以假定两个码本传输的最大值，并且码本到空间层映射可以被用作当前限定的（即，两个码字用于相干联合 PMI 的联合秩，r>1 并且单个码字用于 r = 1）。这样，CQI 开销被限于两个 CW CQI 的最大值，而不管所选的联合码本元素如何。以下总结整个码本。

[0132]

秩、PMI 和 JP 模式的联合编码	
码本元素	CQI
与 JT 对角 PMI 相对应的非相干 PMI 对(V1, V2)，diag(V1,V2)= $\begin{bmatrix} V_1 & 0 \\ 0 & V_2 \end{bmatrix}$	用于从与 PMI V1 相对应的 TP1 发送的 CW1 的 CQI1； 用于从与 PMI V2 相对应的 TP2 发送的 CW2 的 CQI2；
DPS PMI 单个 PMI V1 or V2(用于不传输或到其他用户的传输)	用于 RI=1 的单个码本和用于 RI>1 的两个码本，其中，RI 是 V1 或 V2 的秩
形式$[V1 ; \alpha V2]^T$ 的相干 JT PMI，其中，V1、V2、α 使用单独编码或用于 Vagg 的聚合预编码器码本	用于 RI=1 的单个码本和用于 RI>1 的两个码本，其中，RI 是组合的预编码器($[V1 \ \alpha V2]^T$ 或 Vagg)的秩

[0133]

[0134] 在一个实施例中，基站单元可以通过信令“码本 - 子集 - 限制”，指示其用于特定码本元素或模式的偏好（比如，用于 DPS 相对于相干 JT 相对于非相干 JT 的偏好），其中，这样的编码主要是等于码本的长度的比特串，其中 1 或 0 指示对应的码本元素是否被允许用于在 UE 处的反馈中的选择。当计算用于 DPS 码本元素的 CQI 时，如先前详细描述的，多个选项之一可以被用于捕捉其他 TP（不传输、随机 PMI、固定 PMI）的干扰。

[0135] 所描述的实施例可以容易地扩展用于具有每 TP 更大数目的发射天线或不同数目的发射天线的其他情况。我们简要地描述对于 4Tx/TP 情况的扩展。

[0136] 在一个实施例中，利用 RI 和 PMI 的单独编码，将导致通过 Release-10 基线的 PMI 开销的增加，其中 8 比特用于两个 PMI（每 4Tx PMI4 个）和每个 2 比特的两个秩报告（1<

＝ RI< ＝ 4)。这将支持 rmax ＝ 2/4 情况。

[0137] 在另一个实施例中，秩对的联合编码也可以再次被用于支持 DPS。

[0138]

用于 NRx ＝ 4 的 (RI1, RI2)
1, 1
1, 2
2, 1
2, 2
1, 3
3, 1
1, 0
0, 1
2, 0
0, 2
3, 0
0. 3
4, 0
0, 4

[0139]

[0140] 不像 2Tx，我们看到在该情况下支持相干 JP 的较小益处，所以可能不需要联合编码（非对角）元素。

[0141] 现在参考图 13，描述了根据上述多种实施例的无线通信终端中的方法。该方法包括：接收 (1304) 两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；基于从与第一 CSI 参考信号配置相对应的第一集合天线端口和与第二 CSI 参考信号配置相对应的第二集合天线端口的传输，确定 (1306) 传输参数；传输参数包括码本 (1308)，码本指示从第一集合天线端口和第二集合天线端口的传输权重向量和从第一集合天线端口和第二集合天线端口的空间层的数目；码本包括第一集合一个或多个对角元素 (1310)，所述第一集合一个或多个对角元素对应于从第一集合天线端口的第一集合空间层和从第二集合天线端口的第二集合空间层的传输；基于用于传输的固定假设，假定从第一集合天线端口的一个或多个空间层的传输、以及假定没有在第二集

合天线端口上传输或者假定在第二集合天线端口上传输的情况下，码本包括第二集合元素(1312)；将优选码本索引传送(1316)回基站。在另一个实施例中，假定一个或多个空间层的传输的情况下，码本包括第三集合元素(1314)，从第一集合天线端口和第二集合天线端口两者同时发射每个空间层。

[0142] 现在参考图16，描述了根据本发明的多种实施例的无线通信基站中的方法。该方法包括：发送(1604)两个或更多CSI参考信号配置的指示，每个CSI参考信号配置表示包括天线端口集合的一个或多个天线端口；接收(1606)关于传输参数的信息，所述传输参数对应于从与第一CSI参考信号配置相对应的第一集合天线端口和与第二CSI参考信号配置相对应的第二集合天线端口中的一个或多个的传输；传输参数包括码本(1608)，所述码本指示从第一集合天线端口和第二集合天线端口的传输权重向量；码本包括第一集合一个或多个对角元素(1610)，所述第一集合一个或多个对角元素对应于从第一集合天线端口的第一集合空间层和从第二集合天线端口的第二集合空间层的传输；基于用于传输的固定假设，假定从第一集合天线端口的一个或多个空间层的传输、以及假定不在第二集合天线端口上传输或者假定在第二集合天线端口上传输的情况下，码本包括第二集合元素(1612)。在另一个实施例中，假定一个或多个空间层的传输的情况下，码本包括第三集合元素(1614)，从第一集合天线端口和第二集合天线端口两者同时发射每个空间层。

[0143] 反馈模式的配置

[0144] 在至今的多种实施例中，假定在与子带相关联的频带集合的给定频率资源上的传输的情况下，定义反馈。通常，当它们是整个带宽(宽带或WB)反馈或者通过在用于多个子带(SB)反馈的每个子带上简单地重复，实施例是可应用的。假定从每个TP的单个码字的传输的情况下，在LTE中支持的大多数反馈模式可以被扩展用于具有之前概述的概念的JP。

[0145] 我们描述可应用至大多数模式的优选实施例(除了随后描述的模式“UE选择模式”2-2之外)。

[0146] 选择1：具有从每个TP的1CW的非相干JP

[0147] 在一个实施例中，使用所开发的用于具有所描述的从每个TP的1CW的非相干JT的编码，在下面描述反馈内容。

[0148]

具有从每个 TP 的 1CW 的非相干 JP	
CSI (CQI/PMI/RI)的宽带报告	• (用于 TP1 的 WB PMI 1、用于 TP2 的 WB PMI2)以及 • (用于从 TP1 的 CW1 的 WB CQI、用于从 TP2 的 CW2 的 WB CQI) • 用于 TP1 的 WB RI1、用于 TP2 的 WB RI2
CSI (CQI/PMI/RI)的子带报告	• (用于 TP1 的 SB PMI 1、用于 TP2 的 SB PMI2)以及 • (用于从 TP1 的 CW1 的 SB CQI 、用于从 TP2 的 CW1 的 SB CQI) • RI 不被报告用于 SB

[0149] 选项 2 :非相干 JP+DPS 动态切换

[0150] 在一个实施例中,使用用于包括具有所描述的从每个 TP 的 1CW 的 DPS 的非相干 JT 的所开发的编码,在下面描述反馈内容。在该情况下,联合秩编码和 DPS 编码(增强 RI,缩写为 eRI)被指示为宽带报告(用于以下复制的 4Tx 的实例)。

[0151]

联合秩和具有 rmax = 4 (4 比特)的 DPS 编码 用于 rmax = 4 的(RI1,RI2)
1,1
1,2
2,1
2,2
1,3
3,1
1,0
0,1
2,0
0,2
3,0
0.3
4,0
0,4

[0152]

[0153] 其他宽带和子带报告基于以下捕捉的该报告被调节。

[0154]

非相干 JP+DPS 动态切换	
CSI (CQI/PMI/RI)的宽带报告	1)通过以下联合编码表捕捉的 eRI 报告 2)*如果 JP 由 eRI 指示->* (用于 TP1 的 WB PMI 1、用于 TP2 的 WB PMI2)以及 (用于从 TP1 的 CW 1 的 WB CQI 、用于从 TP2 的 CW2 的 WB CQI) *如果 TP 't' 上的 DPS 由 eRI 指示->* (用于 TP t 的 WB PMI)以及 (假定其他 TP 被噪声抑制，用于从 TP t 的一个或两个 CW 的 WB CQI) *注释：* *i)对于从单个 TP 的 DPS，可以假定如 Rel-10 中的码字到层映射 (用于 RI=1 的 1CW 和用于 RI>1 的 2CW)* *ii)还可以通过假定其他 TP 上的发射分集或假定固定预编码器循环而不是噪声抑制，计算具有 DPS 的 CQI*
CSI (CQI/PMI/RI)的子带报告	除了对于子带(每子带没有 eRI)之外，与以上相同

[0155] 用户选择反馈模式

[0156] Release-10 中的模式 2-2 支持用户选择子带反馈，其中，UE 选择用于反馈的 M 个优选子带集合，并且单个 PMI/CQI 被反馈用于所有 M 个所选子带。还报告宽带 PMI/CQI/RI。该模式的优点在于，在减少开销的同时，获得频率选择性增益，这是因为不从整个带宽中的每个子带报告子带反馈。反馈仅被加倍超过宽带反馈，一个对应于宽带，并且一个对应于 M 个所选子带。由于所选子带方面，导致将其扩展至如较早描述用于相同资源的 JP 反馈与其他模式稍微不同，将对此进一步论述。

[0157] 选项 1 :具有相同 M 个所选子带的具有每 TP1 个 CW 的非相干 JP

[0158] 在一个实施例中，我们考虑支持具有每 TP1 个 CW 的非相干 JT 的反馈，约束 M 个所选子带的选择对于两个 TP 相同。

[0159]

具有相同 M 个所选子带的具有每 TP 1 个 CW 的非相干 JP	
宽带报告(WB CSI)	• (用于 TP1 的 WB PMI 1、用于 TP2 的 WB PMI2)以及 • (用于从 TP1 的 CW 1 的 WB CQI 、用于从 TP2 的 CW 2 的 WB CQI)
“M 个所选子带”报告(mCSI)(用于 M 个所选子带的单个报告)	• (用于 TP1 的 mPMI 1、用于 TP2 的 mPMI2)以及 • (用于从 TP1 的 CW 1 的 mCQI 、用于从 TP2 的 CW 2 的 mCQI)

[0160] 当资源完全重叠并且基于利用 JT 的联合 CQI 最大化被选择时，特定实施例与用于其他模式的非相干 JT 支持相同。缺点在于，如果基站想要退回到单个 TP，则频率选择性增益丢失，这是因为组合的度量被优化。

[0161] 为了克服该限制，描述了另一个实施例，其中，子带的不同集合基于每 TP CQI 的优化被选择如下。

[0162] 选项 2：具有不同 M 个所选子带的具有每 TP1 个 CW 的非相干 JP

[0163]

具有不同 M 个所选子带的具有每 TP 1 个 CW 的非相干 JP、以及假定宽带 PMI 在其他 TP 上的每个 TP 上的 CQI	
WB CSI 报告	• (用于 TP1 的 WB PMI 1、用于 TP2 的 WB PMI2)以及 • (用于从 TP1 的 CW1 的 WB CQI、用于从 TP2 的 CW 2 的 WB CQI)
“M 个所选子带”报告(mCSI)(用于 M 个所选子带的单个报告)	• 对于 TP 1, ○ 选择 M 个子带，其中，选择基于假定基于用于 TP2 的 WB PMI2 的干扰计算的每个子带上的每 TP CQI(来自步骤 1) ○ 报告从 TP1 的 M 个子带 索引 1、mPMI1、CW1 的 mCQI 1 • 对于 TP2, ○ 选择 M 个子带，其中，选择基于假定用于 TP1 的 WB PMI1 计算的每个子带上的每 TP CQI(来自步骤 1) ○ 报告 M 个子带索引 2、mPMI 2、CW1 的 mCQI 2

[0164] 在以上实施例中，UE 首先确定用于每 TP CSI1 的宽带报告，并且为了选择 M 个子带，可以假定其他 TP 正使用其对应宽带预编码器，计算每个子带上的信道质量度量。这允

许在基站处的灵活调度。如果基站在子带上执行 DPS，则其可以基于与该 TP 相对应的以上 M 个所选子带索引，选择用于 TP 的最佳子带，并且从 mPMI/mCQI 报告获得用于该 TP 的 PMI 和 CQI。而且，还可以使用用于一个 TP 的 mPMI 和用于其他 TP 的宽带 PMI，支持进一步联合传输。

[0165] 在以上实施例的变体中，假定其他 TP 不传输，M 个子带被选择用于每个 TP。

[0166]

具有不同 M 个所选子带的具有每 TP 1 个 CW 的非相干 JP、以及用于在其他 TP 上不传输的每个 TP 上的 CQI	
代替 WB PMI、WB CQI	• 对于 TP 1, ○ 假定其他 TP 不发射，从 TP1 的 WB PMI 1、CW1 的 WB CQI 1 • 对于 TP2, ○ 假定其他 TP 不发射，从 TP2 的 WB PMI 2、CW 1 的 WB CQI 2
代替 mPMI, mCQI	• 对于 TP 1, ○ 选择 M 个子带，其中，选择是基于假定其他 TP 不发射计算的每 TP CQI ○ 报告从 TP1 的 M 个子带索引 1、mPMI 1, CW1 的 mCQI 1。 • 对于 TP2, ○ 选择 M 个子带，其中，选择是基于假定其他 TP 不发射计算的每 TP CQI。 ○ 报告 M 个子带 索引 2、mPMI 2、用于 TP2 的 CW1 的 mCQI 2

[0167] 在其他实施例中，再次考虑进一步变体，其中，代替不传输，可以假定用于其他 TP 的发射分集（开环传输）或固定预编码器关系。

[0168] 现在参考图 14，描述了根据本发明的多种实施例的无线通信终端中的方法。该方法包括：接收 (1404) 两个或更多 CSI 参考信号配置的指示，每个 CSI 参考信号配置表示包括天线端口集合的一个或多个天线端口；选择 (1406) 第一集合子带和第二集合子带，所述第一集合子带对应于与第一 CSI 参考信号配置相对应的第一集合天线端口，所述第二集合子带对应于与第二 CSI 参考信号配置相对应的第二集合天线端口；确定 (1408) 第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于第一集合子带上的第一集合天线端口，所述第二集合传输参数对应于第二集合子带上的第二集合天线端口；将关于第一集合传输参数和第二集合传输参数以及第一集合子带和第二集合子带的信息传送 (1412) 到基站。在另一个实施例 (1410) 中，所述选择是基于在每个子带上计算的信道质量，用于从第二集合天线端口的传输的固定假设。

[0169] 已经给本发明提供了用于支持在基站处的联合处理的示例性实施例和用于实现在基站处的传输参数的调度和确定的方法；以及用于确定在与基站单元通信的无线通信终端处反馈的信道状态信息的方法。多个实施例使用了从两个传输点的联合处理的实例。直接将其扩展至多于两个传输点。

[0170] 在一个示例性实施例中，可以从多于两个传输点执行联合传输。相干或非相干或动态点选择传输可以基于多于两个传输点。单个码字可以在每个传输点上被发射，或者单个码字可以从多于一个传输点被联合地发射，同时可以从不同 TP 发射码字的不同空间层。联合传输可以被进一步限制成从所有传输点发射的最大码字到两个码字。

[0171] 在另一个示例性实施例中，用于 JP 的秩确定可以基于多于两个 TP 的各个每 -TP 传输的秩。每 -TP CQI 可以被导出用于在多于两个 TP 中的其他 TP 处的固定传输假设的组合。不同固定传输假设可以用于每个 TP。作为一个实例，可以假定在一个 TP 上不传输并且在另一个 TP 上发射分集，并且在还有的另一个 TP 处发射固定预编码配置。

[0172] 在还有的另一个实施例中，可以对于多于两个 TP 执行每 -TP 秩和码本的联合编码，如之前对于两个 TP 所描述的，其可以包括对角、非对角码本元素和与不从一个或多个 TP 传输相对应的元素的组合。

[0173] 在以上说明中，已经描述了特定实施例。然而，本领域普通技术人员将想到，在不脱离权利要求中阐述的本发明的范围的情况下，可以作出多种修改和改变。从而，说明书和附图将被认为是说明性的而不是限制性的，并且所有这样的修改都旨在包括在本教导的范围内。

[0174] 可能造成任何益处、优点或发生或变得更加明显的解决方案的益处、优点、问题的解决方案和任何要素都不应当被解释为任何或所有权利要求的关键的、要求的或必要特征或要素。本发明仅通过包括在本申请的未决期间作出的任何修改和所授权的那些权利要求的所有等同物的所附权利要求来限定。

[0175] 而且，在本文档中，诸如第一和第二、顶部和底部等的关系术语可以仅被用于区分一个实体或动作与另一个实体或动作，而不一定要求或暗示这样的实体或动作之间的任何实际这样的关系或顺序。术语“包括”、“具有”、“包含”或其任何其他变体旨在覆盖非排他性包括，使得包括、具有、包含要素的列表的处理、方法、条款或装置不仅包括那些元件，而且可以包括未明确列出或者这样的处理、方法、条款或装置固有的其他要素。在没有更多约束的情况下，继之以“包括…一个”、“具有…一个”、“包含…一个”的元件不排除包括、具有、包含该元件的处理、方法、制品或装置中的附加相同元件的存在。除非在此另外明确地阐述，术语“一”和“一个”被限定为一个或多个。术语“主要地”、“基本上”、“近似地”、“大约”或其任何其他变体被限定为接近如本领域普通技术人员所理解的，并且在一个非限制性实施例中，该术语被限定为在 10％内，在另一个实施例中，在 5％内，在另一个实施例中，在 1％内，并且在另一个实施例中，在 0.5％内。在此使用的术语“被耦合”被限定为被连接，但是不一定是直接地并且不一定是机械地。以特定方式“配置”的设备或结构以至少该方式被配置，但是还可以以未列出的其他方式被配置。

[0176] 提供本公开的摘要，以允许读者快速地确定技术公开的性质。将理解，其将不被用于解释或限制权利要求的范围或意义。另外，在以上具体实施方式中，可以看出多种特征在多种实施例中被分组到一起，用于使本公开流畅的目的。本公开的该方法将不被解释为反

映所要求的实施例要求比在每个权利要求中明确阐述的特征更多的特征目的。而是，如权利要求反映的，发明主题在于少于单个公开的实施例的所有特征。从而，以下权利要求被结合到具体实施方式中，其中每个权利要求作为单独要求的主题代表其本身。

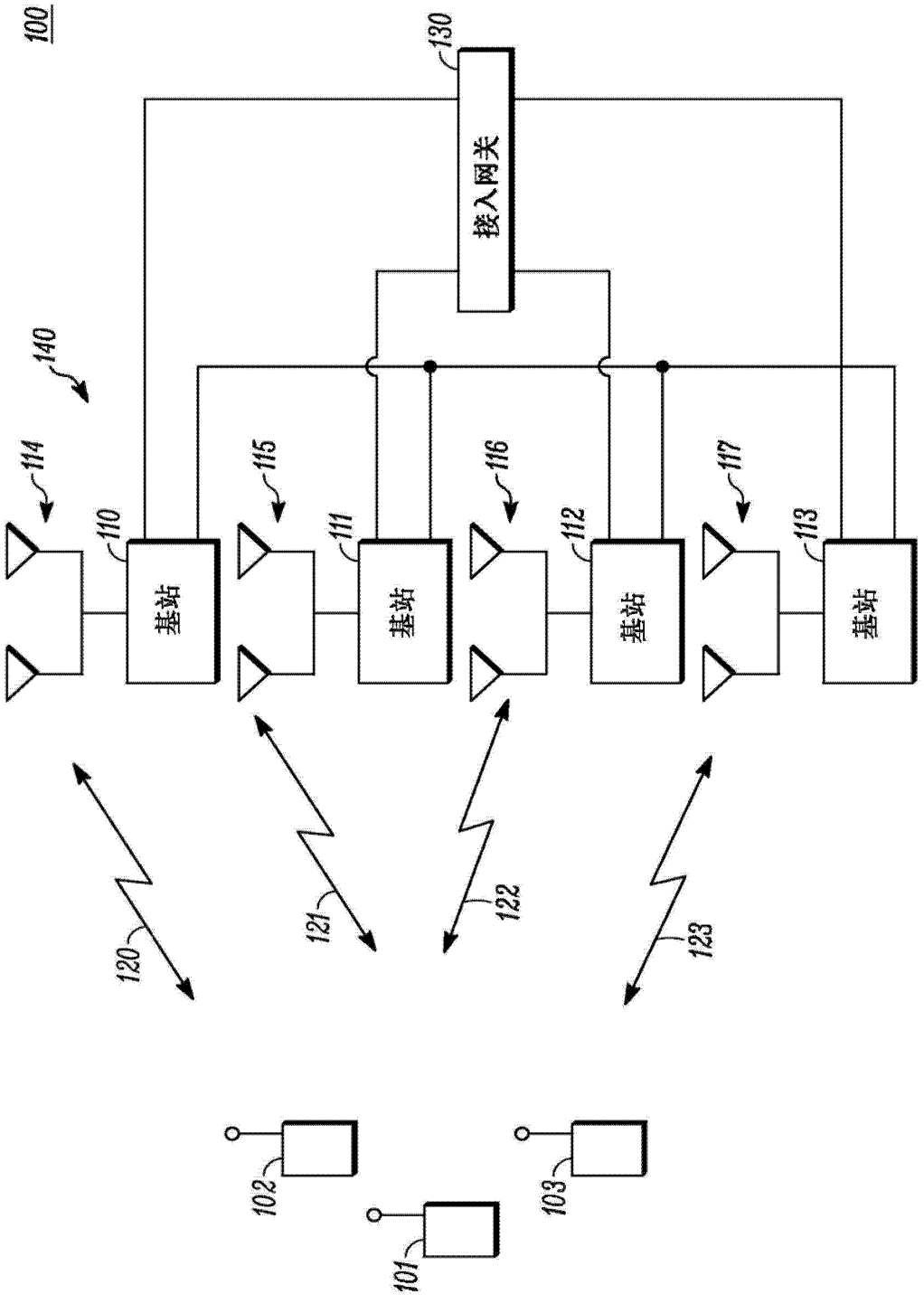

100
130
接入网关
140
114
115
116
117
110
111
112
113
基站
基站
基站
基站
120
121
122
123
102
103
101

图 1

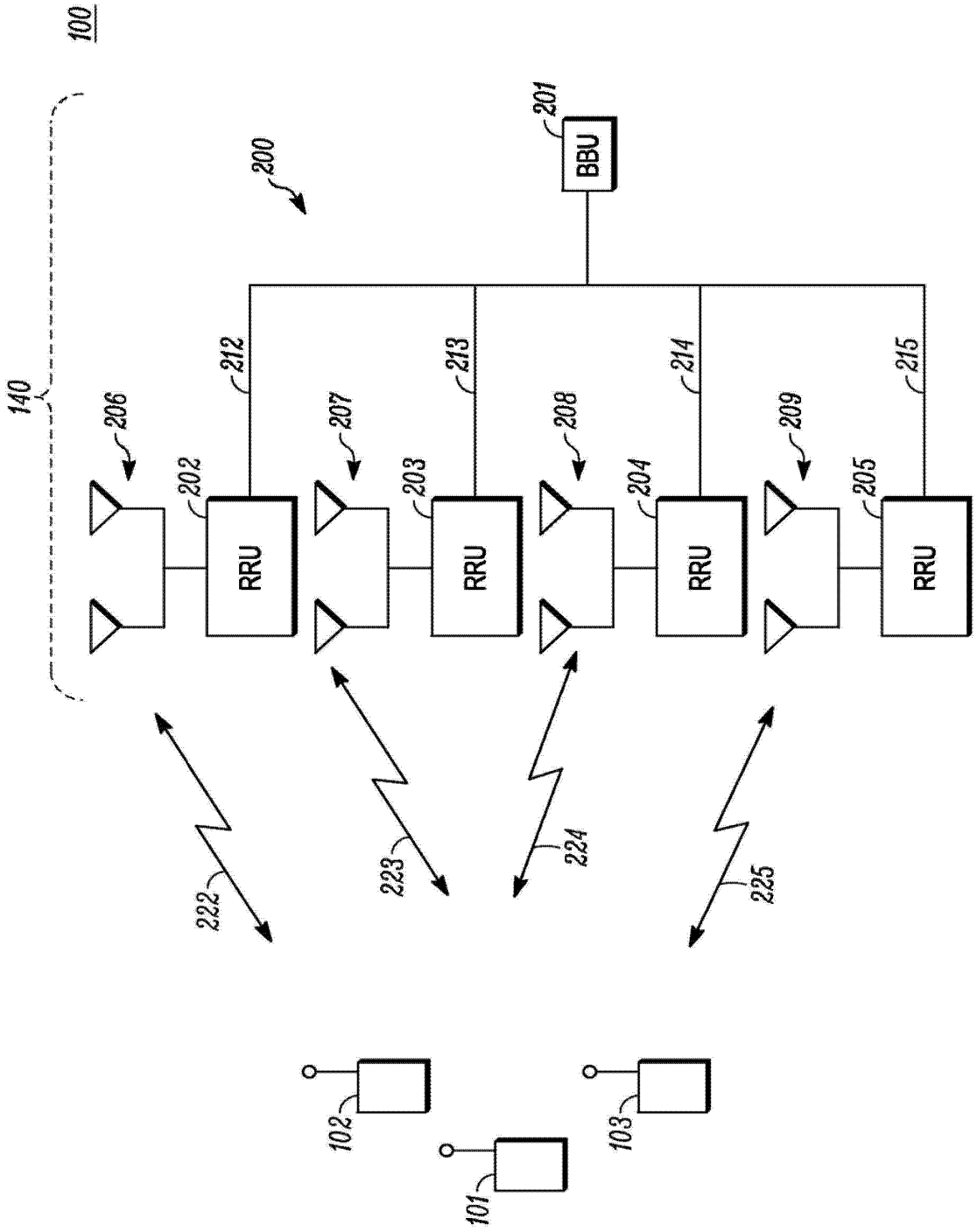

100
140
200
201
BBU
212
213
214
215
206
207
208
209
202
203
204
205
RRU
RRU
RRU
RRU
222
223
224
225
102
101
103

图 2

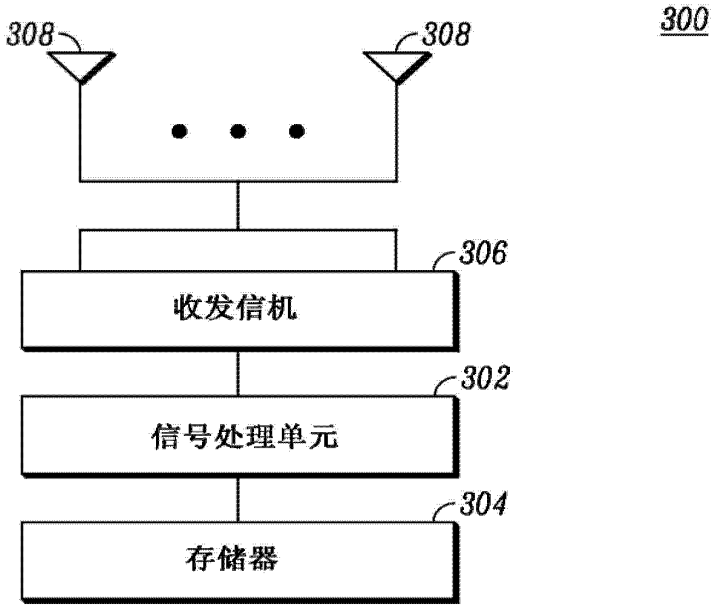

300
308
308
306
收发信机
302
信号处理单元
304
存储器

图 3

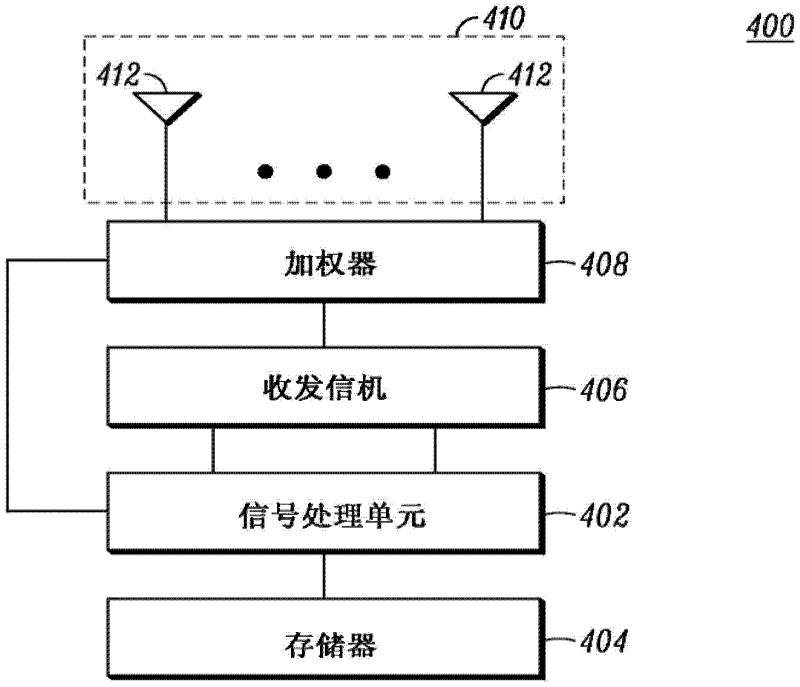

400
410
412
412
加权器
408
收发信机
406
信号处理单元
402
存储器
404

图 4

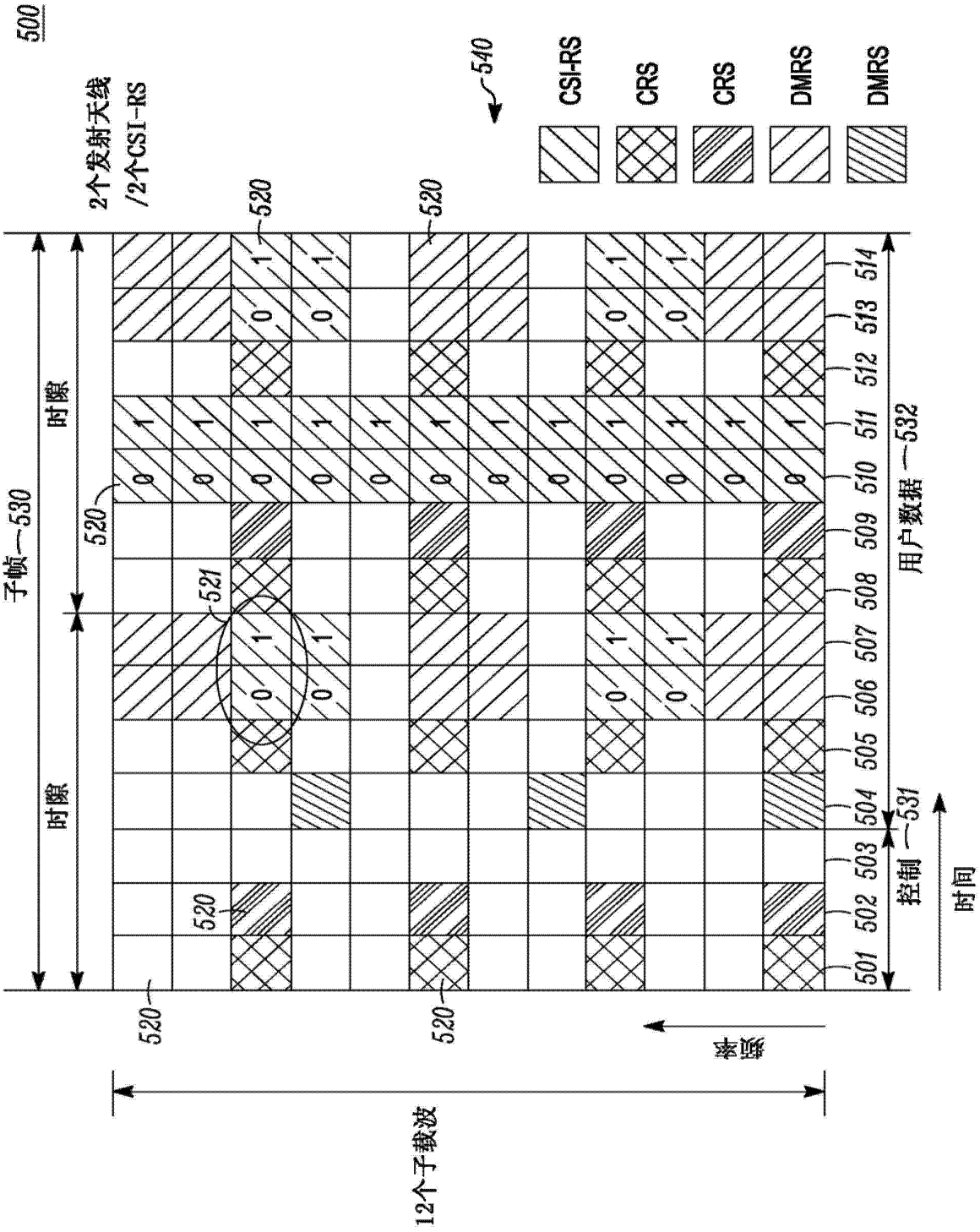

500
2个发射天线
/2个CSI-RS
540
CSI-RS
CRS
CRS
DMRS
DMRS
520
子帧 530
时隙
时隙
521
用户数据 532
控制 531
时间
频率
12个子载波
501
502
503
504
505
506
507
508
509
510
511
512
513
514

图 5

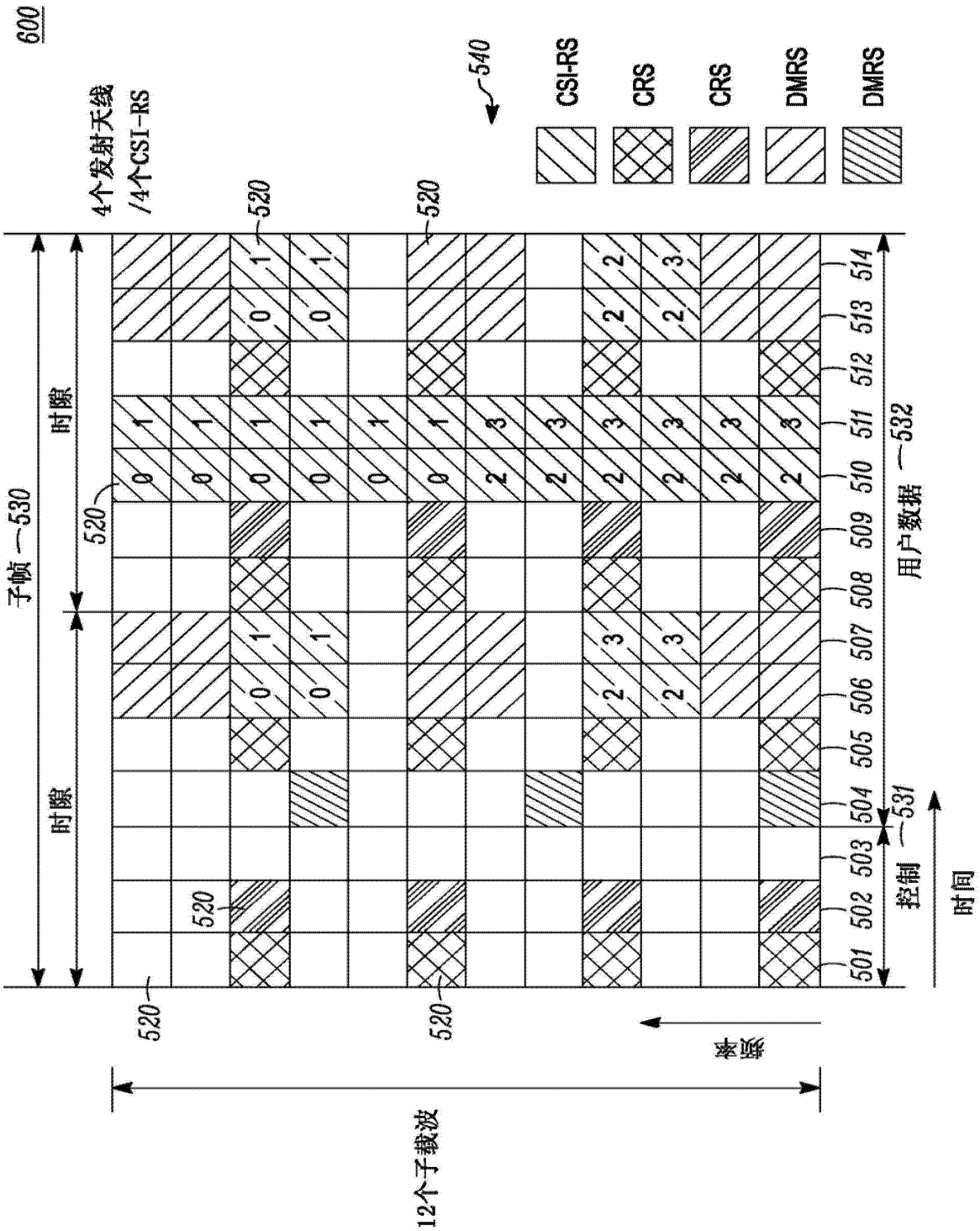

600
4个发射天线
/4个CSI-RS
540
CSI-RS
CRS
CRS
DMRS
DMRS
520
子帧 530
时隙
时隙
用户数据 532
控制 531
时间
频率
12个子载波

图 6

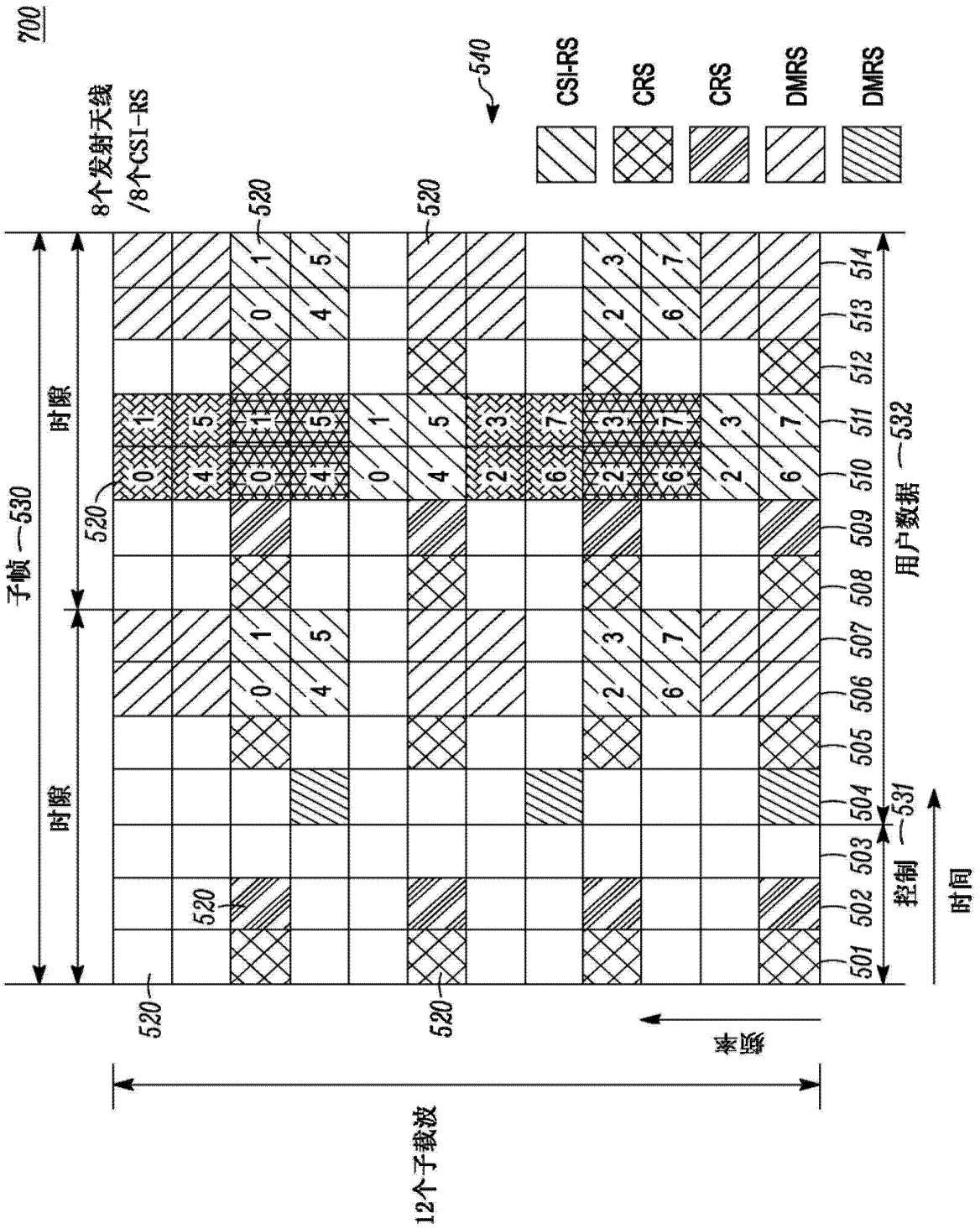

700
8个发射天线
/8个CSI-RS
540
CSI-RS
CRS
CRS
DMRS
DMRS
520
子帧 530
时隙
时隙
用户数据 532
控制 531
时间
频率
12个子载波
501 502 503 504 505 506 507 508 509 510 511 512 513 514

图 7

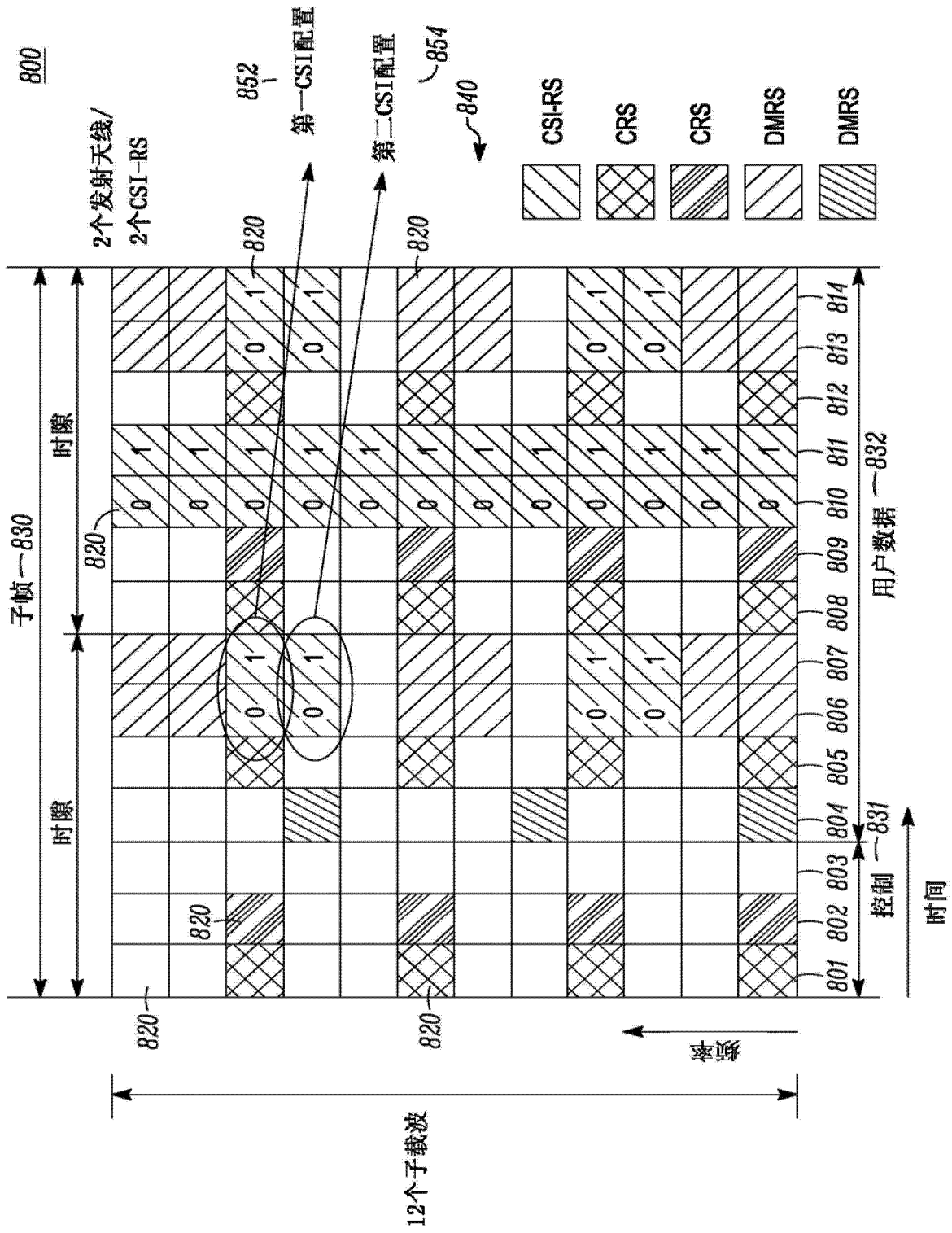

800
2个发射天线/
2个CSI-RS
852
第一CSI配置
第二CSI配置
854
840
CSI-RS
CRS
CRS
DMRS
DMRS
820
子帧 830
时隙
时隙
用户数据 832
控制 831
时间
频率
12个子载波
801
802
803
804
805
806
807
808
809
810
811
812
813
814

图 8

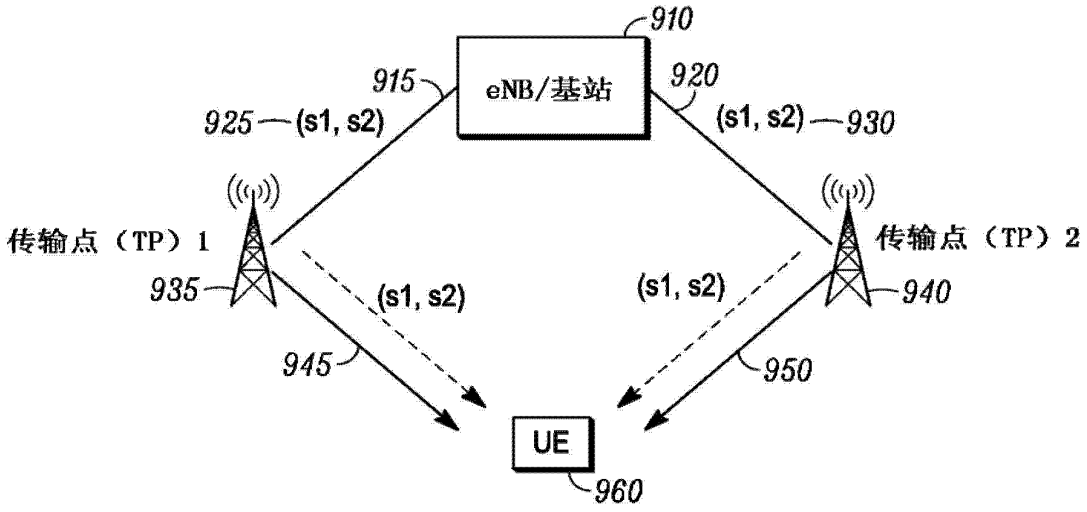

910
eNB/基站
915
920
925
(s1, s2)
(s1, s2)
930
传输点（TP）1
传输点（TP）2
935
(s1, s2)
(s1, s2)
940
945
950
UE
960

图 9

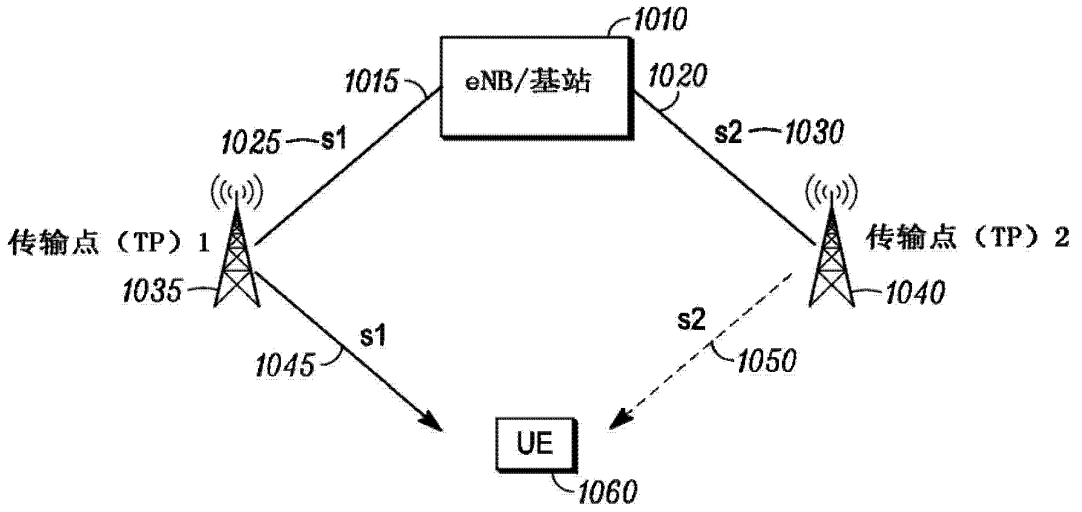

1010
eNB/基站
1015
1020
1025
s1
s2
1030
传输点（TP）1
传输点（TP）2
1035
1040
s1
s2
1045
1050
UE
1060

图 10

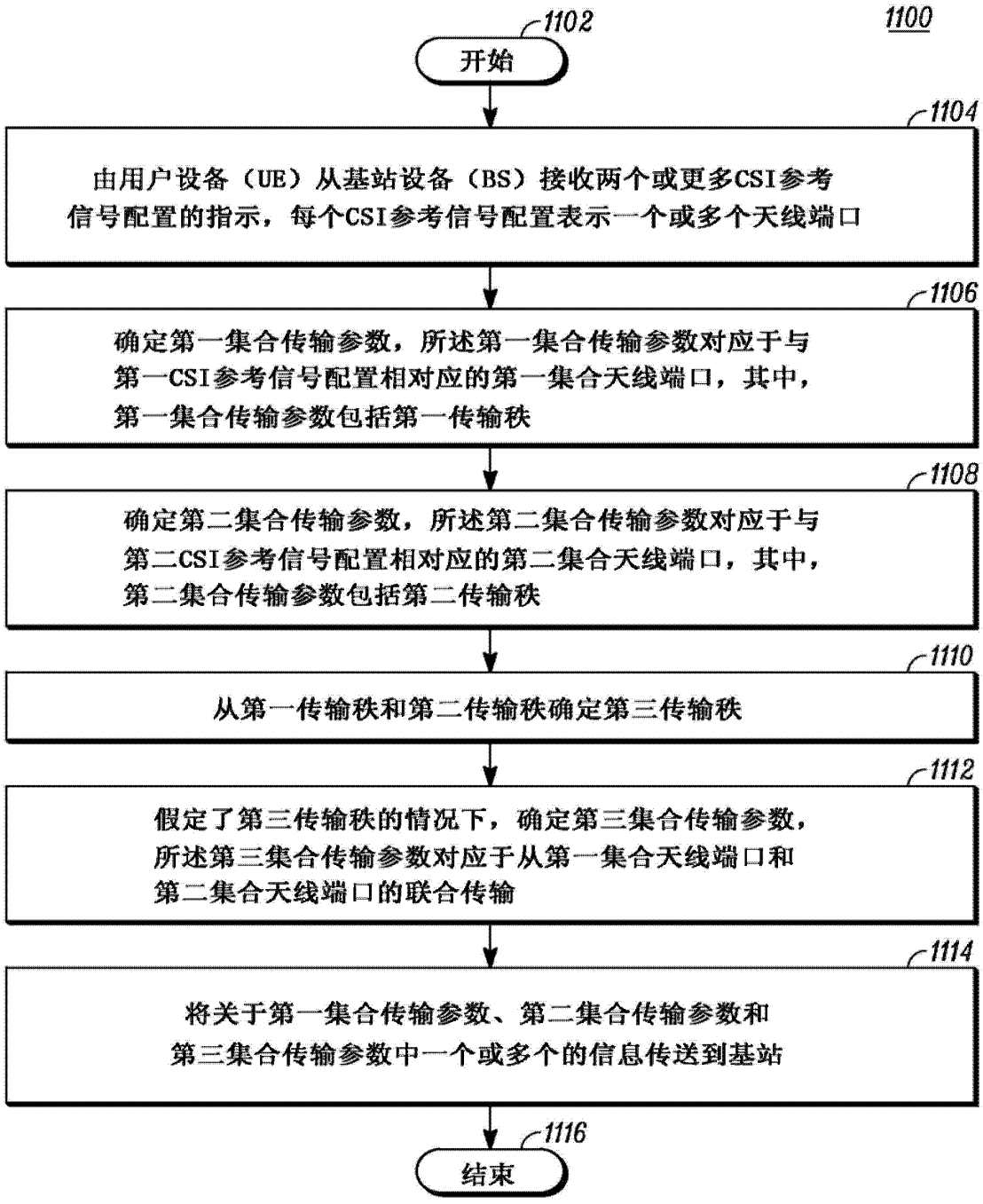

1100
1102
开始
1104
由用户设备（UE）从基站设备（BS）接收两个或更多CSI参考信号配置的指示，每个CSI参考信号配置表示一个或多个天线端口
1106
确定第一集合传输参数，所述第一集合传输参数对应于与第一CSI参考信号配置相对应的第一集合天线端口，其中，第一集合传输参数包括第一传输秩
1108
确定第二集合传输参数，所述第二集合传输参数对应于与第二CSI参考信号配置相对应的第二集合天线端口，其中，第二集合传输参数包括第二传输秩
1110
从第一传输秩和第二传输秩确定第三传输秩
1112
假定了第三传输秩的情况下，确定第三集合传输参数，所述第三集合传输参数对应于从第一集合天线端口和第二集合天线端口的联合传输
1114
将关于第一集合传输参数、第二集合传输参数和第三集合传输参数中一个或多个的信息传送到基站
1116
结束

图 11

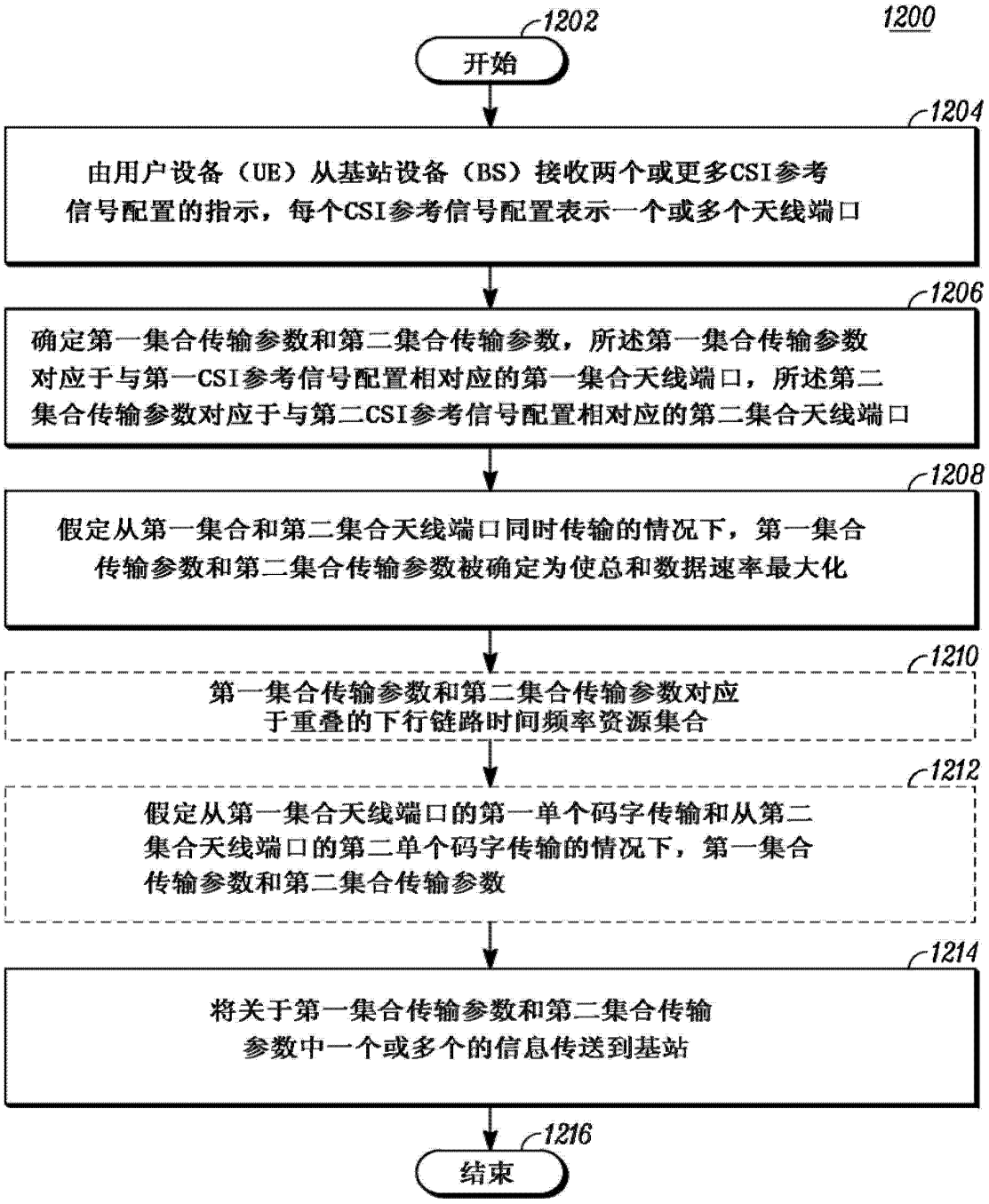

1200
1202
开始
1204
由用户设备（UE）从基站设备（BS）接收两个或更多CSI参考信号配置的指示，每个CSI参考信号配置表示一个或多个天线端口
1206
确定第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于与第一CSI参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二CSI参考信号配置相对应的第二集合天线端口
1208
假定从第一集合和第二集合天线端口同时传输的情况下，第一集合传输参数和第二集合传输参数被确定为使总和数据速率最大化
1210
第一集合传输参数和第二集合传输参数对应于重叠的下行链路时间频率资源集合
1212
假定从第一集合天线端口的第一单个码字传输和从第二集合天线端口的第二单个码字传输的情况下，第一集合传输参数和第二集合传输参数
1214
将关于第一集合传输参数和第二集合传输参数中一个或多个的信息传送到基站
1216
结束

图 12

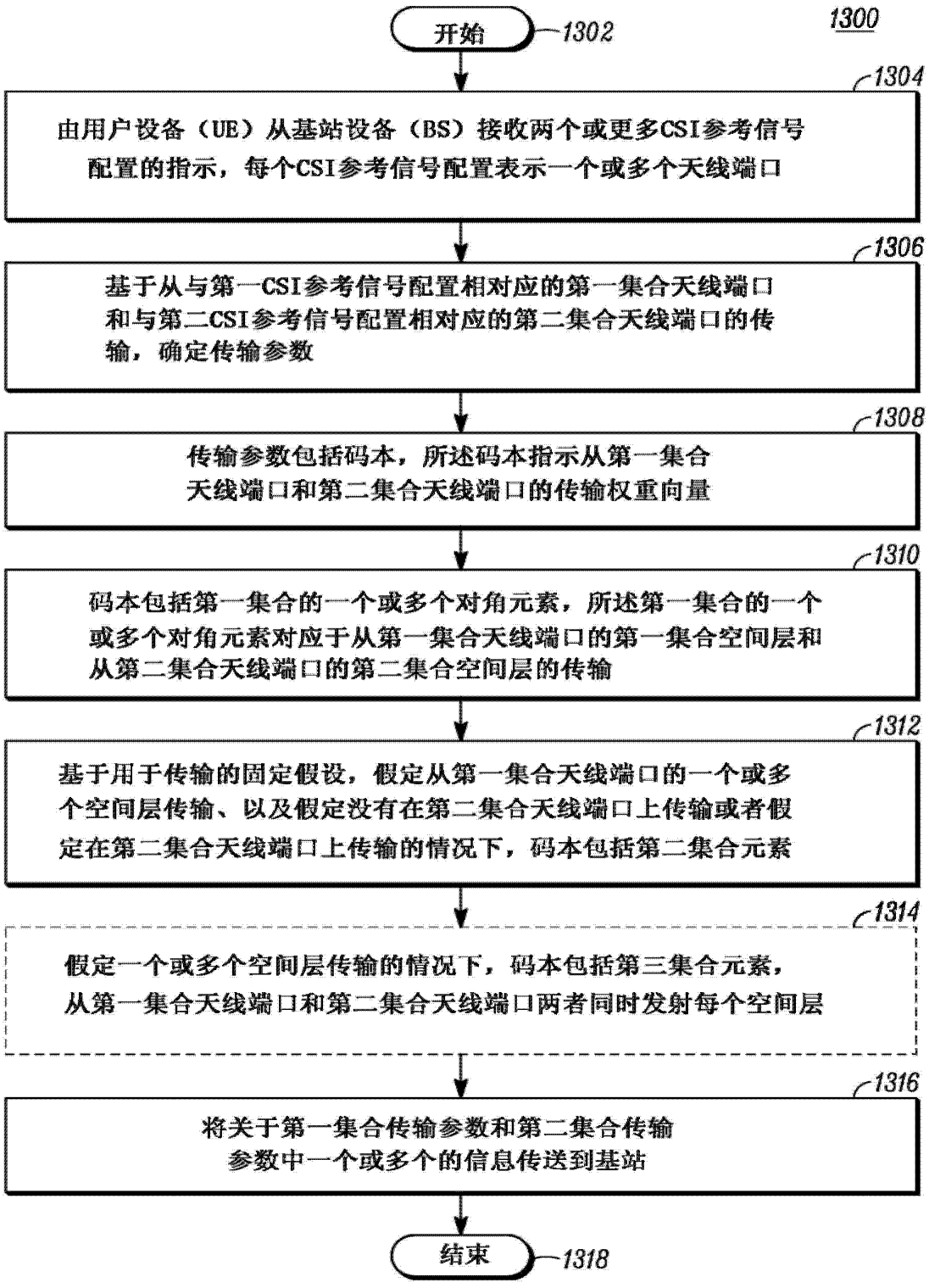

1300
开始
1302
1304
由用户设备（UE）从基站设备（BS）接收两个或更多CSI参考信号配置的指示，每个CSI参考信号配置表示一个或多个天线端口
1306
基于从与第一CSI参考信号配置相对应的第一集合天线端口和与第二CSI参考信号配置相对应的第二集合天线端口的传输，确定传输参数
1308
传输参数包括码本，所述码本指示从第一集合天线端口和第二集合天线端口的传输权重向量
1310
码本包括第一集合的一个或多个对角元素，所述第一集合的一个或多个对角元素对应于从第一集合天线端口的第一集合空间层和从第二集合天线端口的第二集合空间层的传输
1312
基于用于传输的固定假设，假定从第一集合天线端口的一个或多个空间层传输、以及假定没有在第二集合天线端口上传输或者假定在第二集合天线端口上传输的情况下，码本包括第二集合元素
1314
假定一个或多个空间层传输的情况下，码本包括第三集合元素，从第一集合天线端口和第二集合天线端口两者同时发射每个空间层
1316
将关于第一集合传输参数和第二集合传输参数中一个或多个的信息传送到基站
结束
1318

图 13

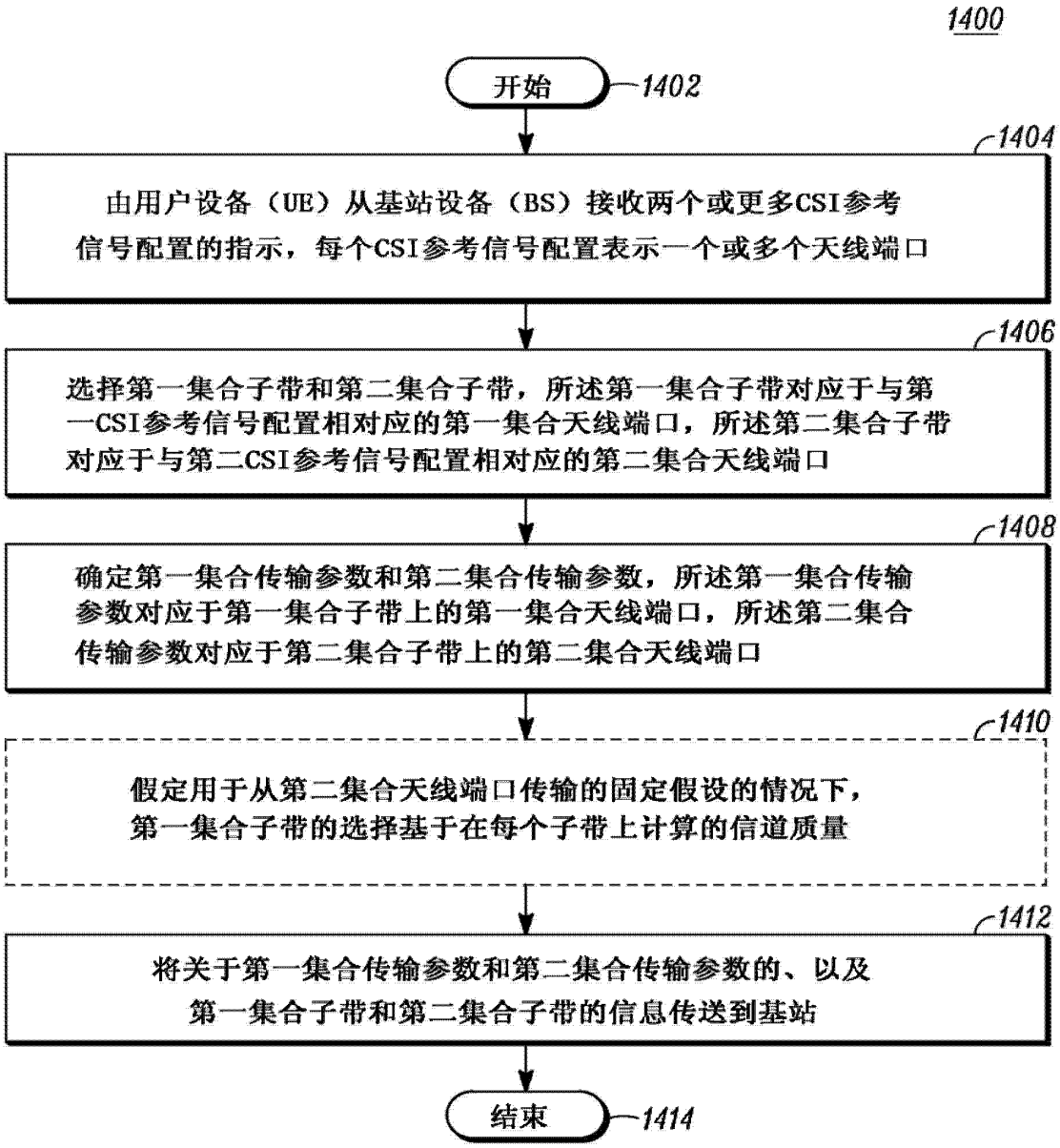

1400
开始
1402
1404
由用户设备（UE）从基站设备（BS）接收两个或更多CSI参考信号配置的指示，每个CSI参考信号配置表示一个或多个天线端口
1406
选择第一集合子带和第二集合子带，所述第一集合子带对应于与第一CSI参考信号配置相对应的第一集合天线端口，所述第二集合子带对应于与第二CSI参考信号配置相对应的第二集合天线端口
1408
确定第一集合传输参数和第二集合传输参数，所述第一集合传输参数对应于第一集合子带上的第一集合天线端口，所述第二集合传输参数对应于第二集合子带上的第二集合天线端口
1410
假定用于从第二集合天线端口传输的固定假设的情况下，第一集合子带的选择基于在每个子带上计算的信道质量
1412
将关于第一集合传输参数和第二集合传输参数的、以及第一集合子带和第二集合子带的信息传送到基站
结束
1414

图 14

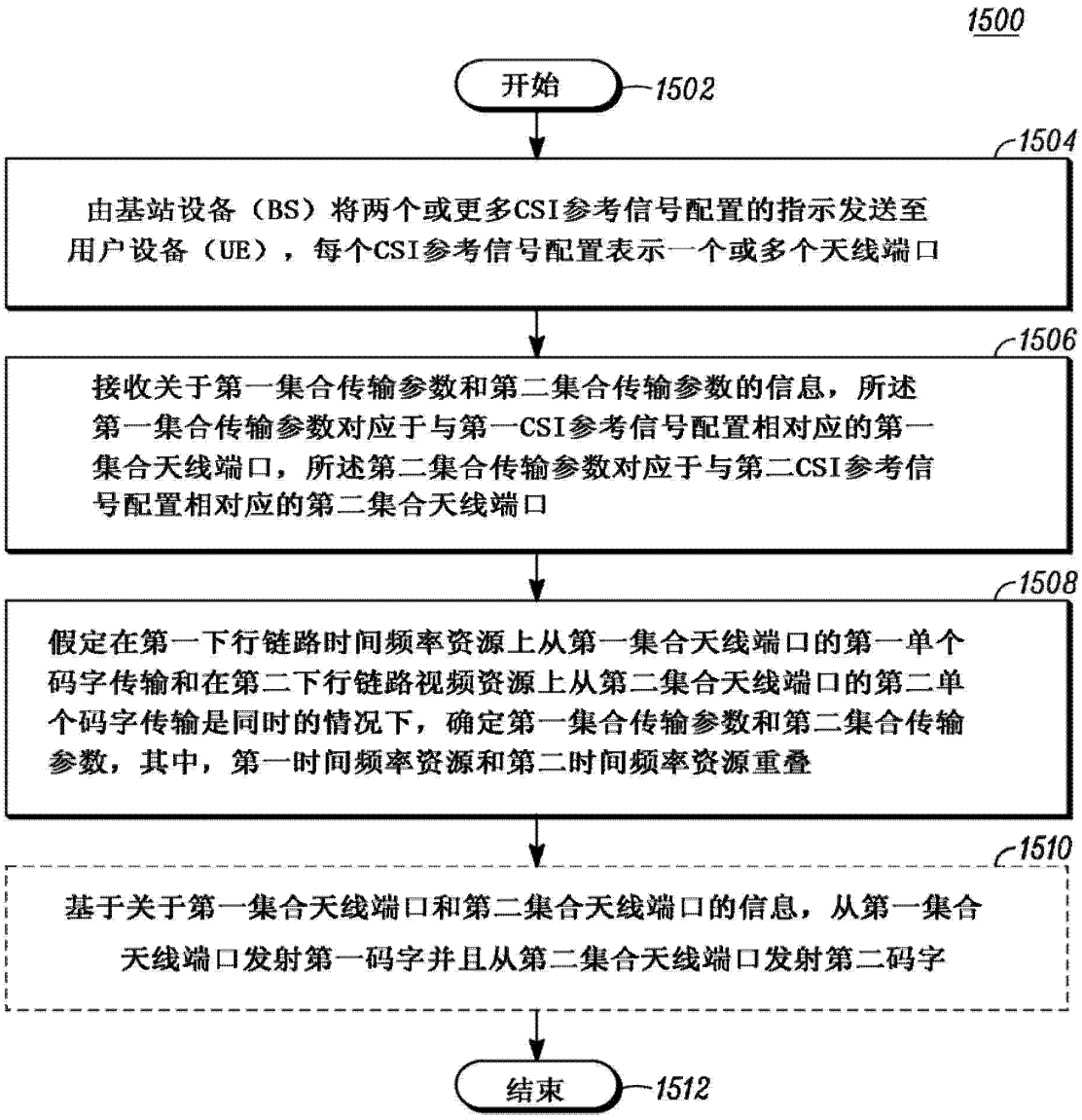

1500
开始
1502
1504
由基站设备（BS）将两个或更多CSI参考信号配置的指示发送至用户设备（UE），每个CSI参考信号配置表示一个或多个天线端口
1506
接收关于第一集合传输参数和第二集合传输参数的信息，所述第一集合传输参数对应于与第一CSI参考信号配置相对应的第一集合天线端口，所述第二集合传输参数对应于与第二CSI参考信号配置相对应的第二集合天线端口
1508
假定在第一下行链路时间频率资源上从第一集合天线端口的第一单个码字传输和在第二下行链路视频资源上从第二集合天线端口的第二单个码字传输是同时的情况下，确定第一集合传输参数和第二集合传输参数，其中，第一时间频率资源和第二时间频率资源重叠
1510
基于关于第一集合天线端口和第二集合天线端口的信息，从第一集合天线端口发射第一码字并且从第二集合天线端口发射第二码字
结束
1512

图 15

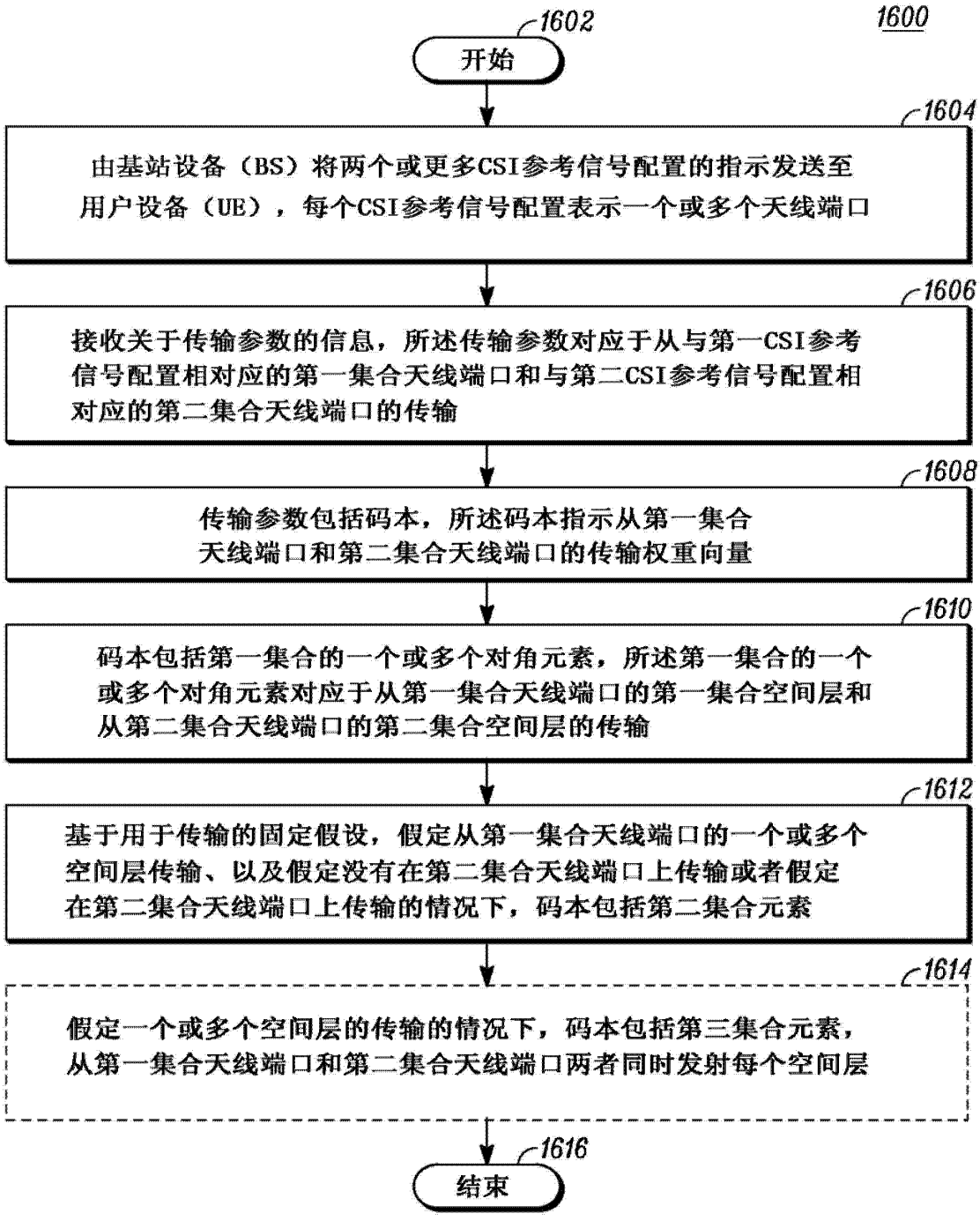

1600
1602
开始
1604
由基站设备（BS）将两个或更多CSI参考信号配置的指示发送至用户设备（UE），每个CSI参考信号配置表示一个或多个天线端口
1606
接收关于传输参数的信息，所述传输参数对应于从与第一CSI参考信号配置相对应的第一集合天线端口和与第二CSI参考信号配置相对应的第二集合天线端口的传输
1608
传输参数包括码本，所述码本指示从第一集合天线端口和第二集合天线端口的传输权重向量
1610
码本包括第一集合的一个或多个对角元素，所述第一集合的一个或多个对角元素对应于从第一集合天线端口的第一集合空间层和从第二集合天线端口的第二集合空间层的传输
1612
基于用于传输的固定假设，假定从第一集合天线端口的一个或多个空间层传输、以及假定没有在第二集合天线端口上传输或者假定在第二集合天线端口上传输的情况下，码本包括第二集合元素
1614
假定一个或多个空间层的传输的情况下，码本包括第三集合元素，从第一集合天线端口和第二集合天线端口两者同时发射每个空间层
1616
结束

图 16

Espacenet

Bibliographic data: CN104170272 (A) — 2014-11-26

Gain normalization correction of PMI and CQI feedback for base station with antenna array

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Applicant(s): MOTOROLA MOBILITY LLC ± (MOTOROLA MOBILITY LLC, ; 谷歌技术控股有限责任公司)

Classification: - international: ***H04B7/06; H04L25/02***
- cooperative: H04B7/0632; H04B7/0634; H04B7/0639; H04L25/0204; H04L25/0228

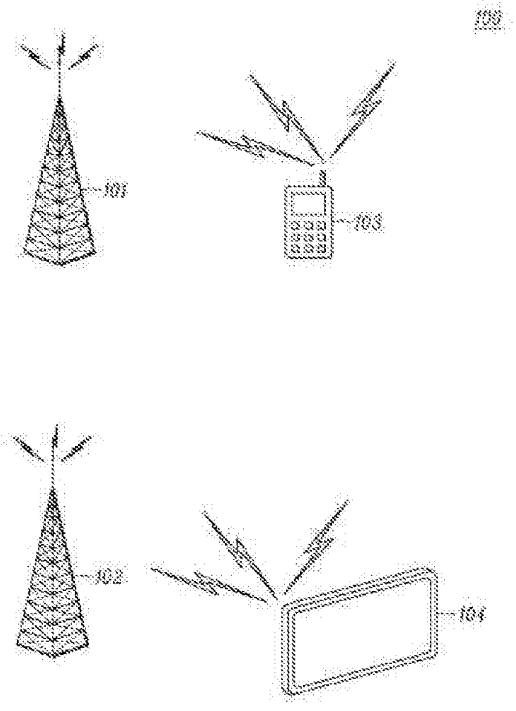
Application number: CN20138008440 20130122 Global Dossier

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Abstract of CN104170272 (A)

A wireless communication device and a method therein includes estimating a channel for each of a plurality of transmit antenna ports using a reference symbol received from the corresponding antenna port, determining a composite channel estimate based on the estimated channels and based on a precoding matrix, and determining an updated composite channel estimate using the composite channel estimate and using a gain correction corresponding to the precoding matrix. The gain correction can be obtained over-the-air or computed at the wireless communication device.



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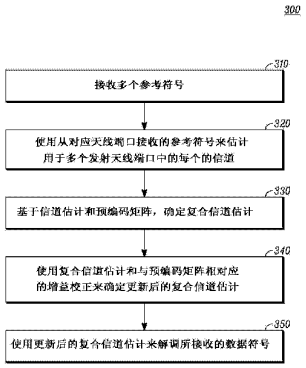
权利要求书2页 说明书10页 附图4页
按照条约第19条修改的权利要求书2页

(54)发明名称

用于具有天线阵列的基站的PMI和CQI反馈的增益归一化校正

(57)摘要

一种无线通信设备和方法在此包括：使用从对应天线端口接收的参考符号来估计用于多个发射天线端口中的每个的信道；基于所估计的信道并且基于预编码矩阵来确定复合信道估计；以及使用复合信道估计并且使用与预编码矩阵相对应的增益校正来确定更新后的复合信道估计。增益校正可以用无线电获取或者在无线通信设备处被计算。



CN 104170272 A

1. 一种无线通信设备，包括：

收发器；

处理器，所述处理器被耦合至所述收发器，

所述处理器被配置成使用从对应的天线端口接收的参考符号来估计用于多个发射天线端口中的每个的信道，

所述处理器被配置成基于所估计的信道并且基于预编码矩阵来确定复合信道估计，

所述处理器被配置成使用所述复合信道估计并且使用与所述预编码矩阵相对应的增益校正来确定更新后的复合信道估计。

2. 根据权利要求 1 所述的设备，所述处理器被配置成使用所述更新后的复合信道估计来解调使用所述预编码矩阵发射并且在所述无线通信设备处接收的数据符号。

3. 根据权利要求 2 所述的设备，其中，所述数据符号在每个发射天线端口处通过从所述预编码矩阵获得的对应的预编码权重被加权。

4. 根据权利要求 1 所述的设备，

所述处理器被配置成对于所述无线通信设备的码本中的对应的多个预编码矩阵确定多个复合信道估计，

所述处理器被配置成使用所述对应的复合信道估计并且使用对应的增益校正来对于所述多个复合信道估计中的每个确定更新后的复合信道估计，

所述处理器被配置成从所述码本选择预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性，

所述无线通信设备被配置成发射与所选择的预编码矩阵相关联的预编码矩阵指示符。

5. 根据权利要求 1 所述的设备，

所述处理器被配置成选择预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性，

所述处理器被配置成基于与所选择的预编码矩阵相对应的所述更新后的复合信道估计来确定信道质量度量，以及

所述无线通信设备被配置成在上行链路信道上发射所述信道质量度量。

6. 根据权利要求 5 所述的设备，其中，所述信道质量度量是传输块尺寸或秩指示。

7. 根据权利要求 1 或 4 所述的设备，所述处理器被配置成确定所述增益校正。

8. 根据权利要求 7 所述的设备，其中，所述增益校正基于在所述无线通信设备处接收的符号的幅度与所述复合信道估计的幅度之比，其中，使用所述预编码矩阵来发射在所述无线通信设备处接收的符号。

9. 一种无线通信设备中的方法，所述方法包括：

在所述无线通信设备处接收多个参考符号；

使用从对应的天线端口接收的参考符号来估计用于多个发射天线端口中的每个的信道；

基于所估计的信道并且基于预编码矩阵来确定复合信道估计；

使用所述复合信道估计和与所述预编码矩阵相对应的增益校正来确定更新后的复合信道估计。

10. 根据权利要求 9 所述的方法，进一步包括：

从所述多个发射天线端口接收使用所述预编码矩阵发射的数据符号，其中所述数据符号在每个发射天线端口处通过从所述预编码矩阵获得的对应的预编码权重被加权，以及使用所述更新后的复合信道估计来解调所述数据符号。

11. 根据权利要求 9 所述的方法，进一步包括：

对于码本中的对应的多个预编码矩阵确定多个复合信道估计；

使用对应的复合信道估计和对应的增益校正对于所述多个复合信道估计中的每个确定更新后的复合信道估计；

从所述码本中选择预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性，

在上行链路信道上发射与所选择的预编码矩阵相关联的预编码矩阵指示符。

12. 根据权利要求 9 所述的方法，进一步包括：

选择预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性，

基于与所选择的预编码矩阵相对应的更新后的复合信道估计来确定信道质量度量，以及

在上行链路信道上基于所述信道质量度量发射。

13. 根据权利要求 9 所述的方法，进一步包括：在从包括以下的组中选择的消息中接收所述增益校正：主信息块 (MIB)；系统信息块 (SIB)；以及单播传输。

14. 根据权利要求 9 所述的方法，进一步包括：接收可以从其计算所述增益校正的矩阵信息，在从包括以下的组中选择的消息中接收所述矩阵信息：主信息块 (MIB)；系统信息块 (SIB)；以及单播传输。

15. 根据权利要求 9 所述的方法，进一步包括：在所述无线通信设备处将所述增益校正确定为在所述无线通信设备处接收的符号的幅度与所述复合信道估计的幅度之比，其中，使用所述预编码矩阵发射在所述无线通信设备处接收的符号。

16. 根据权利要求 15 所述的方法，进一步包括：从所述无线通信设备发射所述增益校正。

17. 根据权利要求 10 所述的方法，其中，用于预编码矩阵的所述增益校正基于从无线终端接收的测量。

18. 根据权利要求 10 所述的方法，其中，用于预编码矩阵的所述增益校正基于校准过程。

19. 根据权利要求 10 所述的方法，其中，从所述多个天线端口发射的符号具有所述无线通信终端已知的幅度。

20. 根据权利要求 10 所述的方法，其中，从所述多个天线端口发射的符号是被用于解调数据符号的解调参考符号 (DMRS)。

用于具有天线阵列的基站的 PMI 和 CQI 反馈的增益归一化校正

技术领域

[0001] 本公开总体涉及无线通信，并且更特别地涉及估计、用信号通知、以及使用阵列天线图案增益归一化校正因子、以及对应方法。

背景技术

[0002] 在第三代合作伙伴计划 (3GPP) 无线通信协议和在别处定义的预编码矩阵通常被认为产生具有相等能量的一组天线图案。然而，规范中的矛盾在于，如果预编码矩阵以所得到的天线图案的能量相等的方式被应用，则被用于解调、预编码矩阵选择、以及信道质量估计的基于预编码矩阵的信道估计将具有指标误差。而且，指标误差将是预编码矩阵的函数。相反地，如果预编码矩阵以基于预编码矩阵的信道估计正确的方式被应用，则所得到的天线图案将不具有相等能量，并且经由来自 UE 的反馈的预编码矩阵选择将不是最佳的。在 3GPP 规范中的预编码矩阵的选择中，假设天线图案的能量等于预编码矩阵的能量。然而，在没有天线图案的归一化的情况下，可以示出对于一些预编码矩阵，所得到的天线图案的能量明显大于预编码矩阵的能量。相反地，对于其他预编码矩阵，所得到的天线图案的能量小于预编码矩阵的能量。在没有用于天线阵列内的能量增益或损耗（例如，欧姆加热、阻抗失配）的模型的情况下，阵列图案应该被归一化，使得天线图案的能量等于用于码本中的所有预编码矩阵的预编码矩阵的能量。

[0003] 在 3GPP 中，用于估计用于数据的信道增益的当前方法假设天线图案的重定比例不必须保持单位能量用于所有预编码矩阵指示符。如果对于所有预编码矩阵，通过相等能量发射数据符号，并且如果在 UE 处不执行基于 PMI 的重新归一化，则基于预编码矩阵指示符 / 小区特定参考符号 (PMI-CRS) 的信道估计将存在误差。为了计算最佳 PMI- 信道质量指示符 (CQI) 对，UE 必须能够计算从给定 PMI 的应用得到的复合信道。通过当前模型，用户不重新归一化用于每个 PMI 的图案增益，并且从而被用于确定 CQI 的对应信道增益估计将有错误。结果，错误的 PMI-CQI 对可能被发送至 UE。而且，即使选择正确的 PMI，对应 CQI 也可能存在误差。上述问题可以被预期为当 eNB 天线阵列密集间隔（例如，半波长间隔阵列）时最显著。利用分集间隔阵列的归一化问题不太显著，但是可能仍然存在问题。

[0004] 当通过以下描述的附图，认真考虑以下具体实施方式时，本发明的多个方面、特征和优点对于本领域普通技术人员来说将变得更充分明显。附图为了清楚起见可以被简化，并且不一定按比例绘制。

附图说明

[0005] 图 1 图示了无线通信系统。

[0006] 图 2 图示了无线通信设备的示意性框图。

[0007] 图 3 是用于在无线通信设备上实现的处理的流程图。

[0008] 图 4 是用于单位范数加权矢量的发射功率比天线分离的图表。

具体实施方式

[0009] 在图 1 中，无线通信系统 100 包括形成跨过地理区域分布的网络的一个或多个固定基础结构单元 101、102，以用于在时域、频域、码域或空间域或其组合中服务远程单元。基础单元还可以被称为接入点、接入终端、基础 (base)、基站、节点 B、增强节点 B(eNodeB)、主节点 (HeNB)、宏增强节点 B(MeNB)、施主增强节点 B(DeNB)、中继节点 (RN)、毫微微小区、毫微微节点、微微小区、网络节点或者在本领域中使用的或者如以下进一步定义的其他术语。一个或多个基础单元每个都包括用于下行链路传输的一个或多个发射器和用于上行链路传输的一个或多个接收器。基础单元通常是包括可通信地耦合至一个或多个对应基础单元的一个或多个控制器的无线电接入网的一部分。接入网通常可通信地耦合至一个或多个核心网，核心网可以耦合至像互联网和公共交换电话网的其他网络等等。接入网和核心网的这些和其他元件不被图示，但是通常由本领域普通技术人员知晓。

[0010] 在图 1 中，一个或多个基础单元经由无线通信链路，服务例如小区或蜂窝扇区的对应服务区域内的多个远程单元 103、104。远程单元可以是固定的或者移动的。远程单元还可以被称为订户单元、移动设备、移动台、移动单元、用户、终端、订户站、用户设备 (UE)、用户终端、无线通信设备、中继节点、或本领域中使用的其他术语。远程单元还包括一个或多个发射器和一个或多个接收器。在图 1 中，基础单元 101 发射下行链路通信信号，以在时域、频域和 / 或空间域中服务远程单元 103。远程单元 104 经由上行链路通信信号与基础单元 102 通信。有时，基础单元被称为用于远程单元的服务或连接或锚小区。远程单元还可以经由中继节点与基础单元通信。

[0011] 在一种实现中，无线通信系统与 3GPP 通用移动通信系统 (UMTS)LTE 协议兼容，其还被称为 EUTRA，便于在下行链路上使用多输入单输出 (MISO) 或多输入多输出 (MIMO) 天线系统以增加容量。在 EUTRA 中，基础单元在下行链路上使用正交频分复用 (OFDM) 调制方案发射，并且用户终端在上行链路上使用单载波频分多址 (SC-FDMA) 方案发射。本公开特别关于 3GPP LTE 版本 8(Rel-8) 及其之后版本。本公开更通常可应用至在上行链路或下行链路上实现 MISO 或 MIMO 传输的其他现有或未来无线通信系统，诸如 IEEE802.11 和 IEEE802.16 系列规范。从而，本公开不旨在以任何特定无线通信系统架构或协议被实现。

[0012] 在 EUTRA 系统中，MIMO 天线系统在 eNB 处通过使用多个发射天线并且在 UE 处通过使用多个接收天线被采用。UE 可以依赖从 eNB 发送的导频或参考符号 (RS)，用于信道估计、随后数据调制、以及用于报告的链路质量测量。用于反馈的链路质量测量可以包括作为秩指示符 (RI) 的空间参数、或者在相同资源上发送的多个数据流、预编码矩阵索引 (PMI)、以及诸如调制编译方案 (MCS) 或信道质量指示符 (CQI) 的编译参数。与 MCS 或 CQI 一起，PMI 和 RI 构成信道状态信息 (CSI) 的元素，其传达指示可靠性的 MIMO 信道的质量和能够支持 eNB 和 UE 之间的多流通信的信道的条件数。例如，如果 UE 确定链路可以支持大于 1 的秩，则其可以报告多个 CQI 值 (例如，当秩 = 2 时，通过用信号通知对应 RI，报告两个 CQI 值)。而且，在所支持的反馈模式之一下，链路质量测量可以周期性地或非周期性地被报告，如由 eNB 指示的。报告可以包括参数的宽带或子带频率选择性信息。eNB 可以使用秩信息、CQI、以及诸如上行链路质量信息的其他参数，以在上行链路和下行链路信道上服务 UE。空间多路复用传输可以是基于 CRS(即，UE 利用 CRS 用于 CQI/PMI/RI 估计并且用于解调) 的或者

基于专用或解调参考符号 (DRS) 的 (即,UE 使用 CRS 或 CSI-RS 用于 CQI/PMI/RI 估计并且使用 DRS 用于解调)。

[0013] 在 EUTRA 系统中,上行链路 (UL) 数据信道可以是物理上行链路共享信道 (PUSCH),UL 控制信道可以是物理上行链路控制信道 (PUCCH),下行链路 (DL) 控制信道可以是物理下行链路控制信道 (PDCCH),并且 DL 数据信道可以是物理下行链路共享信道 (PDSCH)。UL 控制信息可以跨过 PUCCH 和 / 或 PUSCH 被传送,并且 DL 控制信息通常跨过 PDCCH 被传送。UE 可以进一步发射上行链路探测参考信号,以帮助 eNB 调度上行链路传输 (用于频分双工 (FDD)) 以及 UL 和 DL 传输中的一个或两者,用于时分双工 (TDD)。在 UL 上,UE 可以使用连续或非连续资源分配发射,并且 UE 还可以使用所谓的同时 PUCCH 和 PUSCH 传输方案,在 UL 上同时发射数据和控制。在频分双工 (FDD) 操作中,UL 和 DL 中的帧结构每个都包括 10 毫秒 (ms) 无线电帧,其进而被划分为 10 个子帧,每个子帧都具有 1ms 持续时间,其中,每个子帧都被划分为 0.5ms 的两个时隙,其中,每个时隙都包含多个 OFDM 符号。DL 和 UL 带宽被再分为资源块,其中,每个资源块 (RB) 由频域中的一个或多个子载波和时域中的一个或多个 OFDM 符号构成 (12 个子载波 x7 个 OFDM 符号,用于正常循环前缀 (CP))。在 LTE 中,基于时隙限定资源块。资源块 (RB) 是资源分配被指配用于上行链路和下行链路通信的典型单元。

[0014] 在 EUTRA 中,eNB 配置合适信道用于 UL 和 DL 控制信息交换。对于 DL,PDCCH 被用于将 UL 和 DL 控制信息发送至 UE。在潜在可变数目的 OFDM 符号上的子帧的开始部分中发送 PDCCH,并且该数目 (通常 0 至 3 用于诸如 5MHz 等的大系统带宽,并且 0 至 4 用于诸如 1.25MHz 的较小系统带宽) 在物理控制格式指示符信道 (PCFICH) 上被用信号通知,或者经由高层信令被发送。然而,在其他情况下,PDCCH 还可以位于特定固定或可变时间 / 频率 / 空间资源中,即,跨越一个或多个子帧和 / 或一个或多个空间层中的一个或多个子载波。例如,其可以占用资源块的子集,而不是跨越整个 DL 系统带宽。物理混合 ARQ 信道 (PHICH) 是确认指示符信道,该确认指示符信道用于在 DL 上发送 HARQ 反馈,用于从 UE 的 UL 数据传输。在 DL 子帧的开始,在 OFDM 符号上发送 PCFICH、PHICH、PDCCH。在诸如 ABS 的一些子帧中或者当 eNB 不调度 UE(即,非常低或没有负载情况) 时,这些信道可能不存在。

[0015] 图 2 图示了包括可通信地耦合至控制器 220 的收发器 210 的无线通信终端或设备 200。该设备实现如上所述的无线通信协议,并且可能能够进行电路或分组交换通信或两者。UE 还可以包括用户接口 230,用于执行通常与无线通信终端相关联的其他功能,包括但不限于键盘或其他输入设备、显示器、音频输入和输出等的其他用户接口设备。这样的终端的这些和其他元件对于本领域普通技术人员是公知的,并且在此不进一步描述。在一个实施例中,控制器被实现为执行存储在一个或多个存储设备 240 中的指令以执行在此描述的功能的数字处理器。可替换地,控制器可以被实现为等效硬件电路或硬件和软件实现电路的组合。

[0016] 在图 3 的处理过程 300 中,在 310 处,无线通信设备接收多个参考符号。无线通信设备可以是基础单元或远程单元。在 3GPP UMTSLTE 用语中,无线通信设备是 eNB 或 UE。在图 2 中,无线通信设备的收发器 210 在处理器 220 的控制下,接收包括参考符号的信号。

[0017] 在图 3 中,在 320 处,无线通信设备使用从对应天线端口接收的参考符号,估计用于发射设备的多个发射天线端口中的每个的信道。在图 2 中,处理器包括通过执行存储在存储器中的固件或软件指令实现的信道估计功能 212。可替换地,信道估计功能可以通过等

效硬件电路或通过硬件和软件的组合来实现。

[0018] 在图 3 中，在 330 处，无线通信设备基于使用参考符号估计的信道并且基于预编码矩阵，确定复合信道估计。在一个实施例中，无线通信设备确定用于从接收参考符号的设备的多个发射天线端口发射的符号的复合信道估计，其中，数据符号在每个发射天线端口处通过从预编码矩阵获得的对应预编码权重被加权。可替换地，复合信道估计不需要被确定用于所发射的数据符号。在图 2 中，无线通信设备的处理器包括通过执行存储在存储器中的固件或软件指令实现的复合信道估计功能 214。可替换地，复合信道估计功能可以通过等效硬件电路或通过硬件和软件的组合被实现。

[0019] 在图 3 中，在 340 处，无线通信设备使用复合信道估计和与预编码矩阵相对应的增益校正，确定更新后的复合信道估计。在图 2 中，处理器包括通过执行存储在存储器中的固件或软件指令实现的更新后的复合信道估计功能 216。可替换地，更新后的复合信道估计功能可以通过等效硬件电路或通过硬件和软件的组合被实现。

[0020] 在一个实施例中，无线通信设备从自另一个无线通信设备接收的消息获得增益校正。在一个实施例中，例如，基础单元或 EUTRA eNB 在下行链路 (DL) 消息中用信号通知用于至少一个预编码矩阵的增益校正。在 3GPP 中，该消息可以是主信息块 (MIB)、或系统信息块 (SIB)、或单播传输。在其他协议实现中，增益校正可以在某个其他消息中被用信号通知至无线通信设备。

[0021] 在另一个实施例中，无线通信设备计算增益校正。例如，无线通信设备基于从在从另一个实体接收的消息中包括的矩阵信息获得或计算的信息，计算增益校正。在 3GPP LTE 中，传达矩阵的消息可以是主信息块 (MIB)、或系统信息块 (SIB) 或单播传输。在其他协议实现中，增益校正可以在某个其他消息中被用信号通知至无线通信设备。在另一个实施例中，无线通信设备基于在无线通信设备处接收的符号的幅度与复合信道估计的幅度之比，计算增益校正，其中，在无线通信设备处接收的符号使用预编码矩阵被发射。在图 2 中，处理器包括通过执行存储在存储器中的固件或软件指令实现的增益校正计算功能 217。可替换地，更新后的复合信道估计功能可以通过等效硬件电路或通过硬件和软件的组合被实现。以下进一步描述增益校正的计算。

[0022] 在图 3 中，在 350 处，无线通信设备使用更新后的复合信道估计，解调数据符号。从多个发射天线端口接收数据符号，其中，所接收的数据符号在每个发射天线端口处通过从预编码矩阵获得的对应预编码权重被加权。在图 2 中，无线通信设备的处理器包括通过执行存储在存储器中的软件或固件指令被实现的解调功能 218。可替换地，解调功能可以通过等效硬件电路或通过硬件和软件的组合被实现。

[0023] 在另一个实施例中，无线通信设备将与所选择的预编码矩阵相关联的预编码矩阵指示符 (PMI) 发射至接收实体。根据该实施例，无线通信设备首先确定多个复合信道估计，用于存储在设备上的码本中的对应多个预编码矩阵，其中，多个复合信道估计中的每个都基于对应预编码矩阵。使用对应复合信道估计并且使用对应增益校正，确定用于多个复合信道估计中的每个的更新后的复合信道估计。此后，无线通信设备从码本中选择预编码矩阵用于未来传输，其中，所述选择基于更新后的复合信道估计的属性。在图 2 中，无线通信设备的处理器包括通过执行存储在存储器中的软件或固件指令实现的预编码矩阵选择功能 219。可替换地，解调功能可以通过等效硬件电路或通过硬件和软件的组合被实现。然

后，无线通信设备将与所选择的预编码矩阵相关联的 PMI 发射至接收实体。

[0024] 在另一个实施例中，无线通信设备选择预编码矩阵用于未来传输，其中，所述选择基于更新后的复合信道估计的属性。此后，无线通信设备基于与所选择的预编码矩阵相对应的更新后的复合信道估计，确定信道质量指示或度量 (CQI)。信道质量指示可以是传输块尺寸、秩指示或指示信道质量的某个其他度量。根据该实施例，无线通信设备在上行链路信道上发射信道质量度量。

[0025] 增益校正可以被表征为用于使用特定 PMI 发射的数据符号的（实际）复合信道的幅度与从将相同 PMI 应用至每天线端口信道估计得到的复合信道估计的幅度之比。如果相对于 CRS 参考符号的幅度被知晓的参考符号通过与特定 PMI 矩阵相对应的加权被发射，则 UE 可以将增益校正估计为所接收的参考符号的幅度与对应于相同 PMI 矩阵的复合信道的幅度之比。如果知晓在等式 (13) 中定义的矩阵 Q，则可以在 eNB 处计算用于每个 PMI 的增益校正。类似地，如果 UE 知晓等式 (13) 中的矩阵 Q，则可以在 UE 处计算用于每个 PMI 的增益校正。增益校正可以通过以下等式 (14) 被定量表达。

[0026] 以下进一步描述用于将更准确天线阵列归一化信息提供给无线通信设备的替代方法。在论述中，在将增益校正提供给 UE 的例如 EUTRAeNB 的基础单元处执行归一化。然而，更通常地，可以在 UE 或具有 MIMO 天线阵列的任何无线通信设备处执行归一化。在第一实施例中，发射天线阵列通过等于阵列的维度的尺寸的复合矩阵 Q 被表征。当该矩阵是厄米的时，足以给 UE 提供仅复矩阵的上部对角线或下部对角线值。该矩阵被用于执行计算用于每个 PMI 的复合信道增益所必需的图案归一化。在第二实施例中，UE 被直接提供有用于每个 PMI 矢量的实值增益。复合 Q 矩阵仅是发射器天线阵列的函数，并且从而复合 Q 矩阵对于由该阵列服务的所有 UE 是公共的。结果，信息可以跨过公共信道被发送，诸如 MIB 或 SIB。可替换地，该信息可以跨过专用信道被发送。类似地，PMI 缩放或校正值仅是 PMI 矩阵而不是由阵列服务的 UE 的函数。结果，PMI 校正值可以跨过公共信道被发送，诸如 MIB 或 SIB。可替换地，该信息可以跨过专用信道被发送。

[0027] 如果天线阵列被校准，则 Q 矩阵和 PMI 增益校正值将是时间不变的。结果，这些值可以仅被计算一次。相反地，如果天线阵列不被校准，使得天线馈电的相对相位随着时间改变，则 Q 矩阵计算和 PMI 校正值必须被周期性地重新计算和 / 或重新测量。Q 矩阵的计算很可能使用天线室作出，同时其可以用于 UE 以决策导向方式直接估计 PMI 增益校正值。

[0028] 如果 UE 可以准确地估计 PMI 校正值，则 eNB 可能不必须将这些值发送至 UE。然而，假定一些 UE 可能具有很差的信噪比 (SNR) 和 / 或可能不通过足够频率观测所有 PMI 值，则 UE 最好将用于每个 PMI 的增益校正的测量发送至 eNB，其中，eNB 可以组合这些估计，并且将改进的估计经由 MIB 或 SIB 发送至所有 UE。从而，在一些实施例中，基础单元或其他实体基于从一个或多个其他无线通信设备接收的测量，确定用于预编码矩阵的增益校正。

[0029] 如果阵列不被校准，则馈电的相对相位必须不随着时间太快地改变，或者在值变为过期并且废弃之前，eNB 将不可能收集、组合并且发射 PMI 校正值。如果相对相位非常快地改变，则即使 UE 可以估计校正值，当 UE 可以应用这些校正值时，在一个时隙中估计的校正值也可能是废弃的。注意，PMI 校正值不能在单个时隙内由单个 UE 计算，这是因为仅使用单个 PMI。

[0030] 在一个实施例中，基础单元基于校准过程（例如，发射器天线阵列子系统内的天

线范围测量或活动校准处理），确定用于预编码矩阵的增益校正。

[0031] 以下描述用于 2- 元件阵列的发射功率的计算。考虑 2- 元件阵列，其中，两个阵列元件中的每个都是全向天线。对于该实例，假设全向天线仅在平面中辐射，使得

[0032] $$p(\phi,\theta)=\begin{cases}\frac{1}{2\pi} & \phi=0,\ 0\le\theta<2\pi\\ 0 & \phi\neq 0\end{cases} \qquad (1)$$

[0033] 其中，p（φ，θ）表示元件图案，并且 φ（-π/2 ≤ φ ≤ π/2）和 θ（0 ≤ θ ≤ 2π）分别表示天线仰角和方位角。注意，全向元件被缩放，使得其在平面中辐射单位功率。

[0034] 使 w_0 和 w_1 表示分别应用至第一和第二天线元件的加权系数，并且使 d • λ 表示两个元件的间隔，其中，λ 表示信号波长。作为方位的函数的所得到的远场阵列图案由以下给出

[0035] $$a_w(\theta)=\frac{1}{\sqrt{2\pi}}\left(w_0+w_1 e^{-\frac{j2\pi}{\lambda}(d\lambda)\sin\theta}\right)$$
$$=\frac{1}{\sqrt{2\pi}}\left(w_0+w_1 e^{-j2\pi d\sin\theta}\right) \qquad (2)$$

[0036] 在 3GPP 模型中，假设等式（2）中的从阵列辐射的功率对于所有加权矢量 w 都相等，对于其，L_2 范数的平方 $\|w\|^2=|w_1|^2+|w_2|^2$ 被保持恒定（或相等，只要 L_2 范数被保持恒定）。然而，该假设可以通过简单反例被示出为假。特别是，对于该简单二元件实例，将示出我们可以选择任何数目对的加权矢量 w 和 v，使得 $\|w\|^2=\|v\|^2$，然而所得到的天线图案不辐射相等功率。

[0037] 从天线辐射的功率等于远场天线图案的幅度的平方的积分，使得辐射功率由以下给出

[0038] $$\int_0^{2\pi}\|a_w(\theta)\|^2 d\theta \ , \qquad (3)$$

[0039] 其中，在该实例中，当元件图案 p（φ，θ）被限定为使得其仅在平面中辐射时，仅必须对方位角 θ 积分。更通常地，还必须对仰角 φ 积分。除了要求 $\|w\|^2=1$ 之外，实例可以被进一步简化，我们进一步要求复合权重 w_0 和 w_1 具有相等幅度，使得 $|w_0|=|w_1|=1/\sqrt{2}$。在不进一步损失一般性的情况下，我们获得

[0040] $$w_0=1/\sqrt{2}$$
$$w_1=e^{j\psi}/\sqrt{2} \qquad (4)$$

[0041] 使得 $\|w\|^2=1$，而不管相位差 ψ 如何。通过这些复合权重，天线图案由以下给出

[0042] $$a_w(\theta)=\frac{1}{2\sqrt{\pi}}\left(1+e^{-j(\psi+2\pi d\sin\theta)}\right) \qquad (5)$$

[0043] 并且所发射的功率由以下给出

[0044]
$$\int_0^{2\pi}\left|a_w(\theta)\right|^2 d\theta = \int_0^{2\pi}\frac{1}{4\pi}\left|1+e^{-j(\psi+2\pi d\sin\theta)}\right|^2 d\theta$$
$$= \frac{1}{4\pi}\int_0^{2\pi}(2+2\cos(\psi+2\pi d\sin\theta))d\theta$$
$$= 1+\frac{1}{4\pi}\int_0^{2\pi}2(\cos(\psi)\cos(2\pi d\sin\theta)-\sin(\psi)\sin(2\pi d\sin\theta))d\theta$$
$$= 1+\frac{1}{4\pi}\int_0^{2\pi}2\cos(\psi)\cos(2\pi d\sin\theta)d\theta \qquad (6)$$

[0045] 其中，项 $\sin(\psi)\sin(2\pi d\sin\theta)$ 在最后步骤中下降，就像其是 θ 的奇函数，并且从而跨过间隔 [0，2π) 积分到0。对于两个元件之间的相位差 ψ 的多个不同值，如在等式 (6) 中计算的辐射功率以 dB 为单位被给出为以波长为单位的天线分离 d 的函数。当天线分离到 0 时，辐射功率从最大 2(3dB) 改变至最小 0(- 无穷 dB)，而不管在所有情况下，$\|w\|^2 = 1$ 的事实如果。

[0046] 可以从该二元件实例作出两个其他观测。首先，通过一半波长的天线分离，辐射功率从 -1.58dB(ψ = 0) 改变至 1.15dB(ψ = π)。从而，即使当加权矢量的范数保持恒定 (如果跨过 ψ 的所有值估计，则可能稍微更多)，功率可以改变 2.73dB 作为天线相位差的函数。第二，当天线分离增加时，作为相对相位 ψ 的函数的功率的改变减小。特别是，天线分离等于 9.5λ，辐射功率从最小值 -0.33dB(ψ = 0) 改变至最大值 0.31dB(ψ = π)，使得差值仅为 0.62dB(如果跨过 ψ 的所有值估计，可能稍微更多)。

[0047] 以下描述天线图案的归一化。如通常假设的，如果阵列的输入阻抗被匹配用于相位差 ψ 的所有值，则必须遵循从天线辐射的功率等于激励矢量的 L_2 范数的平方的平方。初看起来，该要求可能看起来矛盾，这是因为 $\|w\|^2$ 是恒定的，并且等式 (5) 中的用于天线图案的辐射功率也是相对相位 ψ 的函数。该表面矛盾的解决方案是，如果到阵列的阻抗匹配，使得辐射功率等于 $\|w\|^2$，则天线图案不由等式 (2) 给出，而是由归一化图案给出

[0048]
$$a_{w,n}(\theta) = \frac{\|w\|\frac{1}{\sqrt{2\pi}}\left(w_0+w_1e^{-j2\pi d\sin\theta}\right)}{\left(\int_0^{2\pi}\left|\frac{1}{\sqrt{2\pi}}\left(w_0+w_1e^{-j2\pi d\sin\phi}\right)\right|^2 d\phi\right)^{1/2}} \qquad (7)$$

[0049] 其中，下标 n 表示图案被归一化，以具有等于 $\|w\|^2$ 的辐射功率。对于等式 (7) 中的归一化天线图案，辐射功率由以下给出

[0050]
$$\int_0^{2\pi}\left|a_{\mathbf{w},n}(\theta)\right|^2 d\theta = \int_0^{2\pi}\left|\frac{\frac{1}{\sqrt{2\pi}}\left(w_0 + w_1 e^{-j2\pi d\sin\theta}\right)}{\left(\int_0^{2\pi}\left|\frac{1}{\sqrt{2\pi}}\left(w_0 + w_1 e^{-j2\pi d\sin\phi}\right)\right|^2 d\phi\right)^{1/2}}\right|^2 d\theta$$

$$= \frac{\|\mathbf{w}\|^2}{\left(\int_0^{2\pi}\left|\frac{1}{\sqrt{2\pi}}\left(w_0 + w_1 e^{-j2\pi d\sin\phi}\right)\right|^2 d\phi\right)} \int_0^{2\pi}\left|\frac{1}{\sqrt{2\pi}}\left(w_0 + w_1 e^{-j2\pi d\sin\theta}\right)\right|^2 d\theta$$

$$= \|\mathbf{w}\|^2 .$$

[0051] (8)。重申，如果到天线阵列的输入阻抗匹配，使得辐射功率等于 ‖w‖²，则所得到的天线阵列图案由等式 (7) 而不由等式 (2) 给出。在没有该归一化的情况下，明显的矛盾在于，到阵列的功率不等于从阵列出来的功率。

[0052] 以下描述基于 PMI 的信道估计的校正。对于多个 3GPP 发射模式，用于数据的信道估计通过将 PMI 应用至用于每个发射天线端口的信道估计来生成。然而，基于 PMI 的信道估计假定远场天线图案是用于各个端口的信道估计的基于 PMI 的线性组合。为了使该假定正确，天线图案必须如等式 (2) 那样给出。然而，等式 (2) 中的天线图案不被归一化，以具有等于 ‖w‖² 的能量。如果天线图案被归一化为 ‖w‖²（当然应该与规范兼容），基于 PMI 的信道估计将通过实值归一化标量（对于二元件阵列，该因子在以下等式 (9) 中给出）存在误差。为了适当地计算信道估计，UE 必须知晓用于每个 PMI 的正确归一化标量。特别是，对于等式 (2) 中的二元件实例，归一化标量通过以下给出

[0053]
$$\left(\int_0^{2\pi}\left|\frac{1}{\sqrt{2\pi}}\left(w_0 + w_1 e^{-j2\pi d\sin\phi}\right)\right|^2 d\phi\right)^{1/2} \qquad (9)$$

[0054] 对于预编码矢量 w 是以下的特定实例

[0055]
$$w_0 = 1/\sqrt{2}$$
$$w_1 = e^{j\psi}/\sqrt{2} \qquad (10)$$

[0056] 归一化标量由以下给出

[0057]
$$\left(\int_0^{2\pi}\left|\frac{1}{2\sqrt{\pi}}\left(1 + e^{-j(\psi+2\pi d\sin\theta)}\right)\right|^2\right)^{-1/2} \qquad (11)$$

[0058] 以下描述基于 PMI 的 CQI 估计的校正。为了估计信道质量 (CQI) 或信道状态 (CSI)，必须可以正确地估计通过应用每个 PMI 得到的信道。对于以上识别的原因，在不进行每 -PMI 增益归一化校正的情况下，用于每个 PMI 的复合信道估计将具有定标误差，并且这将导致 CQI 的计算的误差。如果 UE 访问基于每 PMI 的归一化校正，则 UE 可以正确地计算用于每个 PMI 的 CQI 和 / 或 CSI。通过正确增益归一化，UE 可以正确地确定最好 PMI 和

关联的 CSI/CQI。

[0059] 以下描述用于一般天线阵列的发射功率的计算。为了该分析的目的，考虑天线元件的数目是 K 的更一般情况。而且，不需要要求阵列元件具有相同图案，但是通常假设就是这样。使长度为 K 的复矢量 q(θ，Φ) 表示用于这些元件的天线图案，其中，如前，Φ(-π/2 ≤ Φ ≤ π/2) 和 θ (0 ≤ θ ≤ 2π) 分别表示天线仰角和方位角。

[0060] 发射功率由以下给出

$$\int_0^{\pi}\int_0^{2\pi}\left|\mathbf{w}^H\mathbf{q}(\theta,\phi)\right|^2\sin(\phi)d\theta\,d\phi=\int_0^{\pi}\int_0^{2\pi}\mathbf{w}^H\mathbf{q}(\theta,\phi)\mathbf{q}^H(\theta,\phi)\mathbf{w}\sin(\phi)d\theta\,d\phi$$

[0061]

$$=\mathbf{w}^H\left(\int_0^{\pi}\int_0^{2\pi}\mathbf{q}(\theta,\phi)\mathbf{q}^H(\theta,\phi)\sin(\phi)d\theta\,d\phi\right)\mathbf{w}$$

$$=\mathbf{w}^H\mathbf{Q}\mathbf{w} \qquad (12)$$

[0062] 其中，矩阵 Q 被限定为

[0063]

$$\mathbf{Q}=\int_0^{\pi}\int_0^{2\pi}\mathbf{q}(\theta,\phi)\mathbf{q}^H(\theta,\phi)\sin(\phi)d\theta\,d\phi \qquad (13)$$

[0064] 注意，Q 矩阵具有以下属性：Q 矩阵的维数是 K x K，其中，K 是发射器阵列中的天线元件的数目；并且从 Q 矩阵的定义，明显地，Q 矩阵是厄米的，使得 $Q^H = Q$。

[0065] 通常，每个 PMI 都是维数为 K x L 的矩阵，其中，K 是阵列中的天线（或天线端口）的数目，并且 L 是发射层的数目。我们假设 PMI 矩阵的每个矢量都必须满足相同单位能量约束。使 w 表示用于给定发射层的预编码矢量，或者等效地，使 w 表示 PMI 的任何列。然后，遵循该预编码矢量所需的校正因子由对应发射能量的逆的平方根给出，或者等效地，通过以下给出

[0066] $(w^HQw)^{-1/2}$ (14)

[0067] 其中，w 是通过天线元件图案和天线元件的间隔确定的预编码矩阵 Q。从而，存在与每个 PMI 的每列相关联的归一化校正因子。这些归一化因子必须从 eNB 被发送至 UE，或者它们必须由 UE 获悉。

[0068] 以下进一步描述增益归一化校正因子到 UE 的信令。用于每个 PMI 的增益归一化校正因子以多种形式被发射至 UE。以一种形式，eNB 可以将用于每个 PMI 的增益归一化校正因子发射至 UE。用于每个可能预编码矢量的增益归一化校正因子必须被测量和 / 或计算，并且被发射至 UE。注意，对于多层 PMI 矩阵，一个校正因子必须被发送用于每个层。在大多数情况下，不同 PMI 矩阵将具有一些公共预编码矢量。UE 足以测量和 / 或计算用于到 UE 的每个可能预编码矢量（跨过所有可能 PMI 的结合）的增益归一化。增益归一化校正因子仅取决于 PMI 而不是取决于 UE。从而，增益归一化校正因子可以跨过诸如 MIB 或 SIB 的公共信道被发送。可替换地，增益校正因子可以跨过专用信道被发送至 UE。

[0069] 在替代实施例中，Q 矩阵被发送至 UE。通过 Q 矩阵的知识，UE 可以计算增益归一化校正因子本身。如在先前部分中指示的，Q 矩阵是厄米的，所以仅必须将矩阵的上三角形值或下三角形值发射至 UE。如果发射天线阵列具有 K 个元件，则仅必须将 K 个实值和 K x(K-1)/2 个复值（相等地，总计 K^2 个实值）发射至 UE，以便 UE 能够计算增益校正值。取决于天线的数目和 PMI 矩阵的数目，在一些情况下，将更有效地发送用于每个 PMI 矩阵的增

益校正，同时在其他情况下，将更有效地发送 Q 矩阵的值。

[0070] 必须估计或测量增益归一化校正因子。在一些情况下，可以在天线室中测量用于天线阵列的 Q 矩阵。相反地，可以单独测量阵列的各个元件的图案 q（θ，Φ）。如果天线馈电之间的相位差被知晓或者可以被测量，则可以使用数值积分计算 Q 矩阵。

[0071] 另一个替代是 UE 以某种方式测量增益归一化校正因子。例如，UE 可以试图估计复合或合成导频（通过将 PMI 应用至被测量用于每个端口的复合信道增益）和所计算的幅度之间的幅度差。由于该差值仅是 PMI 而不是 UE 的函数，所以这些测量可以被反馈到 eNB。eNB 可以组合来自 UE 的估计，以形成更好估计，然后其可以经由 MIB 或 SIB 被发送出去。应该注意，UE 可以仅测量用于被用于发送数据的 PMI 的增益校正因子。从而，如果 PMI 度量的集合大，则在用户具有测量所有增益校正因子的机会之前需要一段时间。应该进一步注意，测量的质量将取决于用于 UE 的信号干扰噪声比 (SINR)。对于在覆盖范围的边缘处的 UE，估计的质量可能很差，并且从而 eNB 可以选择丢弃或者降低这样的测量的重要性。

[0072] 如果天线馈电的相对相位快速地改变，则增益校正因子的估计在它们可以被应用之前可能已荒废。特别是，当 PMI/CQI 反馈的计算要求增益归一化校正估计用于所有 PMI 时，用于 PMI/CQI 选择的增益校正因子在它们可以被使用之前可能已荒废，但是 UE 可以估计被用于当前子帧的 PMI 的增益归一化校正。

[0073] 虽然已经以确立拥有并且使本领域普通技术人员能够作出和使用其的方式描述了本公开及其最佳模式，但是将理解和想到，存在在此公开的示例性实施例的等价物，并且在不脱离本发明的范围和精神的情况下，可以对其作出修改和改变，其中，本发明的范围和精神不由示例性实施例而是由所附权利要求限制。

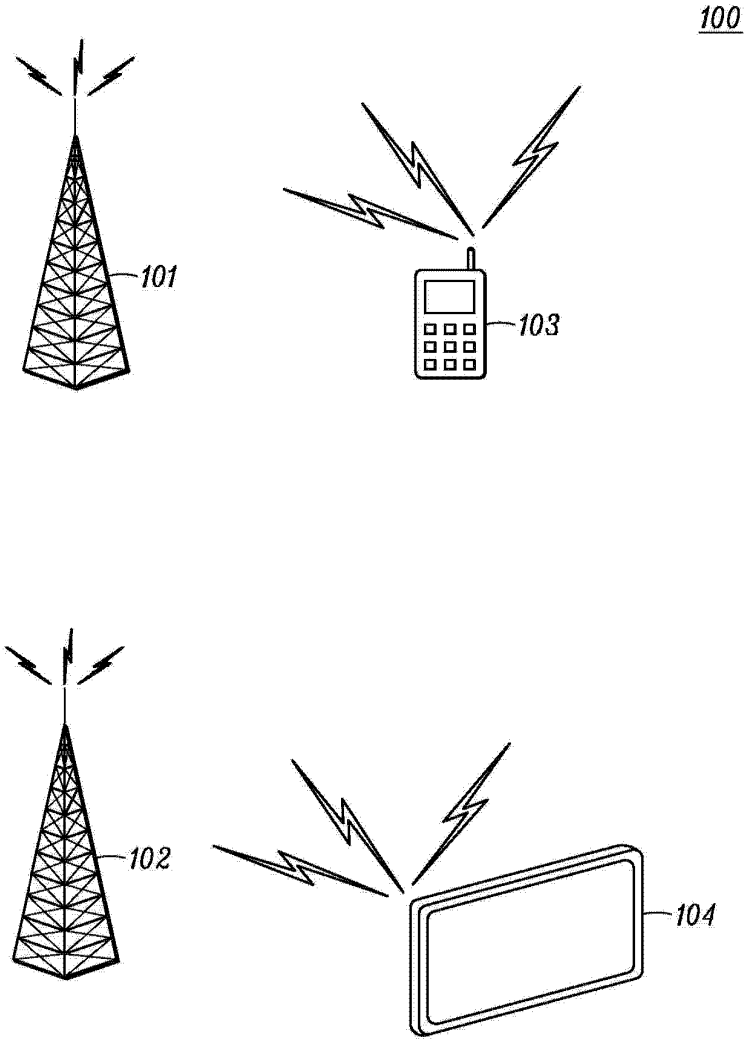


图 1

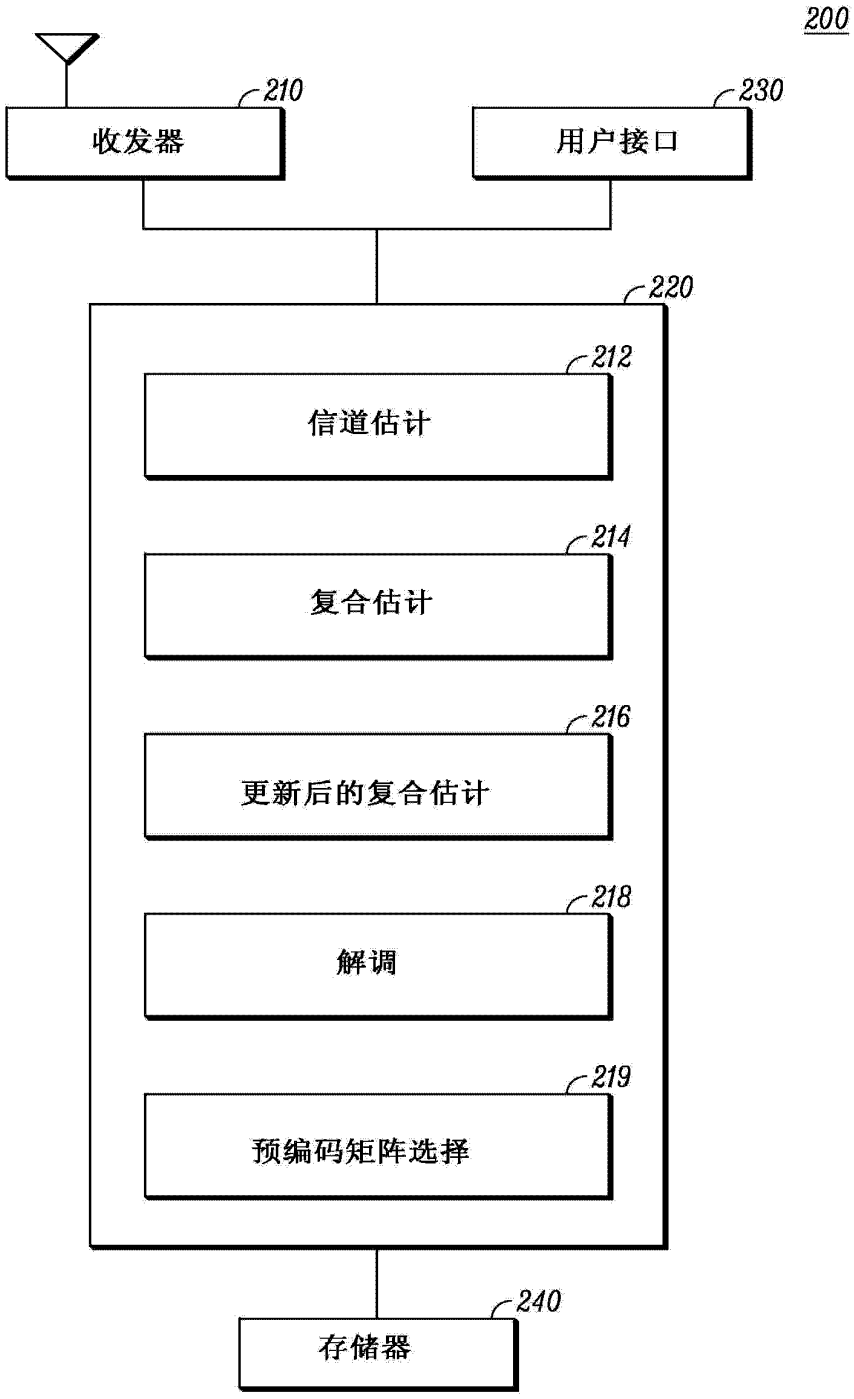

200
210
收发器
230
用户接口
220
212
信道估计
214
复合估计
216
更新后的复合估计
218
解调
219
预编码矩阵选择
240
存储器

图 2

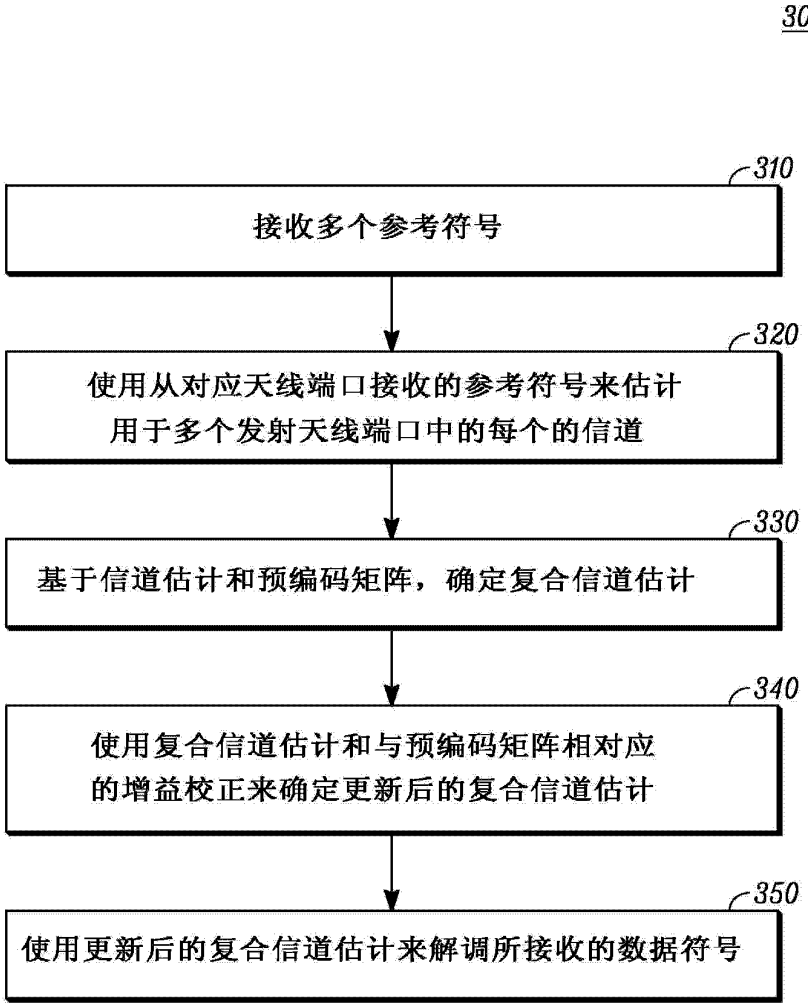

300
310
接收多个参考符号
320
使用从对应天线端口接收的参考符号来估计
用于多个发射天线端口中的每个的信道
330
基于信道估计和预编码矩阵，确定复合信道估计
340
使用复合信道估计和与预编码矩阵相对应
的增益校正来确定更新后的复合信道估计
350
使用更新后的复合信道估计来解调所接收的数据符号

图 3

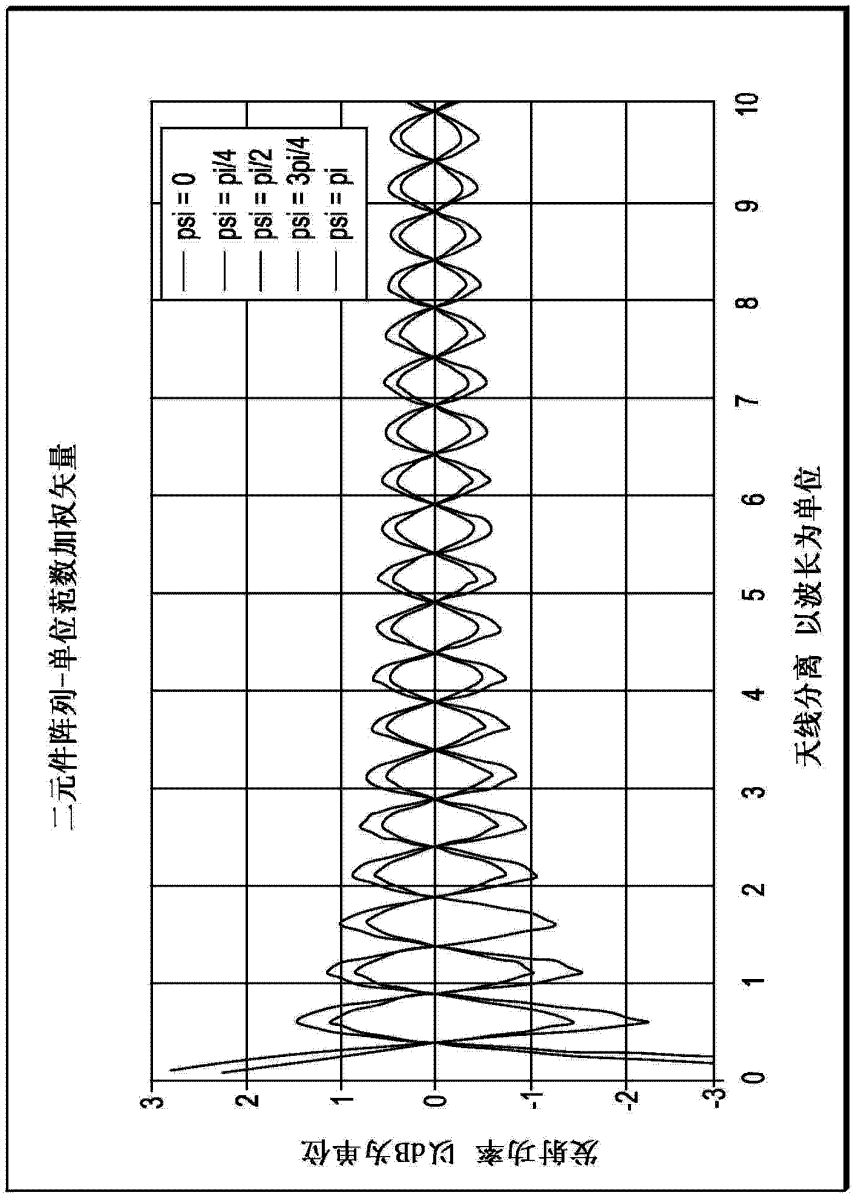

二元件阵列-单位范数加权矢量
psi = 0
psi = pi/4
psi = pi/2
psi = 3pi/4
psi = pi
发射功率 以dB为单位
天线分离 以波长为单位
3
2
1
0
-1
-2
-3
0
1
2
3
4
5
6
7
8
9
10

图 4

1. 一种无线通信设备 (103、104)，包括 ：

收发器 (210) ；以及

处理器 (220)，所述处理器 (220) 被耦合至所述收发器 (210)，所述处理器 (220) 被配置成使用从对应的天线端口接收的参考符号来估计 (320) 用于多个发射天线端口中的每个的信道，所述处理器 (220) 被配置成基于所估计的信道并且基于预编码矩阵来确定 (330) 复合信道估计，所述处理器 (220) 被配置成使用所述复合信道估计并且使用与所述预编码矩阵相对应的增益校正来确定 (340) 更新后的复合信道估计，所述处理器 (2,20) 被配置成对于所述无线通信设备 (103、104) 的码本中的对应的多个预编码矩阵确定多个复合信道估计，所述处理器 (220) 被配置成使用所述对应的复合信道估计并且使用对应的增益校正来对于所述多个复合信道估计中的每个确定更新后的复合信道估计，所述处理器 (220) 被配置成从所述码本选择 (219) 预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性，

其中，所述无线通信设备 (103、104) 被配置成发射与所选择的预编码矩阵相关联的预编码矩阵指示符。

5. 根据权利要求 1 所述的设备 ：

其中，所述处理器被配置成选择预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性 ；

其中，所述处理器被配置成基于与所选择的预编码矩阵相对应的所述更新后的复合信道估计来确定信道质量度量 ；以及

其中，所述无线通信设备被配置成在上行链路信道上发射所述信道质量度量。

7. 根据权利要求 1 或 4 所述的设备，其中，所述处理器被配置成确定所述增益校正。

8. 根据权利要求 7 所述的设备，其中，所述增益校正基于在所述无线通信设备处接收的符号的幅度与所述复合信道估计的幅度之比，其中，使用所述预编码矩阵来发射在所述无线通信设备处接收的符号。

9. 一种无线通信设备 (103、104) 中的方法，所述方法包括 ：

在所述无线通信设备 (103、104) 处接收 (310) 多个参考符号 ；

使用从对应的天线端口接收的参考符号来估计 (320) 用于多个发射天线端口中的每个的信道 ；

基于所估计的信道并且基于预编码矩阵来确定 (330) 复合信道估计 ；

使用所述复合信道估计和与所述预编码矩阵相对应的增益校正来确定 (340) 更新后的复合信道估计 ；

对于码本中的对应的多个预编码矩阵确定多个复合信道估计 ；

使用对应的复合信道估计和对应的增益校正对于所述多个复合信道估计中的每个确定更新后的复合信道估计 ；

从所述码本中选择 (219) 预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性 ；以及

在上行链路信道上发射与所选择的预编码矩阵相关联的预编码矩阵指示符。

10. 根据权利要求 9 所述的方法，进一步包括 ：

从所述多个发射天线端口接收使用所述预编码矩阵发射的数据符号，其中所述数据符

号在每个发射天线端口处通过从所述预编码矩阵获得的对应的预编码权重被加权，以及

使用所述更新后的复合信道估计来解调所述数据符号。

12. 根据权利要求 9 所述的方法，进一步包括：

选择预编码矩阵以用于未来传输，所述选择基于所述更新后的复合信道估计的属性；

基于与所选择的预编码矩阵相对应的更新后的复合信道估计来确定信道质量度量；以及

在上行链路信道上基于所述信道质量度量发射。

14. 根据权利要求 9 所述的方法，进一步包括：接收可以从其计算所述增益校正的矩阵信息，在从由以下的组成的组中选择的消息中接收所述矩阵信息：主信息块；系统信息块；以及单播传输。

15. 根据权利要求 9 所述的方法，进一步包括：在所述无线通信设备处将所述增益校正确定为在所述无线通信设备处接收的符号的幅度与所述复合信道估计的幅度之比，其中，使用所述预编码矩阵发射在所述无线通信设备处接收的符号。

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/094209

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; H04W; 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: 多天线, MIMO, 信令, 无线信号, 信道质量, 天线端口, 信息, 参考信号, 波束赋型, 波束赋形

VEN; DWPI; USTXT; WOTXT: multi+ 1w antenna, MIMO, signaling, wireless, radio, signal, channel quality, antenna, port?, information, reference signal, beam forming

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 106034360 A (LONGBO COMMUNICATION TECHNICAL CO., LTD.), 19 October 2016 (19.10.2016), claims 1-16	1, 2, 6-8, 12-14, 16, 17
Y	CN 106209195 A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY), 07 December 2016 (07.12.2016), claim 1	1, 2, 6-8, 12-14, 16, 17
A	WO 2016047505 A1 (NTT DOCOMO INC.), 31 March 2016 (31.03.2016), entire document	1-18
A	CN 102170335 A (ZTE CORP.), 31 August 2011 (31.08.2011), entire document	1-18
A	CN 103918195 A (MOTOROLA MOBILITY LLC.), 09 July 2014 (09.07.2014), entire document	1-18
A	US 2016143055 A1 (TELEFONAKTIEBOLAGET L M ERICSSON), 19 May 2016 (19.05.2016), entire document	1-18
A	CN 104170272 A (MOTOROLA MOBILITY LLC.), 26 November 2014 (26.11.2014), entire document	1-18

☐ 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 September 2017	23 October 2017
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 WU, Zhibiao Telephone No. (86-10) 62411320

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/094209

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 106034360 A	19 October 2016	WO 2016146073 A1	22 September 2016
CN 106209195 A	07 December 2016	None	
WO 2016047505 A1	31 March 2016	EP 3200497 A1	02 August 2017
		JP WO 2016047505 A1	25 May 2017
		CN 107079308 A	18 August 2017
		JP 6185188 B2	23 August 2017
CN 102170335 A	31 August 2011	CN 102170335 B	28 September 2016
		WO 2012149892 A1	08 November 2012
CN 103918195 A	09 July 2014	BR 112014011040 A2	13 June 2017
		KR 101607416 B1	29 March 2016
		US 8953699 B2	10 February 2015
		KR 20140099893 A	13 August 2014
		EP 2777171 A1	17 September 2014
		WO 2013070577 A1	16 May 2013
		US 2013114656 A1	09 May 2013
US 2016143055 A1	19 May 2016	WO 2016079694 A1	26 May 2016
CN 104170272 A	26 November 2014	KR 20140125372 A	28 October 2014
		TW I580209 B	21 April 2017
		EP 2813005 A1	17 December 2014
		MX 337710 B	15 March 2016
		TW 201338452 A	16 September 2013
		US 9294179 B2	22 March 2016
		MX 2014009478 A	22 September 2014
		US 2013202015 A1	08 August 2013
		WO 2013119382 A1	15 August 2013

Form PCT/ISA/210 (patent family annex) (July 2009)

国际检索报告

国际申请号 PCT/CN2017/094209

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; H04W; 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:多天线，MIMO，信令，无线信号，信道质量，天线端口，信息，参考信号，波束赋型，波束赋形 VEN; DWPI; USTXT; WOTXT: multi+ lw antenna, MIMO, signaling, wireless, radio, signal, channel quality, antenna, port?, information, reference signal, beam forming

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
Y	CN 106034360 A (上海朗帛通信技术有限公司) 2016年 10月 19日 (2016-10-19) 权利要求1-16	1,2,6-8,12-14,16,17
Y	CN 106209195 A (电信科学技术研究院) 2016年 12月 7日 (2016-12-07) 权利要求1	1,2,6-8,12-14,16,17
A	WO 2016047505 A1 (株式会社NTT都科摩) 2016年 3月 31日 (2016-03-31) 全文	1-18
A	CN 102170335 A (中兴通讯股份有限公司) 2011年 8月 31日 (2011-08-31) 全文	1-18
A	CN 103918195 A (摩托罗拉移动有限责任公司) 2014年 7月 9日 (2014-07-09) 全文	1-18
A	US 2016143055 A1 (瑞典爱立信有限公司) 2016年 5月 19日 (2016-05-19) 全文	1-18
A	CN 104170272 A (摩托罗拉移动有限责任公司) 2014年 11月 26日 (2014-11-26) 全文	1-18

☐ 其余文件在C栏的续页中列出。

☑ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的当天或之后公布的在先申请或专利

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"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触，但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
2017年 9月 29日	2017年 10月 23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 吴志彪 电话号码 (86-10)62411320

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/CN2017/094209

检索报告引用的专利文件			公布日（年/月/日）	同族专利			公布日（年/月/日）
CN	106034360	A	2016年 10月 19日	WO	2016146073	A1	2016年 9月 22日
CN	106209195	A	2016年 12月 7日		无		
WO	2016047505	A1	2016年 3月 31日	EP	3200497	A1	2017年 8月 2日
				JP	WO2016047505	A1	2017年 5月 25日
				CN	107079308	A	2017年 8月 18日
				JP	6185188	B2	2017年 8月 23日
CN	102170335	A	2011年 8月 31日	CN	102170335	B	2016年 9月 28日
				WO	2012149892	A1	2012年 11月 8日
CN	103918195	A	2014年 7月 9日	BR	112014011040	A2	2017年 6月 13日
				KR	101607416	B1	2016年 3月 29日
				US	8953699	B2	2015年 2月 10日
				KR	20140099893	A	2014年 8月 13日
				EP	2777171	A1	2014年 9月 17日
				WO	2013070577	A1	2013年 5月 16日
				US	2013114656	A1	2013年 5月 9日
US	2016143055	A1	2016年 5月 19日	WO	2016079694	A1	2016年 5月 26日
CN	104170272	A	2014年 11月 26日	KR	20140125372	A	2014年 10月 28日
				TW	I580209	B	2017年 4月 21日
				EP	2813005	A1	2014年 12月 17日
				MX	337710	B	2016年 3月 15日
				TW	201338452	A	2013年 9月 16日
				US	9294179	B2	2016年 3月 22日
				MX	2014009478	A	2014年 9月 22日
				US	2013202015	A1	2013年 8月 8日
				WO	2013119382	A1	2013年 8月 15日

表 PCT/ISA/210（同族专利附件）（2009年7月）

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证　　明

本证明之附件是向本局提交的下列专利申请文件副本。

申　　请　　号：201611236923.2

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 28 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 10 日

权 利 要 求 书

1. 一种被用于多天线传输的UE中的方法，其中，包括如下步骤：

- 步骤A. 接收第一信令；

- 步骤B. 接收第一无线信号；

- 步骤C. 发送第一信息；

其中， K个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述K个天线端口组。所述K是大于1的正整数。所述K个天线端口组分别对应K个信道质量值。所述K个信道质量值是K个非负实数。所述K个天线端口组中的K1个天线端口组对应所述K个信道质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述K1个天线端口组，所述第一比例序列}。

2. 根据权利要求1所述的方法，其特征在于，所述 K 个天线端口组中的K2个天线端口组对应所述K个信道质量值中的K2个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述K2个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述 K2 个天线端口组，所述第二比例序列}。

3. 根据权利要求1-2所述的方法，其特征在于，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所述K1个天线端口组中的任意两个天线端口，所述K2个天线端口组中的任意两个天线端口}在同一个载波上。

4. 根据权利要求1-3所述的方法，其特征在于，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述 K1 个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述K2个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三

信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

5. 根据权利要求 1-4 所述的方法，其特征在于，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

6. 根据权利要求 1-5 所述的方法，其特征在于，包括如下步骤：

- 步骤 D：接收第二无线信号。

其中，目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

7. 一种被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. 发送第一信令；

- 步骤 B. 发送第一无线信号；

- 步骤 C. 接收第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

8. 根据权利要求 7 所述的方法，其特征在于，所述 K 个天线端口组中的K2个天线端口组对应所述K个信道质量值中的K2个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述 K2 个天线端口组，所述第二比例序列}。

9. 根据权利要求 7-8 所述的方法，其特征在于，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所

述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}在同一个载波上。

10. 根据权利要求 7-9 所述的方法，其特征在于，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述 K1 个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述 K2 个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

11. 根据权利要求 7-10 所述的方法，其特征在于，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

12. 根据权利要求 7-11 所述的方法，其特征在于，包括如下步骤：

- 步骤 D：发送第二无线信号

其中，目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

13. 一种被用于多天线传输的用户设备，其中，包括如下步骤：

- 第一接收模块：用于接收第一信令；
- 第二接收模块：用于接收第一无线信号；
- 第三发送模块：用于发送第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

14. 一种被用于多天线传输的基站设备，其中，包括如下模块：

- 第一发送模块：用于发送第一信令；

- 第二发送模块：用于发送第一无线信号；

- 第三接收模块：用于接收第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

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权 利 要 求 书

1. 一种被用于多天线传输的用户设备中的方法，包括：

- 步骤 A. 接收第一信令；

- 步骤 B. 接收第一无线信号；

- 步骤 C. 发送第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值；所述K1是小于或者等于所述K的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列；所述第一信令被用于确定目标阈值；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值大于或者等于所述目标阈值。

2. 根据权利要求 1 所述的方法，其特征在于，所述 K 个天线端口组中的K2个天线端口组对应所述K个信道质量值中的K2个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

3. 根据权利要求 2 所述的方法，其特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

4. 根据权利要求 2 所述的方法，其特征在于，所述第一信令被用于确定所述 K1、所述 K2 和目标阈值中的至少最后一项；第三信道质量

是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第四信道质量与所述第三信道质量之间的比值大于或者等于所述目标阈值。

5. 根据权利要求 4 所述的方法，其特征在于，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

6. 根据权利要求 2 至 5 中的任一权利要求所述的方法，其特征在于，包括：

- 步骤 D：接收第二无线信号；

其中，目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组及所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组及所述第二比例序列关联。

7. 一种被用于多天线传输的基站中的方法，包括：

- 步骤 A. 发送第一信令；

- 步骤 B. 发送第一无线信号；

- 步骤 C. 接收第一信息；

其中，K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值；所述 K1 是小于或者等于所述 K 的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组及所述第一比例序列；所述第一信令被用于确定目标阈值；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值大于或者等于所述目标阈值。

8. 根据权利要求 7 所述的方法，其特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述

K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

9. 根据权利要求 8 所述的方法，其特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

10. 根据权利要求 8 所述的方法，其特征在于，所述第一信令被用于确定所述 K1、所述 K2 和目标阈值中的至少最后一项；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第四信道质量与所述第三信道质量之间的比值大于或者等于所述目标阈值。

11. 根据权利要求 10 所述的方法，其特征在于，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

12. 根据权利要求 8 至 11 中的任一权利要求所述的方法，其特征在于，包括：

- 步骤 D：发送第二无线信号

其中，目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组及所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组及所述第二比例序列关联。

13. 一种被用于多天线传输的用户设备，其中，包括如下模块：

- 第一接收机模块，用于接收第一信令；
- 第二接收机模块，用于接收第一无线信号；
- 第三发射机模块，用于发送第一信息；

其中，K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值；所述 K1 是小于或者等于所述 K 的正整数；

第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列；所述第一信令被用于确定目标阈值；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值大于或者等于所述目标阈值。

14. 根据权利要求 13 所述的用户设备，其特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

15. 根据权利要求 14 所述的用户设备，其特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

16. 根据权利要求 14 所述的用户设备，其特征在于，所述第一信令被用于确定所述 K1、所述 K2 和目标阈值中的至少最后一项；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第四信道质量与所述第三信道质量之间的比值大于或者等于所述目标阈值。

17. 根据权利要求 16 所述的用户设备，其特征在于，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

18. 根据权利要求 14 至 17 中的任一权利要求所述的用户设备，其特征在于，所述第二接收机模块接收第二无线信号；其中，目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组及所述第一比例序列关联，或者，所述目标天线端口组与所

述 K2 个天线端口组及所述第二比例序列关联。

19. 一种被用于多天线传输的基站设备，其中，包括如下模块：

- 第一发射机模块，用于发送第一信令；

- 第二发射机模块，用于发送第一无线信号；

- 第三接收机模块，用于接收第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号，所述第一信令被用于确定所述 K 个天线端口组，所述 K 是大于 1 的正整数，所述 K 个天线端口组分别对应 K 个信道质量值，所述 K 个信道质量值是 K 个非负实数，所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值，所述K1是小于或者等于所述K的正整数，第一比例序列对应所述 K1 个信道质量值之间的比值，所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列；所述第一信令被用于确定目标阈值；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值大于或者等于所述目标阈值。

20. 根据权利要求 19 所述的设备，其特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

21. 根据权利要求 20 所述的设备，其特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

22. 根据权利要求 20 所述的设备，其特征在于，所述第一信令还

被用于确定所述 K1、所述 K2 和目标阈值中的至少最后一项；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第四信道质量与所述第三信道质量之间的比值大于或者等于所述目标阈值。

23. 根据权利要求 22 所述的设备，其特征在于，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

24. 根据权利要求 20 至 23 中的任一权利要求所述的设备，其特征在于，所述第二发射机模块发送第二无线信号；其中，目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组及所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组及所述第二比例序列关联。

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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（Multi-Input Multi-Output）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。大规模MIMO还可以通过多个天线形成不同的方向，同时服务多个用户，以提高大规模MIMO系统的吞吐量，降低传输时延。

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）的混合波束赋型(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，基站可以进行在一段时间资源上进行波束扫描，UE对波束进行选择并上报，但由于空口资源的限制，用于波束扫描的波束数量和UE上报的波束数量是有限的，另外，由于UE位置的不确定性，用于波束扫描的波束不一定包括对UE服务最好的波束。如何利用UE上报信息形成对UE服务的最佳波束是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。

本发明公开了一种被用于多天线传输的UE中的方法，其中，包括如下步骤：

- 步骤A. 接收第一信令；
- 步骤B. 接收第一无线信号；

- 步骤 C. 发送第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

作为一个实施例，上述方法的好处在于基站可以获得多个波束对应的接收质量之间的比例关系，根据所述比例关系生成对 UE 更准确的服务波束，从而提高传输质量。

作为一个实施例，所述波束和所述服务波束是模拟波束。

作为一个实施例，所述天线端口由多根物理天线通过天线虚拟化（Virtualization）叠加而成。所述天线端口到所述多根物理天线的映射系数组成波束赋型向量用于所述天线虚拟化，形成波束。

作为一个实施例，所述天线虚拟化包括模拟波束赋型与数字波束赋型。所述模拟波束赋型是 RF 链路输出到所述多根物理天线的映射，被用于形成模拟波束。所述数字波束赋型是所述天线端口到 RF 链路的映射，被用于形成数字波束。

作为一个实施例，所述波束赋型向量是一个模拟波束赋型矩阵与一个数字波束赋型向量的乘积。所述模拟波束赋型矩阵由一个或者多个模拟波束赋型向量组成。

作为一个实施例，所述波束赋型向量是一个模拟波束赋型向量与一个数字波束赋型向量的 Kronecker 乘积。

作为一个实施例，所述天线虚拟化只包括模拟波束赋型。

作为一个实施例，所述天线端口组由一个所述天线端口组成。

作为一个实施例，所述天线端口组由多个所述天线端口组成。

作为一个实施里，相同的模拟波束赋型向量和不同的数字波束赋型向量被用于所述天线端口组内不同的天线端口的天线虚拟化。

作为一个实施例，所述 K 个天线端口组中存在两个所述天线端口组，所述两个所述天线端口组中所包括的所述天线端口的数量不同。

作为一个实施例，所述天线端口对应一个参考信号。所述参考信号通过所述天线端口发送。

作为一个实施例，所述参考信号是一个参考符号。

作为一个实施例，所述参考信号由多个参考符号组成。一个参考符号占一个 RE （Resource Element, RE)。

作为一个实施例，所述参考信号是 SS（Synchronization Signal，同步信号)。

作为一个实施例，所述参考信号是 PSS（Primary Synchronization Signal，主同步信号)。

作为一个实施例，所述参考信号是 SSS(Secondary Synchronization Signal，第二同步信号)。

作为一个实施例，所述参考信号是 CSI-RS （Channel State Information Reference Signal，信道状态信息参考信号)。

作为一个实施例，所述参考信号是 DMRS（Demodulation Reference Signal，解调参考信号)。

作为一个实施例，所述参考信号是 PBCH（Physical Broadcast Channel，物理广播信道）的 DMRS。

作为一个实施例，所述参考信号是 PDSCH(Physical Downlink Share Channel，物理下行共享信道）的 DMRS。

作为一个实施例，所述第一无线信号是多个多载波符号。

作为一个实施例，所述第一无线信号是一个 SS 突发。所述 SS 突发包括多个 SS 块。所述 SS 块至少包括一个同步信号。

作为一个实施例，所述第一无线信号是一个 CSI-RS 突发。

作为一个实施例，所述第一无线信号是一次波束扫描(beam sweep)。所述波束扫描是在一段时间内以预定的方式通过发送或者接收的波束覆盖一个空间区域的操作。

作为一个实施例，所述 K 个天线端口组分别对应 K 个参考信号组，所述 K 个参考信号组分别通过所述 K 个天线端口组发送，所述第一无线信号由所述 K 个参考信号组组成。

作为一个实施例，K 个不同的模拟波束赋型向量被用于所述 K 个天线端口组的模拟波束赋型。

作为一个实施例，所述K个参考信号组中至少有两个参考信号组在一个时间单元中的时频图案和OCC（Orthogonal Cover Code，正交覆盖码）是相同的。所述两个参考信号在不同的时间资源上发送。

作为一个实施例，所述时间单元是符号。

作为一个实施例，所述时间单元是时隙。

作为一个实施例，所述时间单元是子帧（subframe）。

作为一个实施例，所述时间单元是sTTI（short Transmission Time Interval，短传输时间长度）。

作为一个实施例，所述第一信令显式的指示所述K个天线端口组。

作为一个实施例，所述第一信令隐式的指示所述K个天线端口组。

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，所述第一信令是RRC（Radio Resource Control，无线资源控制）信令。

作为一个实施例，所述第一信令是MAC层信令。

作为一个实施例，所述第一信令是MAC CE（MAC Control Element，MAC控制粒子）。

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PDCCH（Physical Downlink Control Channel，物理下行控制信道）承载。

作为一个实施例，所述第一信令是DCI（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UE特定的。

作为一个实施例，所述第一信令是UE组特定的。

作为一个实施例，所述信道质量值是{瞬时RSRP Reference Signal Received Power，参考信号接收功率），长期RSRP，SINR，SNR}中的一种。

作为一个实施例，所述K个信道质量值是宽带信道质量值。

作为一个实施例，所述第一信息显式的指示所述K1个天线端口组。

作为一个实施例，所述第一信息隐式的指示所述K1个天线端口组。

作为一个实施例，所述第一信息显式的指示所述第一比例序列。

作为一个实施例，所述第一信息隐式的指示所述第一比例序列。

作为一个实施例，所述第一信息由 PUSCH（Physical Uplink Shared Channel，物理上行共享信道）承载。

作为一个实施例，所述第一信息由 PUCCH（(Physical Uplink Control Channel，物理上行控制信道）承载。

作为一个实施例，所述第一信息在 CSI 报告中发送。

作为一个实施例，所述第一信息在多条消息中发送。

作为一个实施例，比特映射（bitmap）被用于确定所述 K1 个天线端口组。

作为一个实施例，所述 K1 个天线端口组对应相同的接收波束赋型向量。

作为一个实施例，所述接收波束赋型向量是模拟接收波束赋型向量。

作为一个实施例，所述 K 个天线端口组用一个长度为 K 的比特串表示，所述 K1 个天线端口组对应的比特位置 1，其他比特位置 0。

作为一个实施例，所述 K1 大于 1。

作为一个实施例，所述 K1 等于 1。

作为一个实施例，所述第一比例序列由 K1-1 个正实数组成。所述 K1-1 个正实数是所述 K1 个信道质量值中除最好的信道质量值以外的信道质量值与所述最好的信道质量值之间的比值。

作为一个实施例，所述第一比例序列由 K1-1 个正实数对应的量化值组成。

作为一个实施例，当所述 K1 等于 1 时，所述第一比例序列被确定为不存在。

作为一个实施例，所述第一比例序列由 K1 个正实数组成。所述 K1 个正实数分别是所述 K1 个信道质量值与所述 K1 个信道质量值中的最好的信道质量值之间的比值。

作为一个实施例，所述第一比例序列由 K1 个正实数对应的量化值组成。

作为一个实施例，所述第一比例序列由 K1 个小于或者等于 1 的正实数组成，所述第一比例序列至少包括一个 1。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型

向量和所述第一比例序列被用于生成用于与所述 UE 之间数据传输的服务波束。

作为一个实施例，所述第一无线信号的发送者根据覆盖空间确定与所述 UE 所在的相对位置有关的服务波束和{所述 K1 个天线端口，所述第一比例序列}之间的对应关系，然后根据所述 UE 上报的{所述 K1 个天线端口，所述第一比例序列}确定所述服务波束。

作为一个实施例，第一天线端口组和第二天线端口组是所述 K1 个天线端口组中的两个天线端口组，所述 K1 等于 2。第一波束赋型向量被用于所述第一天线端口组的波束赋型，第二波束赋型向量被用于所述第二天线端口组的波束赋型。所述第一比例序列由第一元素和第二元素组成，其中，所述第一元素对应所述第一天线端口组，所述第二元素对应所述第二天线端口组。所述第一元素等于 1，所述第二元素等于 a,所述 a 是小于 1 的正实数。

作为一个实施例，所述第一无线信号的发送者使用第一元素和第二元素分别加权所述第一波束赋型向量对应的方向和所述第二波束赋型向量对应的方向得到服务波束对应的方向。

作为一个实施例，所述第一无线信号的发送者存有一张对应关系表，所述对应关系表被用于确定 UE 的服务波束和{所述 K1 个天线端口，所述第一比例序列}之间的对应关系。所述第一无线信号的发送者根据{所述第一天线端口组，所述第二天线端口组，所述第一比例序列}检索所述对应关系表，得到用于与所述 UE 之间通信的模拟波束方向。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型向量和所述第一比例序列被用于生成下一次波束扫描的信号。所述信号使用的多个波束赋型向量的生成函数的变量是所述 K1 个波束赋型向量和所述第一比例序列。

作为一个实施例，所述多个波束赋型向量的覆盖空间的中心由所述 K1 个天线端口组及所述第一比例序列确定。

具体的，根据本发明的一个方面，其特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1

个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述K2个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述K2个天线端口组，所述第二比例序列}。

作为一个实施例，上述方法的好处在于，针对不同的接收波束赋型向量分别通过不同的天线端口组对应的波束赋型向量和不同的比例序列生成多个候选服务波束，增加传输分集效果。

作为一个实施例，所述K1个天线端口组中的天线端口和所述K2个天线端口组中的天线端口不重叠。

作为一个实施例，{所述 K1 个天线端口组，所述第一比例序列}被用于生成第一发送波束赋型向量，{所述K2个天线端口组，所述第二比例序列}被用于生成第二发送波束赋型向量。所述第一发送波束赋型向量和所述第一接收波束赋型向量被用于第一时间窗上的数据传输的波束赋型；所述第二发送波束赋型向量和所述第二接收波束赋型向量被用于第二时间窗上的数据传输的波束赋型。所述第一时间窗与所述第二时间窗在时域上正交。

作为一个实施例，第一目标信道质量是所述 K1 个信道质量值的函数，第二目标信道质量是所述 K2 个信道质量值的函数。当所述第一目标信道质量高于所述第二目标信道质量时，所述第一发送波束赋型向量被优先使用。

作为一个实施例，所述第一目标信道质量和所述第二目标信道质量分别是所述K1个信道质量值和所述K2个信道质量值的加权平均值，所述第一比例序列和所述第二比例序列被分别用于所述加权平均。

作为一个实施例，所述第一目标信道质量和所述第二目标信道质量分别是所述K1个信道质量值和所述K2个信道质量值的平均值。

作为一个实施例，所述发送波束赋型向量与所述接收波束赋型向量是模拟波束赋型向量。

具体的，根据本发明的一个方面，其特征在于，{所述K1个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所述K1个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意

两个天线端口}在同一个载波上。

作为一个实施例，上述方法的好处在于，基站通过使用所述 K1 个天线端口组指示共站（类共站）或者共载波的天线端口可以更有效的利用所述第一比例序列。

作为一个实施例，所述第一信令被用于确定所述共站或者 QCL 信息。

作为一个实施例，所述第一信令明示的指示所述共站或者 QCL 信息。

作为一个实施例，所述第一信令暗示的指示所述共站或者 QCL 信息。

作为一个实施例，所述第一信令被用于确定所述共载波的信息。

作为一个实施例，所述第一信令明示的指示所述共载波的信息。

作为一个实施例，所述第一信令暗示的指示所述共载波的信息。

具体的，根据本发明的一个方面，其特征在于，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述 K1 个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述 K2 个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

作为一个实施例，上述方法的好处在于所述目标阈值可以用于控制上报开销，从而提高上报效率。

作为一个实施例，所述目标阈值的单位是 dB。

作为一个实施例，所述第一信令明示的指示{所述 K1，所述 K2，目标阈值}中的至少最后一项。

作为一个实施例，所述第一信令暗示的指示{所述 K1，所述 K2，目标阈值}中的至少最后一项。

作为一个实施例，所述第一信令在多个消息中发送。

具体的，根据本发明的一个方面，其特征在于，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

作为一个实施例，上述方法的好处在于，基站可以通过所述第一信道质量（所述第三信道质量）和所述第一比例序列（所述第二比例序列）近似恢复所述 K1 个信道质量（所述 K2 个信道质量），从而提高波束生

成和调度的灵活性。

作为一个实施例，所述第一信息在多个消息中发送。

作为一个实施例，所述第一信息被用于确定所述第一信道质量（所述第三信道质量）的部分在测量报告中发送，所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}（{所述 K2 个天线端口组，所述第二比例序列}）的部分在 CSI 报告中发送。

具体的，根据本发明的一个方面，其特征在于，其特征在于，包括如下步骤：

- 步骤 D：接收第二无线信号。

其中，目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

作为一个实施例，上述方法的好处在于，{所述 K1 个天线端口组对应的波束赋型向量，所述第一比例序列}或者{所述 K2 个天线端口组对应的波束赋型向量，所述第二比例序列}被用于所述第二无线信号的波束赋型，从而提高作用于所述第二无线信号的波束赋型增益。

作为一个实施例，所述 K1 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量。

作为一个实施例，所述 K2 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量。

作为一个实施例，当所述 K1 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量时，所述第一接收波束赋型向量被用于接收所述第二无线信号；当所述 K2 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量时，所述第二接收波束赋型向量被用于接收所述第二无线信号。

作为一个实施例，所述发送波束赋型向量和所述接收波束赋型向量是模拟波束赋型向量。

作为一个实施例，所述第二无线信号是 PDCCH 承载的信号。

作为一个实施例，所述第二无线信号是 PDSCH 承载的信号。

作为一个实施例，所述第二无线信号是参考信号。

说 明 书

本发明公开了一种被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. 发送第一信令；
- 步骤 B. 发送第一无线信号；
- 步骤 C. 接收第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型向量和所述第一比例序列被用于生成用于与 UE 之间数据传输的服务波束。

作为一个实施例，所述基站根据覆盖空间确定与 UE 所在的相对位置有关的服务波束和{所述 K1 个天线端口，所述第一比例序列}之间的对应关系，然后根据 UE 上报的{所述 K1 个天线端口，所述第一比例序列}确定所述服务波束。

作为一个实施例，所述基站存有一张对应关系表，所述对应关系表被用于确定针对 UE 的服务波束和{所述 K1 个天线端口，所述第一比例序列}之间的对应关系。所述基站根据{所述 K1 个天线端口，所述第一比例序列}检索所述对应关系表，得到用于与所述 UE 之间通信的波束赋型向量。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型向量和所述第一比例序列被用于生成下一次波束扫描的信号。所述信号使用的多个波束赋型向量的生成函数的变量是所述 K1 个波束赋型向量和所述第一比例序列。

作为一个实施例，所述多个波束赋型向量的覆盖空间的中心使用的波束赋型向量对应的方向对应所述 K1 个波束赋型向量对应的方向使用

所述第一比例序列权重加和的结果。

具体的，根据本发明的一个方面，其特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述 K2 个天线端口组，所述第二比例序列}。

作为一个实施例，所述第一信息还被所述基站用于确定{所述第一接收波束赋型向量,所述第二接收波束赋型向量}。

作为一个实施例，所述第一信息显式的指示{所述第一接收波束赋型向量,所述第二接收波束赋型向量}。

作为一个实施例，所述第一信息隐式的指示{所述第一接收波束赋型向量,所述第二接收波束赋型向量}

具体的，根据本发明的一个方面，其特征在于，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}在同一个载波上。

作为一个实施例，所述基站使用共站（类共站）或者共载波的波束赋型向量及其对应的比例序列生成服务波束。

具体的，根据本发明的一个方面，其特征在于，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述 K1 个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述 K2 个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

作为一个实施例，所述基站通过{所述 K1，所述 K2，目标阈值}控

制上报开销。

具体的，根据本发明的一个方面，其特征在于，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

作为一个实施例，所述基站结合{所述第一信道质量，所述 K1 个天线端口组和所述第一比例序列}近似恢复所述 K1 个信道质量值，用于多用户 MIMO 调度。

作为一个实施例，所述基站结合{所述第三信道质量，所述 K2 个天线端口组和所述第二比例序列}近似恢复所述 K2 个信道质量值，用于多用户 MIMO 调度。

具体的，根据本发明的一个方面，其特征在于，包括如下步骤：

- 步骤 D：发送第二无线信号。

其中，目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

作为一个实施例，所述 K1 个天线端口组对应的 K1 个波束赋型向量与所述第一比例序列被用于生成目标波束赋型向量。所述目标波束赋型向量用于所述目标天线端口组的波束赋型。

作为一个实施例，所述 K2 个天线端口组对应的 K2 个波束赋型向量与所述第一比例序列被用于生成目标波束赋型向量。所述目标波束赋型向量用于所述目标天线端口组的波束赋型。

本发明公开了一种被用于多天线传输的用户设备，其中，包括如下步骤：

- 第一接收模块：用于接收第一信令；
- 第二接收模块：用于接收第一无线信号；
- 第三发送模块：用于发送第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道

质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

作为一个实施例，上述用户设备的特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述 K2 个天线端口组，所述第二比例序列}。

作为一个实施例，上述用户设备的特征在于，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}在同一个载波上。

作为一个实施例，上述用户设备的特征在于，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述K1个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述K2个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

作为一个实施例，上述用户设备的特征在于，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

作为一个实施例，上述用户设备的特征在于，所述第二接收设备还被用于接收第二无线信号。其中，目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

本发明公开了一种被用于多天线传输的基站设备，其中，包括如下模块：

- 第一发送模块：用于发送第一信令；
- 第二发送模块：用于发送第一无线信号；
- 第三接收模块：用于接收第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值。所述K1是小于或者等于所述K的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

作为一个实施例，上述基站设备的特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述 K2 个天线端口组，所述第二比例序列}。

作为一个实施例，上述基站设备的特征在于，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}在同一个载波上。

作为一个实施例，上述基站设备的特征在于，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述K1个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道

质量是所述 K2 个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

作为一个实施例，上述基站设备的特征在于，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

作为一个实施例，上述基站设备的特征在于，所述第二发送设备还被用于发送第二无线信号。其中，目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

和传统方案相比，本发明具备如下优势：

- 通过信道质量比例的上报更灵活的生成和使用服务波束，增加波束赋型增益；
- 通过针对不同的接收波束赋型的多套上报，增加了后续传输的鲁棒性和灵活性；
- 通过最佳信道质量的上报，结合信道质量比例的上报，增加了基站多用户调度的灵活性。

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一个实施例的 K 个参考信号组的模拟波束赋型的示意图。

图 3 示出了根据本发明的一个实施例的 K 个参考信号组的时序示意图。

图 4 示出了根据本发明的一个实施例的 K1 个天线端口组和 K2 个天线端口组的示意图。

图 5 示出了根据本发明的一个实施例的第二无线信号波束赋型的示意图。

图 6 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 7 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 中的步骤是可选的。

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

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

在实施例 1 中，K 个天线端口组被 N1 用于发送所述第一无线信号。所述第一信令被 U2 用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值。所述 K1 是小于或者等于所述 K 的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被 N1 用于确定{所述 K1 个天线端口组，所述第一比例序列}。

作为实施例 1 的子实施例 1，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被 U2 用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被 U2 用于接收通过所述 K2 个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被 N1 用于确定{所述 K2 个天线端口组，所述第二比例序列}。

作为实施例 1 的子实施例 2，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类

共站（Quasi-Co-Located，QCL）的；或者，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}在同一个载波上。

作为实施例 1 的子实施例 3，所述第一信令还 U2 被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述 K1 个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述 K2 个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

作为实施例 1 的子实施例 4，所述第一信息还被 U2 用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

作为实施例 1 的子实施例 5，目标天线端口组被 N1 用于发送所述第二无线信号。

作为实施例 1 的子实施例 6，所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联。所述 K1 个天线端口组对应 K1 个模拟波束赋型向量，所述 K1 个模拟波束向量和所述第一比例序列被 N1 用于生成第一目标模拟波束赋型向量，所述第一目标模拟波束赋型向量被用于所述目标天线端口组的模拟波束赋型。所述第一接收波束赋型向量被 U2 用于接收所述第二无线信号。

作为实施例 1 的子实施例 7，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。所述 K2 个天线端口组对应 K2 个模拟波束赋型向量，所述 K2 个模拟波束向量和所述第二比例序列被 N1 用于生成第二目标模拟波束赋型向量，所述第二目标模拟波束赋型向量被用于所述目标天线端口组的模拟波束赋型。所述第二接收波束赋型向量被 U2 用于接收所述第二无线信号。

实施例 2

实施例 2 示例了 K 个参考信号组的模拟波束赋型的示意图，如附图 2 所示。

在实施例 2 中，所述 K 个参考信号组和 K 个天线端口组一一对应。所述参考信号组中的参考信号的数量等于对应的所述天线端口组中的天线端口的数量。

在实施例 2 中，一个天线端口对应的物理天线被分成了 S 个天线组，每个所述天线组包括多根天线。所述 S 为正整数。所述天线端口由 S 个天线组中的多根天线通过天线虚拟化（Virtualization）叠加而成，所述 S 个天线组中的多根天线到所述天线端口的映射系数组成波束赋型向量。一个所述天线组通过一个 RF（Radio Frequency，射频）链路（Chain）连接到基带处理器。一个所述波束赋型向量由一个模拟波束赋型向量和一个数字波束赋型向量的 Kronecker 积构成。同一个所述天线组内的多根天线到所述天线端口的映射系数组成这个天线组的模拟波束赋型向量，一个所述天线端口包括的不同天线组对应相同的模拟波束赋型向量。一个所述天线端口包括的不同所述 RF 链路到所述天线端口的映射系数组成这个天线端口的数字波束赋型向量。

作为实施例 2 的子实施例 1，所述参考信号组仅包括一个所述参考信号，所述参考信号组中的参考信号被对应的发送天线端口组中的天线端口发送。

作为实施例 2 的子实施例 2，所述参考信号组仅包括多个所述参考信号，所述参考信号组中的多个参考信号分别被对应的发送天线端口组中的多个天线端口发送。一个所述天线端口组中的不同所述天线端口对应相同的所述模拟波束赋型向量。

作为实施例 2 的子实施例 3，一个所述天线端口组中的不同所述天线端口对应不同的所述数字波束赋型向量。

作为实施例 2 的子实施例 4，所述 K 个天线端口组是 M 个天线端口组的子集，UE 根据针对所述 M 个天线端口组中的测量发送辅助信息，基站根据所述辅助信息确定并为 UE 配置所述 K 个天线端口组。

实施例 3

实施例 3 示例了 K 个参考信号组的时序示意图，如附图 3 所示。

实施例 3 中，K 个天线端口组对应 K 个参考信号组。所述 K 个参考信号组中的任意两个参考信号组所占用的时域资源是正交的。所述 K 个参

考信号组中的任意两个参考信号组对应的模拟波束赋型向量不能被认为是相同的。所述 K 个参考信号组占用 K 个时间窗。所述 K 个时间窗在时域上是正交的。

作为实施例 3 的子实施例 1，附图 3 描述了所述 K 个参考信号组的一次发送。所述 K 个参考信号组是周期性发送的。

作为实施例 3 的子实施例 2，在一个时间窗内，所述参考信号采用 CSI-RS 的图案。

作为实施例 3 的子实施例 3，在一个时间窗内，所述参考信号采用 SS 的图案。

作为实施例 3 的子实施例 4，附图 3 中的所述时间窗中包括 Q1 个 OFDM 符号，所述 Q1 是{2，4，7，14}中的一种。

实施例 4

实施例 4 示例了 K1 个天线端口组和 K2 个天线端口组的示意图，如附图 4 所示。

在实施例 4 中，K 个天线端口组被用于发送第一无线信号。K 个模拟波束赋型向量被分别用于所述 K 个天线端口组的发送模拟波束赋型。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值中最好的 K1+K2 个信道质量值分别对应第一接收波束赋型向量和第二接收波束赋型向量。其中，所述第一接收波束赋型向量对通过所述 K1 个天线端口组发送的信号做接收模拟波束赋型；所述第二接收波束赋型向量对通过所述 K2 个天线端口组发送的信号做接收模拟波束赋型。

实施例 5

实施例 5 示例了第二无线信号波束赋型的示意图，如附图 5 所示。在附图 5 中，虚线椭圆形是用于发送第一无线信号的模拟波束，实线椭圆形是用于发送第二无线信号的模拟波束。

在实施例 5 中，UE 接收通过 K 个天线端口组发送的第一无线信号。所述 K 个天线端口组对应 K 个信道质量值。UE 接收第一信令确定 K1 等于 2。第一天线端口组和第二天线端口组是所述 K 个天线端口组中的两个天线端口组。所述第一天线端口组对应第一信道质量。所述第二天线

端口组是对应第二信道质量。所述第一信道质量是所述 K 个信道质量值中最好的信道质量值。所述第二信道质量是所述 K 个信道质量值中次好的信道质量值。UE 向基站上报{所述第一天线端口组，所述第二天线端口组，第一比例序列}。所述第一比例序列由{1，所述第二信道质量与第一信道质量比值}组成。第一模拟波束赋型向量被用于所述第一天线端口组的模拟波束赋型。第二模拟波束赋型向量被用于所述第二天线端口组的模拟波束赋型。所述基站根据 UE 上报使用{所述第一模拟波束赋型向量对应的方向，所述第二模拟波束赋型向量对应的方向，所述第一比例序列}生成目标模拟波束赋型向量。所述目标模拟波束赋型向量对应的波束方向在所述第一模拟波束赋型向量对应的波束方向和所述第二模拟波束赋型向量对应的波束方向之间。所述目标模拟波束赋型向量被用于目标天线端口组的模拟波束赋型。所述目标天线端口组被用于发送所述第二无线信号。

实施例 6

实施例 6 示例了用于 UE 中的处理装置的结构框图，如附图 6 所示。在附图 6 中，UE 装置 200 主要由第一接收模块 201，第二接收模块 202 和第三发送模块 203 组成。

在实施例 6 中，第一接收模块 201 用于接收第一信令；第二接收模块 202 用于接收第一无线信号；第三发送模块 203 用于发送第一信息。

在实施例 6 中，K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述 K 个天线端口组。所述 K 是大于 1 的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值。所述 K1 是小于或者等于所述 K 的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

作为实施例 6 的子实施例 1，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组

发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述 K2 个天线端口组，所述第二比例序列}。

作为实施例 6 的子实施例 2，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}在同一个载波上。

作为实施例 6 的子实施例 3，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述 K1 个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述 K2 个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

作为实施例 6 的子实施例 4，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

作为实施例 6 的子实施例 5，所述第二接收模块 202 还被用于接收第二无线信号。目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

实施例 7

实施例 7 示例了用于基站中的处理装置的结构框图，如附图 7 所示。

在附图 7 中，基站装置 300 主要由第一发送模块 301，第二发送模块 302 和第三接收模块 303 组成。

在实施例 7 中，第一发送模块 301 用于发送第一信令；第二发送模块 302 用于发送第一无线信号；第三接收模块 303 用于接收第一信息。

在实施例 7 中，K 个天线端口组被用于发送所述第一无线信号。所述第一信令被用于确定所述K个天线端口组。所述K是大于1的正整数。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值是 K 个非负实数。所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值。所述 K1 是小于或者等于所述 K 的正整数。第一比例序列对应所述 K1 个信道质量值之间的比值。所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}。

作为实施例 7 的子实施例 1，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值。所述 K2 是小于或者等于所述 K 的正整数。第二比例序列对应所述 K2 个信道质量值之间的比值。第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号。所述第一接收波束赋型向量和所述第二接收波束赋型向量不同。所述第一信息还被用于确定{所述 K2 个天线端口组，所述第二比例序列}。

作为实施例 7 的子实施例 2，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}是共站或者类共站（Quasi-Co-Located，QCL）的；或者，{所述 K1 个天线端口组中的任意两个天线端口，所述 K2 个天线端口组中的任意两个天线端口}在同一个载波上。

作为实施例 7 的子实施例 3，所述第一信令还被用于确定{所述 K1，所述 K2，目标阈值}中的至少最后一项。所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值。第二信道质量是所述 K1 个信道质量值中最差的信道质量值。第三信道质量是所述 K2 个信道质量值中最好的信道质量值。第四信道质量是所述 K2 个信道质量值中最差的信道质量值。{所述第二信道质量与所述第一信道质量之间的比值，所述第四信道质量与所述第三信道质量之间的比值}中的至少之一大于或者等于所述目标阈值。

作为实施例 7 的子实施例 4，所述第一信息还被用于确定{所述第一信道质量，所述第三信道质量}中的至少之一。

作为实施例 7 的子实施例 5，所述第二发送模块还被用于发送第二

无线信号。目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与{所述 K1 个天线端口组，所述第一比例序列}关联；或者，所述目标天线端口组与{所述 K2 个天线端口组，所述第二比例序列}关联。

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。

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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

本申请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（Multi-Input Multi-Output）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。大规模MIMO还可以通过多个天线形成不同的方向，同时服务多个用户，以提高大规模MIMO系统的吞吐量，降低传输时延。

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）的混合波束赋型(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，基站可以进行在一段时间资源上进行波束扫描，UE对波束进行选择并上报，但由于空口资源的限制，用于波束扫描的波束数量和UE上报的波束数量是有限的，另外，由于UE位置的不确定性，用于波束扫描的波束不一定包括对UE服务最好的波束。如何利用UE上报信息形成对UE服务的最佳波束是一个亟待解决的问题。

发明内容

本申请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。

本申请公开了一种被用于多天线传输的UE中的方法，包括：

- 步骤A. 接收第一信令；
- 步骤B. 接收第一无线信号；
- 步骤C. 发送第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值;所述K1是小于或者等于所述K的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列。

作为一个实施例，上述方法的好处在于基站可以获得多个波束对应的接收质量之间的比例关系，根据所述比例关系生成对 UE 更准确的服务波束，从而提高传输质量。

作为一个实施例，所述波束和所述服务波束是模拟波束。

作为一个实施例，所述天线端口由多根物理天线通过天线虚拟化（Virtualization）叠加而成。所述天线端口到所述多根物理天线的映射系数组成波束赋型向量用于所述天线虚拟化，形成波束。

作为一个实施例，所述天线虚拟化包括模拟波束赋型与数字波束赋型。所述模拟波束赋型是 RF 链路输出到所述多根物理天线的映射，被用于形成模拟波束。所述数字波束赋型是所述天线端口到 RF 链路的映射，被用于形成数字波束。

作为一个实施例，所述波束赋型向量是一个模拟波束赋型矩阵与一个数字波束赋型向量的乘积。所述模拟波束赋型矩阵由一个或者多个模拟波束赋型向量组成。

作为一个实施例，所述波束赋型向量是一个模拟波束赋型向量与一个数字波束赋型向量的 Kronecker 乘积。

作为一个实施例，所述天线虚拟化只包括模拟波束赋型。

作为一个实施例，所述天线端口组由一个所述天线端口组成。

作为一个实施例，所述天线端口组由多个所述天线端口组成。

作为一个实施例，相同的模拟波束赋型向量和不同的数字波束赋型向量被用于所述天线端口组内不同的天线端口的天线虚拟化。

作为一个实施例，所述 K 个天线端口组中存在两个所述天线端口组，所述两个所述天线端口组中所包括的所述天线端口的数量不同。

作为一个实施例，所述天线端口对应一个参考信号。所述参考信号

通过所述天线端口发送。

作为一个实施例，所述参考信号是一个参考符号。

作为一个实施例，所述参考信号由多个参考符号组成。一个参考符号占一个 RE （Resource Element，RE）。

作为一个实施例，所述参考信号是 SS（Synchronization Signal，同步信号）。

作为一个实施例，所述参考信号是 PSS（Primary Synchronization Signal，主同步信号）。

作为一个实施例，所述参考信号是 SSS（Secondary Synchronization Signal，第二同步信号）。

作为一个实施例，所述参考信号是 CSI-RS （Channel State Information Reference Signal，信道状态信息参考信号）。

作为一个实施例，所述参考信号是 DMRS（Demodulation Reference Signal，解调参考信号）。

作为一个实施例，所述参考信号是 PBCH（Physical Broadcast Channel，物理广播信道）的 DMRS。

作为一个实施例，所述参考信号是 PDSCH（Physical Downlink Share Channel，物理下行共享信道）的 DMRS。

作为一个实施例，所述第一无线信号是多个多载波符号。

作为一个实施例，所述第一无线信号是一个 SS 突发。所述 SS 突发包括多个 SS 块。所述 SS 块至少包括一个同步信号。

作为一个实施例，所述第一无线信号是一个 CSI-RS 突发。

作为一个实施例，所述第一无线信号是一次波束扫描(beam sweep)。所述波束扫描是在一段时间内以预定的方式通过发送或者接收的波束覆盖一个空间区域的操作。

作为一个实施例，所述 K 个天线端口组分别对应 K 个参考信号组，所述 K 个参考信号组分别通过所述 K 个天线端口组发送，所述第一无线信号由所述 K 个参考信号组组成。

作为一个实施例，K 个不同的模拟波束赋型向量被用于所述 K 个天线端口组的模拟波束赋型。

作为一个实施例，所述 K 个参考信号组中至少有两个参考信号组在

一个时间单元中的时频图案和OCC（Orthogonal Cover Code，正交覆盖码）是相同的。所述两个参考信号在不同的时间资源上发送。

作为一个实施例，所述时间单元是符号。

作为一个实施例，所述时间单元是时隙。

作为一个实施例，所述时间单元是子帧（subframe）。

作为一个实施例，所述时间单元是sTTI（short Transmission Time Interval，短传输时间长度）。

作为一个实施例，所述第一信令显式的指示所述K个天线端口组。

作为一个实施例，所述第一信令隐式的指示所述K个天线端口组。

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，所述第一信令是RRC（Radio Resource Control，无线资源控制）信令。

作为一个实施例，所述第一信令是MAC层信令。

作为一个实施例，所述第一信令是MAC CE（MAC Control Element，MAC控制粒子）。

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PDCCH（Physical Downlink Control Channel，物理下行控制信道）承载。

作为一个实施例，所述第一信令是DCI（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UE特定的。

作为一个实施例，所述第一信令是UE组特定的。

作为一个实施例，所述信道质量值是{瞬时RSRP Reference Signal Received Power，参考信号接收功率），长期RSRP，SINR，SNR}中的一种。

作为一个实施例，所述K个信道质量值是宽带信道质量值。

作为一个实施例，所述第一信息显式的指示所述K1个天线端口组。

作为一个实施例，所述第一信息隐式的指示所述K1个天线端口组。

作为一个实施例，所述第一信息显式的指示所述第一比例序列。

作为一个实施例，所述第一信息隐式的指示所述第一比例序列。

作为一个实施例，所述第一信息由 PUSCH（Physical Uplink Shared Channel，物理上行共享信道）承载。

作为一个实施例，所述第一信息由 PUCCH（(Physical Uplink Control Channel，物理上行控制信道）承载。

作为一个实施例，所述第一信息在 CSI 报告中发送。

作为一个实施例，所述第一信息在多条消息中发送。

作为一个实施例，比特映射（bitmap）被用于确定所述 K1 个天线端口组。

作为一个实施例，所述 K1 个天线端口组对应相同的接收波束赋型向量。

作为一个实施例，所述接收波束赋型向量是模拟接收波束赋型向量。

作为一个实施例，所述 K 个天线端口组用一个长度为 K 的比特串表示，所述 K1 个天线端口组对应的比特位置 1，其他比特位置 0。

作为一个实施例，所述 K1 大于 1。

作为一个实施例，所述 K1 等于 1。

作为一个实施例，所述第一比例序列由 K1-1 个正实数组成。所述 K1-1 个正实数是所述 K1 个信道质量值中除最好的信道质量值以外的信道质量值与所述最好的信道质量值之间的比值。

作为一个实施例，所述第一比例序列由 K1-1 个正实数对应的量化值组成。

作为一个实施例，当所述 K1 等于 1 时，所述第一比例序列被确定为不存在。

作为一个实施例，所述第一比例序列由 K1 个正实数组成。所述 K1 个正实数分别是所述 K1 个信道质量值与所述 K1 个信道质量值中的最好的信道质量值之间的比值。

作为一个实施例，所述第一比例序列由 K1 个正实数对应的量化值组成。

作为一个实施例，所述第一比例序列由 K1 个小于或者等于 1 的正实数组成，所述第一比例序列至少包括一个 1。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型向量和所述第一比例序列被用于生成用于与所述 UE 之间数据传输的服

务波束。

作为一个实施例，所述第一无线信号的发送者根据覆盖空间确定与所述 UE 所在的相对位置有关的服务波束和所述 K1 个天线端口及所述第一比例序列之间的对应关系，然后根据所述 UE 上报的所述 K1 个天线端口及所述第一比例序列确定所述服务波束。

作为一个实施例，第一天线端口组和第二天线端口组是所述 K1 个天线端口组中的两个天线端口组，所述 K1 等于 2。第一波束赋型向量被用于所述第一天线端口组的波束赋型，第二波束赋型向量被用于所述第二天线端口组的波束赋型。所述第一比例序列由第一元素和第二元素组成，其中，所述第一元素对应所述第一天线端口组，所述第二元素对应所述第二天线端口组。所述第一元素等于 1，所述第二元素等于 a,所述 a 是小于 1 的正实数。

作为一个实施例，所述第一无线信号的发送者使用第一元素和第二元素分别加权所述第一波束赋型向量对应的方向和所述第二波束赋型向量对应的方向得到服务波束对应的方向。

作为一个实施例，所述第一无线信号的发送者存有一张对应关系表，所述对应关系表被用于确定 UE 的服务波束和所述 K1 个天线端口及所述第一比例序列之间的对应关系。所述第一无线信号的发送者根据所述第一天线端口组，所述第二天线端口组和所述第一比例序列检索所述对应关系表，得到用于与所述 UE 之间通信的模拟波束方向。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型向量和所述第一比例序列被用于生成下一次波束扫描的信号。所述信号使用的多个波束赋型向量的生成函数的变量是所述 K1 个波束赋型向量和所述第一比例序列。

作为一个实施例，所述多个波束赋型向量的覆盖空间的中心由所述 K1 个天线端口组及所述第一比例序列确定。

具体的，根据本申请的一个方面，其特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述

K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

作为一个实施例，上述方法的好处在于，针对不同的接收波束赋型向量分别通过不同的天线端口组对应的波束赋型向量和不同的比例序列生成多个候选服务波束，增加传输分集效果。

作为一个实施例，所述 K1 个天线端口组中的天线端口和所述 K2 个天线端口组中的天线端口不重叠。

作为一个实施例，所述 K1 个天线端口组和所述第一比例序列被用于生成第一发送波束赋型向量，所述 K2 个天线端口组和所述第二比例序列被用于生成第二发送波束赋型向量。所述第一发送波束赋型向量和所述第一接收波束赋型向量被用于第一时间窗上的数据传输的波束赋型；所述第二发送波束赋型向量和所述第二接收波束赋型向量被用于第二时间窗上的数据传输的波束赋型。所述第一时间窗与所述第二时间窗在时域上正交。

作为一个实施例，第一目标信道质量是所述 K1 个信道质量值的函数，第二目标信道质量是所述 K2 个信道质量值的函数。当所述第一目标信道质量高于所述第二目标信道质量时，所述第一发送波束赋型向量被优先使用。

作为一个实施例，所述第一目标信道质量和所述第二目标信道质量分别是所述 K1 个信道质量值和所述 K2 个信道质量值的加权平均值，所述第一比例序列和所述第二比例序列被分别用于所述加权平均。

作为一个实施例，所述第一目标信道质量和所述第二目标信道质量分别是所述 K1 个信道质量值和所述 K2 个信道质量值的平均值。

作为一个实施例，所述发送波束赋型向量与所述接收波束赋型向量是模拟波束赋型向量。

具体的，根据本申请的一个方面，其特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天

线端口在同一个载波上。

作为一个实施例，上述方法的好处在于，基站通过使用所述 K1 个天线端口组指示共站（类共站）或者共载波的天线端口可以更有效的利用所述第一比例序列。

作为一个实施例，所述第一信令被用于确定所述共站或者 QCL 信息。

作为一个实施例，所述第一信令明示的指示所述共站或者 QCL 信息。

作为一个实施例，所述第一信令暗示的指示所述共站或者 QCL 信息。

作为一个实施例，所述第一信令被用于确定所述共载波的信息。

作为一个实施例，所述第一信令明示的指示所述共载波的信息。

作为一个实施例，所述第一信令暗示的指示所述共载波的信息。

具体的，根据本申请的一个方面，其特征在于，所述第一信令还被用于确定所述 K1，所述 K2 和目标阈值中的至少最后一项；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值和所述第四信道质量与所述第三信道质量之间的比值中的至少之一大于或者等于所述目标阈值。

作为一个实施例，上述方法的好处在于所述目标阈值可以用于控制上报开销，从而提高上报效率。

作为一个实施例，所述目标阈值的单位是 dB。

作为一个实施例，所述第一信令明示的指示{所述 K1，所述 K2，目标阈值}中的至少最后一项。

作为一个实施例，所述第一信令暗示的指示{所述 K1，所述 K2，目标阈值}中的至少最后一项。

作为一个实施例，所述第一信令在多个消息中发送。

具体的，根据本申请的一个方面，其特征在于，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

作为一个实施例，上述方法的好处在于，基站可以通过所述第一信道质量（所述第三信道质量）和所述第一比例序列（所述第二比例序列）近似恢复所述 K1 个信道质量（所述 K2 个信道质量），从而提高波束生

成和调度的灵活性。

作为一个实施例，所述第一信息在多个消息中发送。

作为一个实施例，所述第一信息被用于确定所述第一信道质量（所述第三信道质量）的部分在测量报告中发送，所述第一信息被用于确定{所述 K1 个天线端口组，所述第一比例序列}（{所述 K2 个天线端口组，所述第二比例序列}）的部分在 CSI 报告中发送。

具体的，根据本申请的一个方面，其特征在于，其特征在于，包括：

- 接收第二无线信号。

其中，目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组和所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组和所述第二比例序列关联。

作为一个实施例，上述方法的好处在于，所述 K1 个天线端口组对应的波束赋型向量和所述第一比例序列，或者所述 K2 个天线端口组对应的波束赋型向量和所述第二比例序列，被用于所述第二无线信号的波束赋型，从而提高作用于所述第二无线信号的波束赋型增益。

作为一个实施例，所述 K1 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量。

作为一个实施例，所述 K2 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量。

作为一个实施例，当所述 K1 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量时，所述第一接收波束赋型向量被用于接收所述第二无线信号；当所述 K2 个天线端口组对应的发送波束赋型向量被用于生成所述第二无线信号的发送波束赋型向量时，所述第二接收波束赋型向量被用于接收所述第二无线信号。

作为一个实施例，所述发送波束赋型向量和所述接收波束赋型向量是模拟波束赋型向量。

作为一个实施例，所述第二无线信号是 PDCCH 承载的信号。

作为一个实施例，所述第二无线信号是 PDSCH 承载的信号。

作为一个实施例，所述第二无线信号是参考信号。

本申请公开了一种被用于多天线传输的基站中的方法，包括：

- 步骤 A. 发送第一信令；

- 步骤 B. 发送第一无线信号；

- 步骤 C. 接收第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值；所述 K1 是小于或者等于所述 K 的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型向量和所述第一比例序列被用于生成用于与 UE 之间数据传输的服务波束。

作为一个实施例，所述基站根据覆盖空间确定与 UE 所在的相对位置有关的服务波束与所述 K1 个天线端口和所述第一比例序列之间的对应关系，然后根据 UE 上报的所述 K1 个天线端口和所述第一比例序列确定所述服务波束。

作为一个实施例，所述基站存有一张对应关系表，所述对应关系表被用于确定针对 UE 的服务波束与所述 K1 个天线端口和所述第一比例序列之间的对应关系。所述基站根据所述 K1 个天线端口和所述第一比例序列检索所述对应关系表，得到用于与所述 UE 之间通信的波束赋型向量。

作为一个实施例，所述 K1 个天线端口组分别对应的 K1 个波束赋型向量和所述第一比例序列被用于生成下一次波束扫描的信号。所述信号使用的多个波束赋型向量的生成函数的变量是所述 K1 个波束赋型向量和所述第一比例序列。

作为一个实施例，所述多个波束赋型向量的覆盖空间的中心使用的波束赋型向量对应的方向对应所述 K1 个波束赋型向量对应的方向使用所述第一比例序列权重加和的结果。

具体的，根据本申请的一个方面，其特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；

所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

作为一个实施例，所述第一信息还被所述基站用于确定所述第一接收波束赋型向量和所述第二接收波束赋型向量。

作为一个实施例，所述第一信息显式的指示所述第一接收波束赋型向量和所述第二接收波束赋型向量。

作为一个实施例，所述第一信息隐式的指示所述第一接收波束赋型向量和所述第二接收波束赋型向量。

具体的，根据本申请的一个方面，其特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

作为一个实施例，所述基站使用共站（类共站）或者共载波的波束赋型向量及其对应的比例序列生成服务波束。

具体的，根据本申请的一个方面，其特征在于，所述第一信令还被用于确定所述 K1，所述 K2 和目标阈值中的至少最后一项；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值和所述第四信道质量与所述第三信道质量之间的比值中的至少之一大于或者等于所述目标阈值。

作为一个实施例，所述基站通过所述 K1，所述 K2 和目标阈值控制上报开销。

具体的，根据本申请的一个方面，其特征在于，所述第一信息还被

用于确定所述第一信道质量和所述第三信道质量中的至少之一。

作为一个实施例，所述基站结合所述第一信道质量、所述 K1 个天线端口组和所述第一比例序列近似恢复所述 K1 个信道质量值，用于多用户 MIMO 调度。

作为一个实施例，所述基站结合所述第三信道质量，所述 K2 个天线端口组和所述第二比例序列近似恢复所述 K2 个信道质量值，用于多用户 MIMO 调度。

具体的，根据本申请的一个方面，其特征在于，包括：

- 发送第二无线信号。

其中，目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组和所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组和所述第二比例序列关联。

作为一个实施例，所述 K1 个天线端口组对应的 K1 个波束赋型向量与所述第一比例序列被用于生成目标波束赋型向量；所述目标波束赋型向量用于所述目标天线端口组的波束赋型。

作为一个实施例，所述 K2 个天线端口组对应的 K2 个波束赋型向量与所述第一比例序列被用于生成目标波束赋型向量；所述目标波束赋型向量用于所述目标天线端口组的波束赋型。

本申请公开了一种被用于多天线传输的用户设备，其中，包括如下步骤：

- 第一接收机模块，用于接收第一信令；
- 第二接收机模块，用于接收第一无线信号；
- 第三发射机模块，用于发送第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的K1个信道质量值；所述K1是小于或者等于所述K的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列。

作为一个实施例，上述用户设备的特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

作为一个实施例，上述用户设备的特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

作为一个实施例，上述用户设备的特征在于，所述第一信令还被用于确定所述 K1、所述 K2 和目标阈值中的至少最后一项；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值和所述第四信道质量与所述第三信道质量之间的比值中的至少之一大于或者等于所述目标阈值。

作为一个实施例，上述用户设备的特征在于，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

作为一个实施例，上述用户设备的特征在于，所述第二接收机模块用于接收第二无线信号，其中，目标天线端口组被用于发送所述第二无线信号，所述目标天线端口组与所述 K1 个天线端口组和所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组和所述第二比例序列关联。

本申请公开了一种被用于多天线传输的基站设备，包括如下模块，

- 第一发射机模块，用于发送第一信令；

- 第二发射机模块，用于发送第一无线信号；

- 第三接收机模块，用于接收第一信息；

其中， K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值；所述 K1 是小于或者等于所述 K 的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列。

作为一个实施例，上述基站设备的特征在于，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

作为一个实施例，上述基站设备的特征在于，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

作为一个实施例，上述基站设备的特征在于，所述第一信令还被用于确定所述 K1、所述 K2 和目标阈值中的至少最后一项；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值和所述第四信道质量与所述第三信道

质量之间的比值中的至少之一大于或者等于所述目标阈值。

作为一个实施例，上述基站设备的特征在于，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

作为一个实施例，上述基站设备的特征在于，所述第二发送设备还被用于发送第二无线信号，其中，目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组和所述第一比例序列}关联，或者，所述目标天线端口组与所述 K2 个天线端口组和所述第二比例序列关联。

和传统方案相比，本申请具备如下优势：

- 通过信道质量比例的上报更灵活的生成和使用服务波束，增加波束赋型增益；
- 通过针对不同的接收波束赋型的多套上报，增加了后续传输的鲁棒性和灵活性；
- 通过最佳信道质量的上报，结合信道质量比例的上报，增加了基站多用户调度的灵活性。

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，本申请的其它特征、目的和优点将会变得更加明显：

图 1 示出了根据本申请的一个实施例的无线传输的流程图；

图 2 示出了根据本申请的一个实施例的 K 个参考信号组的模拟波束赋型的示意图。

图 3 示出了根据本申请的一个实施例的 K 个参考信号组的时序示意图。

图 4 示出了根据本申请的一个实施例的 K1 个天线端口组和 K2 个天线端口组的示意图。

图 5 示出了根据本申请的一个实施例的第二无线信号波束赋型的示意图。

图 6 示出了根据本申请的一个实施例的用于 UE 中的处理装置的结构框图；

图 7 示出了根据本申请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 中的步骤是可选的。

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

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

在实施例 1 中，K 个天线端口组被 N1 用于发送所述第一无线信号；所述第一信令被 U2 用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值；所述 K1 是小于或者等于所述 K 的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被 N1 用于确定所述 K1 个天线端口组和所述第一比例序列。

作为一个子实施例，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被 U2 用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被 U2 用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被 N1 用于确定所述 K2 个天线端口组和所述第二比例序列。

作为一个子实施例，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

作为一个子实施例，所述第一信令还 U2 被用于确定所述 K1，所述

K2 和目标阈值中的至少最后一项；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值和所述第四信道质量与所述第三信道质量之间的比值中的至少之一大于或者等于所述目标阈值。

作为一个子实施例，所述第一信息还被 U2 用于确定所述第一信道质量和所述第三信道质量中的至少之一。

作为一个子实施例，目标天线端口组被 N1 用于发送所述第二无线信号。

作为一个子实施例，所述目标天线端口组与所述 K1 个天线端口组和所述第一比例序列关联；所述 K1 个天线端口组对应 K1 个模拟波束赋型向量，所述 K1 个模拟波束向量和所述第一比例序列被 N1 用于生成第一目标模拟波束赋型向量，所述第一目标模拟波束赋型向量被用于所述目标天线端口组的模拟波束赋型；所述第一接收波束赋型向量被 U2 用于接收所述第二无线信号。

作为一个子实施例，所述目标天线端口组与所述 K2 个天线端口组和所述第二比例序列关联；所述 K2 个天线端口组对应 K2 个模拟波束赋型向量，所述 K2 个模拟波束向量和所述第二比例序列被 N1 用于生成第二目标模拟波束赋型向量，所述第二目标模拟波束赋型向量被用于所述目标天线端口组的模拟波束赋型；所述第二接收波束赋型向量被 U2 用于接收所述第二无线信号。

实施例 2

实施例 2 示例了 K 个参考信号组的模拟波束赋型的示意图，如附图 2 所示。

在实施例 2 中，所述 K 个参考信号组和 K 个天线端口组一一对应。所述参考信号组中的参考信号的数量等于对应的所述天线端口组中的天线端口的数量。

在实施例 2 中，一个天线端口对应的物理天线被分成了 S 个天线组，

每个所述天线组包括多根天线。所述 S 为正整数。所述天线端口由 S 个天线组中的多根天线通过天线虚拟化（Virtualization）叠加而成，所述 S 个天线组中的多根天线到所述天线端口的映射系数组成波束赋型向量。一个所述天线组通过一个 RF（Radio Frequency，射频）链路（Chain）连接到基带处理器。一个所述波束赋型向量由一个模拟波束赋型向量和一个数字波束赋型向量的 Kronecker 积构成。同一个所述天线组内的多根天线到所述天线端口的映射系数组成这个天线组的模拟波束赋型向量，一个所述天线端口包括的不同天线组对应相同的模拟波束赋型向量。一个所述天线端口包括的不同所述 RF 链路到所述天线端口的映射系数组成这个天线端口的数字波束赋型向量。

作为一个子实施例，所述参考信号组仅包括一个所述参考信号，所述参考信号组中的参考信号被对应的发送天线端口组中的天线端口发送。

作为一个子实施例，所述参考信号组仅包括多个所述参考信号，所述参考信号组中的多个参考信号分别被对应的发送天线端口组中的多个天线端口发送。一个所述天线端口组中的不同所述天线端口对应相同的所述模拟波束赋型向量。

作为一个子实施例，一个所述天线端口组中的不同所述天线端口对应不同的所述数字波束赋型向量。

作为一个子实施例，所述 K 个天线端口组是 M 个天线端口组的子集，UE 根据针对所述 M 个天线端口组中的测量发送辅助信息，基站根据所述辅助信息确定并为 UE 配置所述 K 个天线端口组。

实施例 3

实施例 3 示例了 K 个参考信号组的时序示意图，如附图 3 所示。

实施例 3 中，K 个天线端口组对应 K 个参考信号组。所述 K 个参考信号组中的任意两个参考信号组所占用的时域资源是正交的。所述 K 个参考信号组中的任意两个参考信号组对应的模拟波束赋型向量不能被认为是相同的。所述 K 个参考信号组占用 K 个时间窗。所述 K 个时间窗在时域上是正交的。

作为一个子实施例，附图 3 描述了所述 K 个参考信号组的一次发送。

所述 K 个参考信号组是周期性发送的。

作为一个子实施例，在一个时间窗内，所述参考信号采用 CSI-RS 的图案。

作为一个子实施例，在一个时间窗内，所述参考信号采用 SS 的图案。

作为一个子实施例，附图 3 中的所述时间窗中包括 Q1 个 OFDM 符号，所述 Q1 是{2，4，7，14}中的一种。

实施例 4

实施例 4 示例了 K1 个天线端口组和 K2 个天线端口组的示意图，如附图 4 所示。

在实施例 4 中，K 个天线端口组被用于发送第一无线信号。K 个模拟波束赋型向量被分别用于所述 K 个天线端口组的发送模拟波束赋型。所述 K 个天线端口组分别对应 K 个信道质量值。所述 K 个信道质量值中最好的 K1+K2 个信道质量值分别对应第一接收波束赋型向量和第二接收波束赋型向量。其中，所述第一接收波束赋型向量对通过所述 K1 个天线端口组发送的信号做接收模拟波束赋型；所述第二接收波束赋型向量对通过所述 K2 个天线端口组发送的信号做接收模拟波束赋型。

实施例 5

实施例 5 示例了第二无线信号波束赋型的示意图，如附图 5 所示。在附图 5 中，虚线椭圆形是用于发送第一无线信号的模拟波束，实线椭圆形是用于发送第二无线信号的模拟波束。

在实施例 5 中，UE 接收通过 K 个天线端口组发送的第一无线信号。所述 K 个天线端口组对应 K 个信道质量值。UE 接收第一信令确定 K1 等于 2。第一天线端口组和第二天线端口组是所述 K 个天线端口组中的两个天线端口组。所述第一天线端口组对应第一信道质量。所述第二天线端口组是对应第二信道质量。所述第一信道质量是所述 K 个信道质量值中最好的信道质量值。所述第二信道质量是所述 K 个信道质量值中次好的信道质量值。UE 向基站上报{所述第一天线端口组，所述第二天线端口组，第一比例序列}。所述第一比例序列由{1，所述第二信道质量与第一信道质量比值}组成。第一模拟波束赋型向量被用于所述第一天线

端口组的模拟波束赋型。第二模拟波束赋型向量被用于所述第二天线端口组的模拟波束赋型。所述基站根据 UE 上报使用{所述第一模拟波束赋型向量对应的方向，所述第二模拟波束赋型向量对应的方向，所述第一比例序列}生成目标模拟波束赋型向量。所述目标模拟波束赋型向量对应的波束方向在所述第一模拟波束赋型向量对应的波束方向和所述第二模拟波束赋型向量对应的波束方向之间。所述目标模拟波束赋型向量被用于目标天线端口组的模拟波束赋型。所述目标天线端口组被用于发送所述第二无线信号。

实施例 6

实施例 6 示例了用于 UE 中的处理装置的结构框图，如附图 6 所示。在附图 6 中，UE 装置 200 主要由第一接收机模块 201，第二接收机模块 202 和第三发射机模块 203 组成。

在实施例 6 中，第一接收机模块 201 用于接收第一信令；第二接收机模块 202 用于接收第一无线信号；第三发射机模块 203 用于发送第一信息。

在实施例 6 中，K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；。所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值；所述 K1 是小于或者等于所述 K 的正整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列。

作为一个子实施例，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

作为一个子实施例，所述 K1 个天线端口组中的任意两个天线端口

是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

作为一个子实施例，所述第一信令还被用于确定所述 K1，所述 K2 和目标阈值中的至少最后一项；所述目标阈值是一个非负实数。第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值和所述第四信道质量与所述第三信道质量之间的比值中的至少之一大于或者等于所述目标阈值。

作为一个子实施例，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

作为一个子实施例，所述第二接收机模块 202 还被用于接收第二无线信号。目标天线端口组被用于发送所述第二无线信号。所述目标天线端口组与所述 K1 个天线端口组及所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组及所述第二比例序列关联。

实施例 7

实施例 7 示例了用于基站中的处理装置的结构框图，如附图 7 所示。

在附图 7 中，基站装置 300 主要由第一发射机模块 301，第二发射机模块 302 和第三接收机模块 303 组成。

在实施例 7 中，第一发射机模块 301 用于发送第一信令；第二发射机模块 302 用于发送第一无线信号；第三接收机模块 303 用于接收第一信息。

在实施例 7 中，K 个天线端口组被用于发送所述第一无线信号；所述第一信令被用于确定所述 K 个天线端口组；所述 K 是大于 1 的正整数；所述 K 个天线端口组分别对应 K 个信道质量值；所述 K 个信道质量值是 K 个非负实数；所述 K 个天线端口组中的 K1 个天线端口组对应所述 K 个信道质量值中的 K1 个信道质量值；所述 K1 是小于或者等于所述 K 的正

整数；第一比例序列对应所述 K1 个信道质量值之间的比值；所述第一信息被用于确定所述 K1 个天线端口组和所述第一比例序列。

作为一个子实施例，所述 K 个天线端口组中的 K2 个天线端口组对应所述 K 个信道质量值中的 K2 个信道质量值；所述 K2 是小于或者等于所述 K 的正整数；第二比例序列对应所述 K2 个信道质量值之间的比值；第一接收波束赋型向量被用于接收通过所述 K1 个天线端口组发送的信号，第二接收波束赋型向量被用于接收通过所述 K2 个天线端口组发送的信号；所述第一接收波束赋型向量和所述第二接收波束赋型向量不同；所述第一信息还被用于确定所述 K2 个天线端口组和所述第二比例序列。

作为一个子实施例，所述 K1 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，所述 K2 个天线端口组中的任意两个天线端口是共站或者类共站（Quasi-Co-Located，QCL）的，或者，所述 K1 个天线端口组中的任意两个天线端口在同一个载波上，所述 K2 个天线端口组中的任意两个天线端口在同一个载波上。

作为一个子实施例，所述第一信令还被用于确定所述 K1、所述 K2 和目标阈值中的至少最后一项；所述目标阈值是一个非负实数；第一信道质量是所述 K1 个信道质量值中最好的信道质量值；第二信道质量是所述 K1 个信道质量值中最差的信道质量值；第三信道质量是所述 K2 个信道质量值中最好的信道质量值；第四信道质量是所述 K2 个信道质量值中最差的信道质量值；所述第二信道质量与所述第一信道质量之间的比值和所述第四信道质量与所述第三信道质量之间的比值中的至少之一大于或者等于所述目标阈值。

作为一个子实施例，所述第一信息还被用于确定所述第一信道质量和所述第三信道质量中的至少之一。

作为一个子实施例，所述第二发射机模块还被用于发送第二无线信号；目标天线端口组被用于发送所述第二无线信号；所述目标天线端口组与所述 K1 个天线端口组和所述第一比例序列关联，或者，所述目标天线端口组与所述 K2 个天线端口组和所述第二比例序列关联。

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。本申请中的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。本申请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，仅为本申请的较佳实施例而已，并非用于限定本申请的保护范围。凡在本申请的精神和原则之内，所做的任何修改，等同替换，改进等，均应包含在本申请的保护范围之内。

说 明 书 附 图

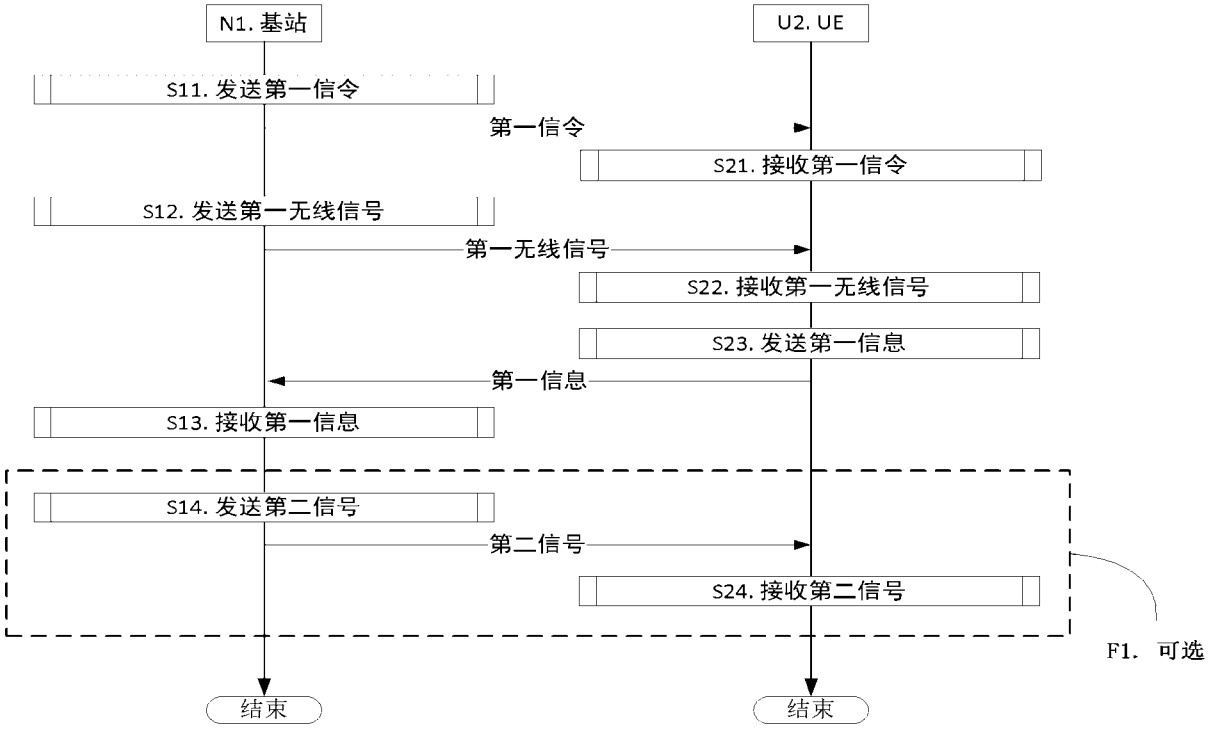

N1. 基站
U2. UE
S11. 发送第一信令
第一信令
S21. 接收第一信令
S12. 发送第一无线信号
第一无线信号
S22. 接收第一无线信号
S23. 发送第一信息
第一信息
S13. 接收第一信息
S14. 发送第二信号
第二信号
S24. 接收第二信号
F1. 可选
结束
结束

图 1

说 明 书 附 图

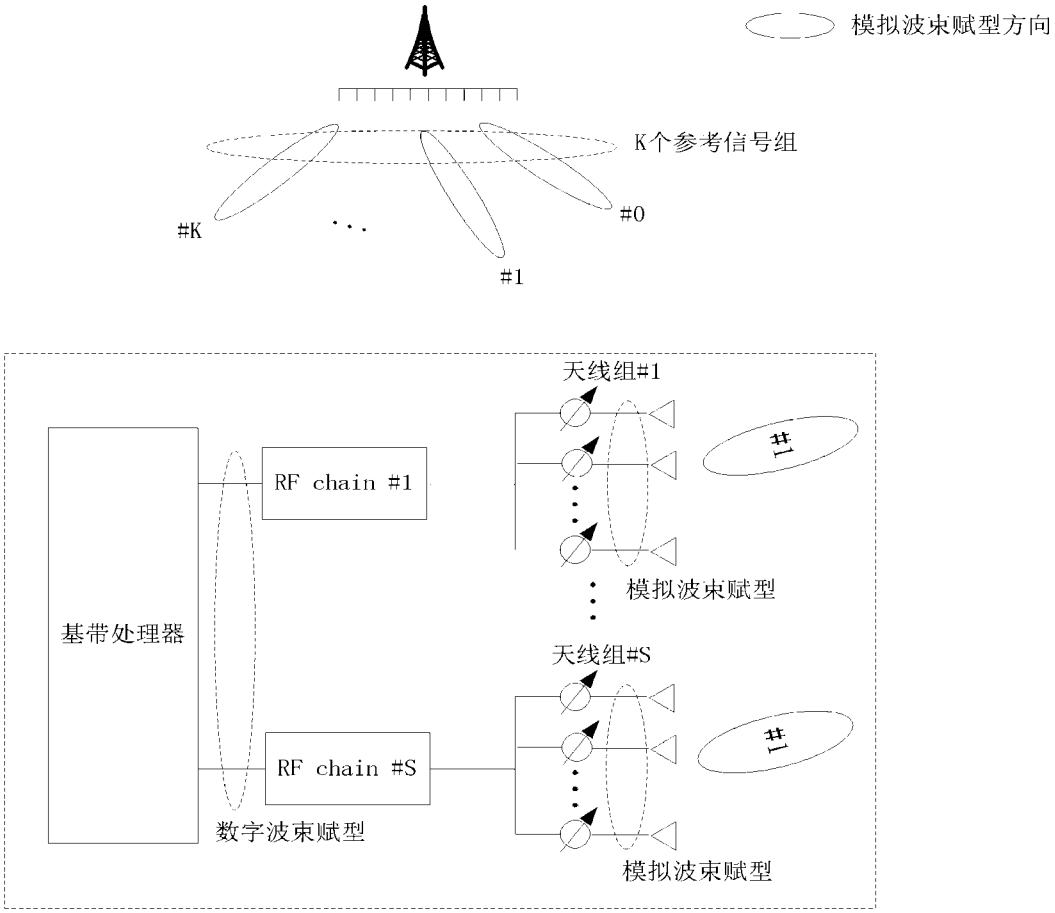

模拟波束赋型方向
K个参考信号组
#0
#1
#K
天线组#1
RF chain #1
基带处理器
模拟波束赋型
天线组#S
RF chain #S
数字波束赋型
模拟波束赋型
天线端口

图 2

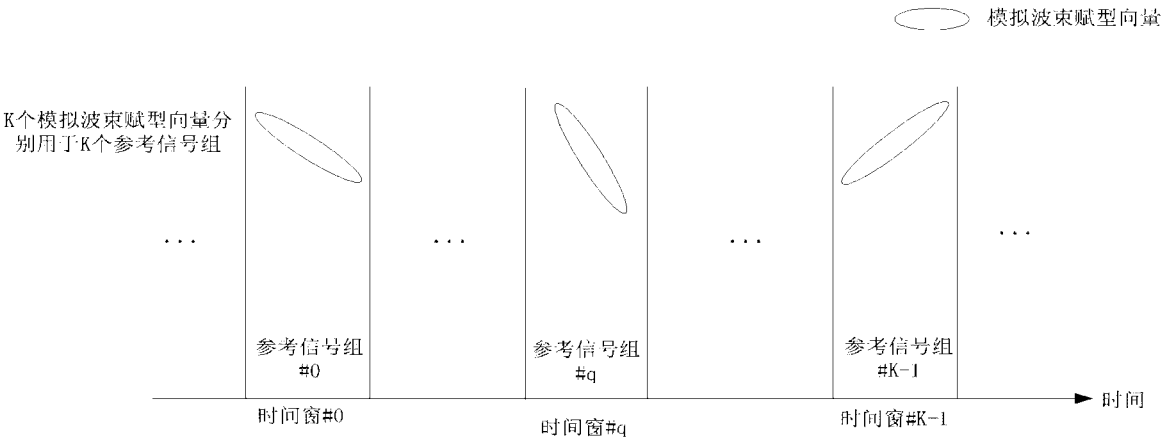

模拟波束赋型向量
K个模拟波束赋型向量分别用于K个参考信号组
参考信号组 #0
参考信号组 #q
参考信号组 #K-1
时间
时间窗#0
时间窗#q
时间窗#K-1

图 3

说 明 书 附 图

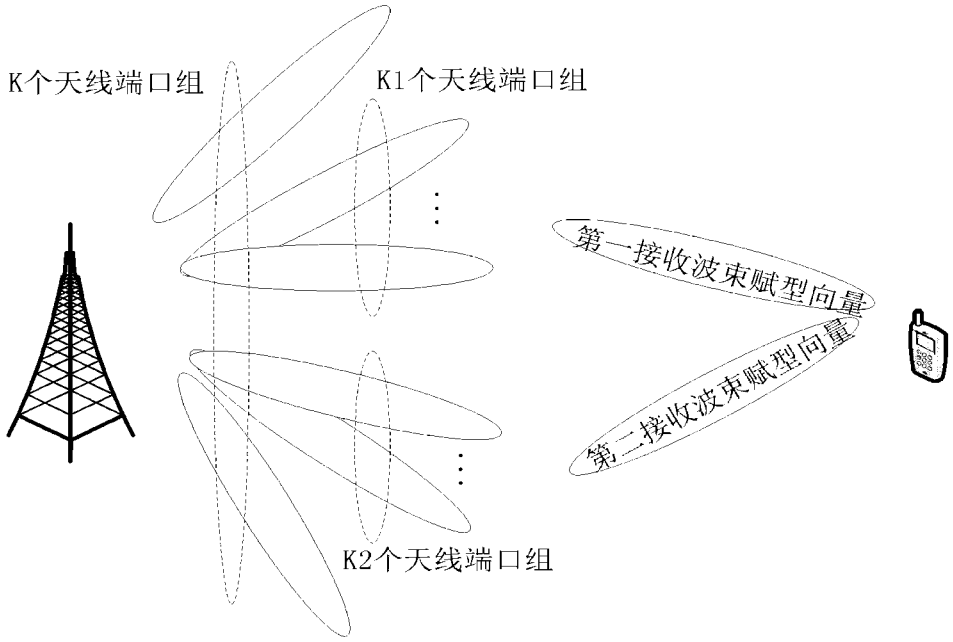

K个天线端口组
K1个天线端口组
第一接收波束赋型向量
第二接收波束赋型向量
K2个天线端口组

图 4

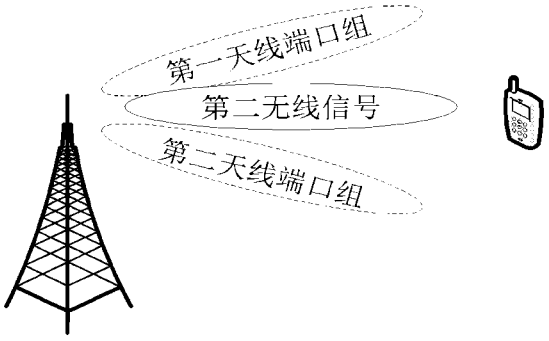

第一天线端口组
第二无线信号
第二天线端口组

图 5

说 明 书 附 图

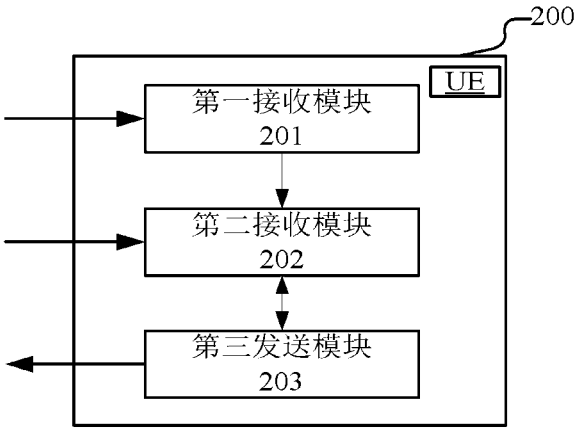

200
UE
第一接收模块
201
第二接收模块
202
第三发送模块
203

图 6

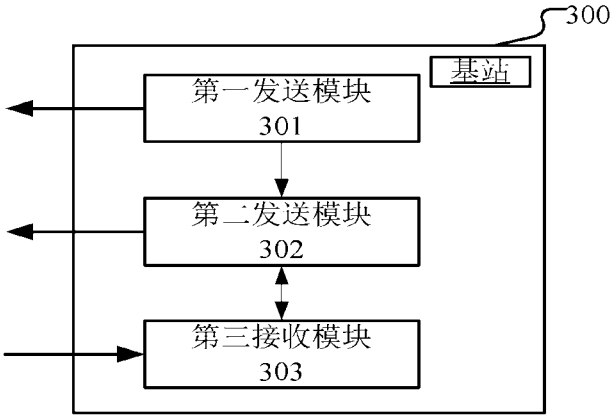

300
基站
第一发送模块
301
第二发送模块
302
第三接收模块
303

图 7

2016112369232

说 明 书 附 图

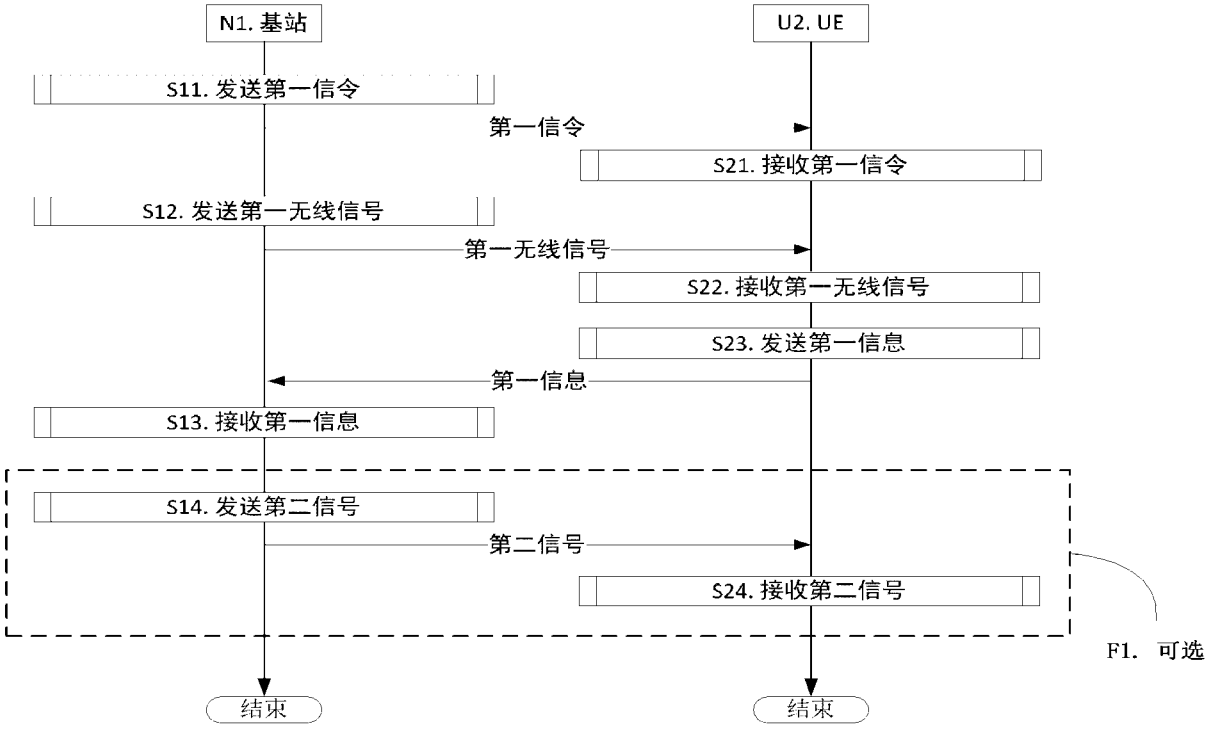


图 1

说 明 书 附 图

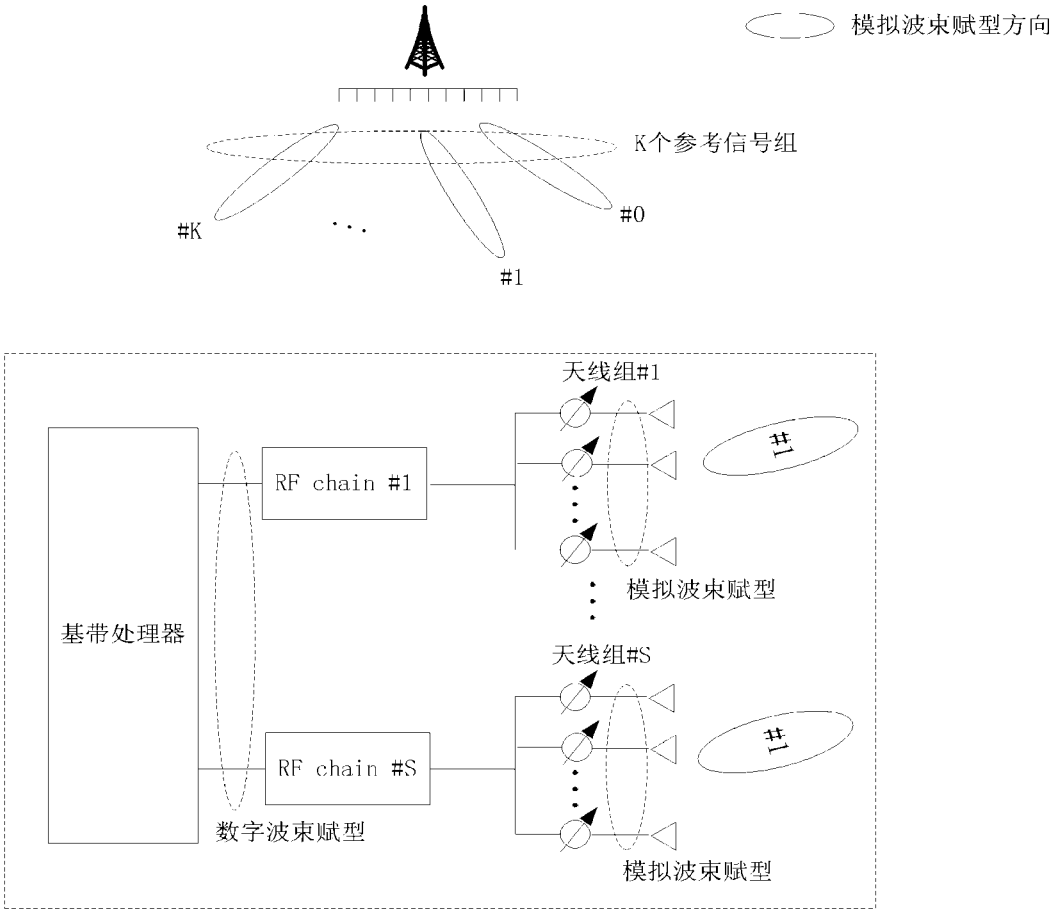

模拟波束赋型方向
K个参考信号组
#K
#0
#1
天线组#1
RF chain #1
基带处理器
模拟波束赋型
天线组#S
RF chain #S
数字波束赋型
模拟波束赋型
天线端口

图 2

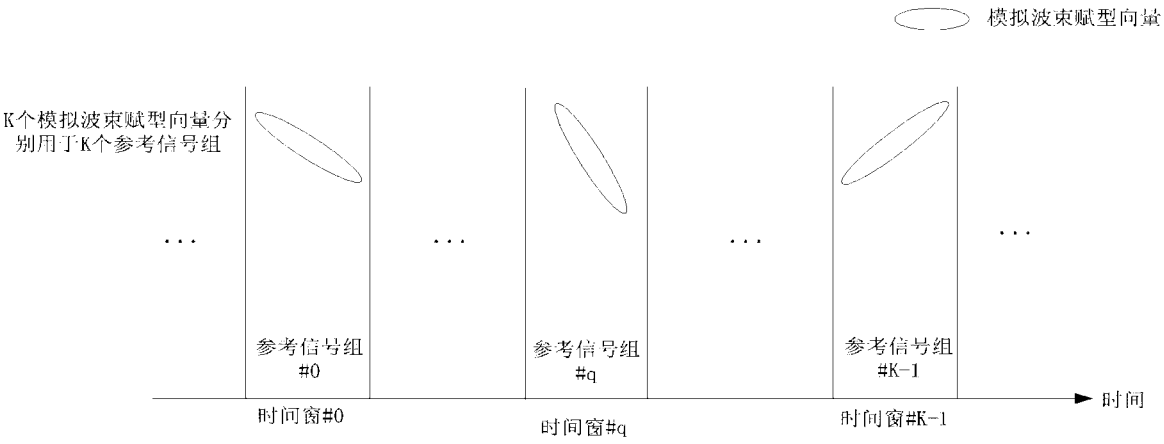

模拟波束赋型向量
K个模拟波束赋型向量分别用于K个参考信号组
参考信号组 #0
参考信号组 #q
参考信号组 #K-1
时间
时间窗#0
时间窗#q
时间窗#K-1

图 3

说 明 书 附 图

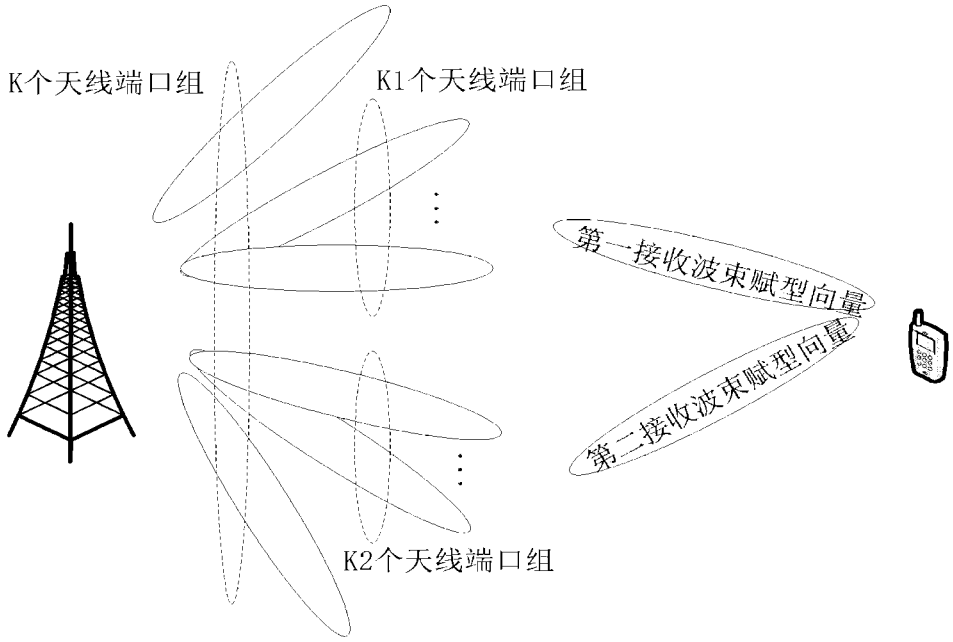

K个天线端口组
K1个天线端口组
第一接收波束赋型向量
第二接收波束赋型向量
K2个天线端口组

图 4

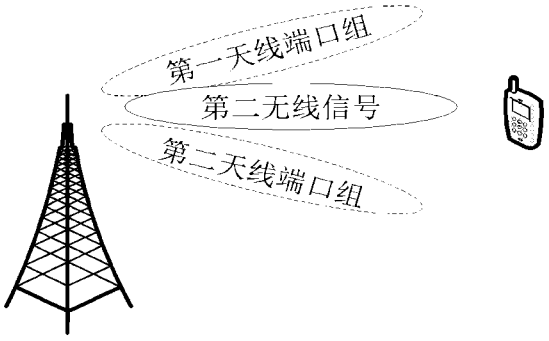

第一天线端口组
第二无线信号
第二天线端口组

图 5

说 明 书 附 图

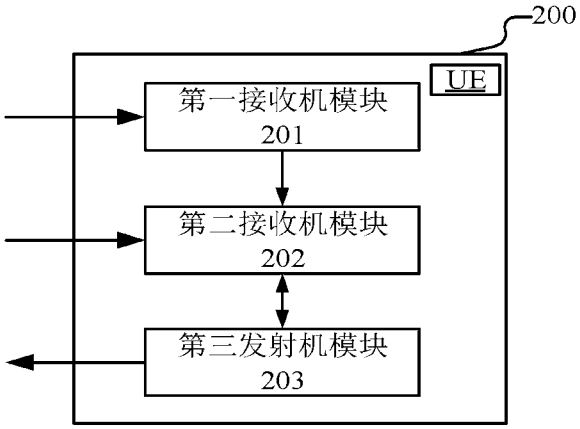

200
UE
第一接收机模块
201
第二接收机模块
202
第三发射机模块
203

图 6

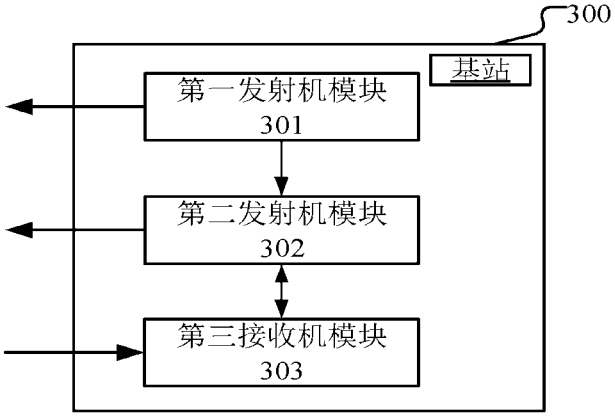

300
基站
第一发射机模块
301
第二发射机模块
302
第三接收机模块
303

图 7

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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
16/454,075	06/27/2019	2649	1015	20160102-PCT-US	20	4

CONFIRMATION NO. 3768

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

FILING RECEIPT



Date Mailed: 07/11/2019

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

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

Inventor(s)

Xiaobo ZHANG, Shanghai, CHINA;

Applicant(s)

Xiaobo ZHANG, Shanghai, CHINA;

Assignment For Published Patent Application

SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED, Shanghai, CHINA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of PCT/CN2017/094209 07/25/2017

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 201611236923.2 12/28/2016 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: 07/09/2019
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/454,075**
Projected Publication Date: 10/17/2019
Non-Publication Request: No
Early Publication Request: No
**** SMALL ENTITY ****
Title

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

Preliminary Class

455

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

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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).

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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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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/454,075

APPLICATION AS FILED - PART I

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

APPLICATION AS AMENDED - PART II

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	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
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.

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
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2019-06-27
First Named Inventor	XiaoBo ZHANG
Art Unit	-
Examiner Name	Not Yet Assigned
Attorney Docket Number	20160102-PCT-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	1	106034360	CN	A	2016-10-19	LONGBO COMMUNICATION TECHNICAL CO LTD		☓
	2	106209195	CN	A	2016-12-07	CHINA ACADEMY TELECOMMUNICATIONS TECHNOLOGY		☒
	3	105474556	CN	A	2016-04-06	INTEL CORPORATION		☒

EFS Web 2.1.17

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-06-27
	First Named Inventor	XiaoBo ZHANG
	Art Unit	-
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	20160102-PCT-US

	4	105580468	CN	A	2016-05-11	NTT DOCOMO INC		☒
	5	106211338	CN	A	2016-12-07	ZTE WAVETONE SCINECE&TECHNOLOGY LTD		☒

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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.	T[5]
	1	CN 1st Search Report received in application no. 201611236923.2 dated November 30, 2018	
	2	CN 1st Office Action received in application no. 201611236923.2 dated December 10, 2018	
	3	CN Notice of Allowance received in application no. 201611236923.2 dated January 14, 2019	

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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	
	Filing Date	2019-06-27
	First Named Inventor	XiaoBo ZHANG
	Art Unit	-
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	20160102-PCT-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/XiaoBo ZHANG/	Date (YYYY-MM-DD)	2019-06-27
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.**

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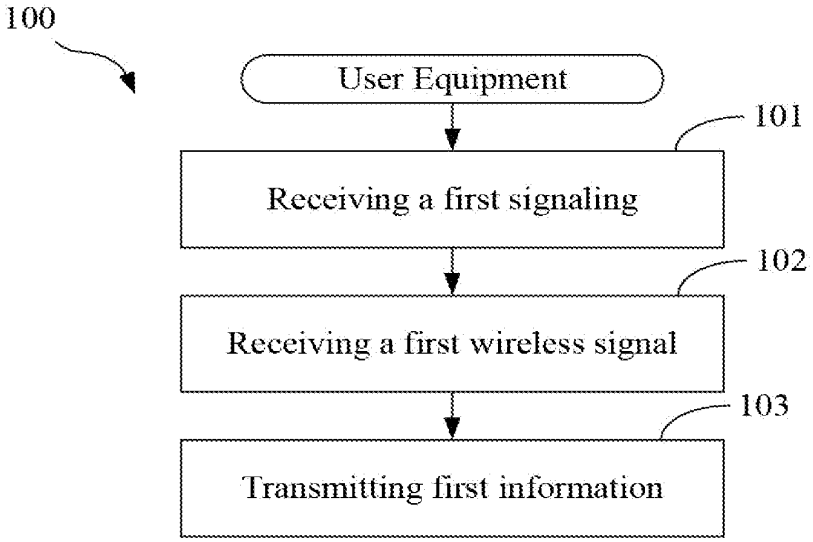

100
User Equipment
101
Receiving a first signaling
102
Receiving a first wireless signal
103
Transmitting first information

Fig. 1

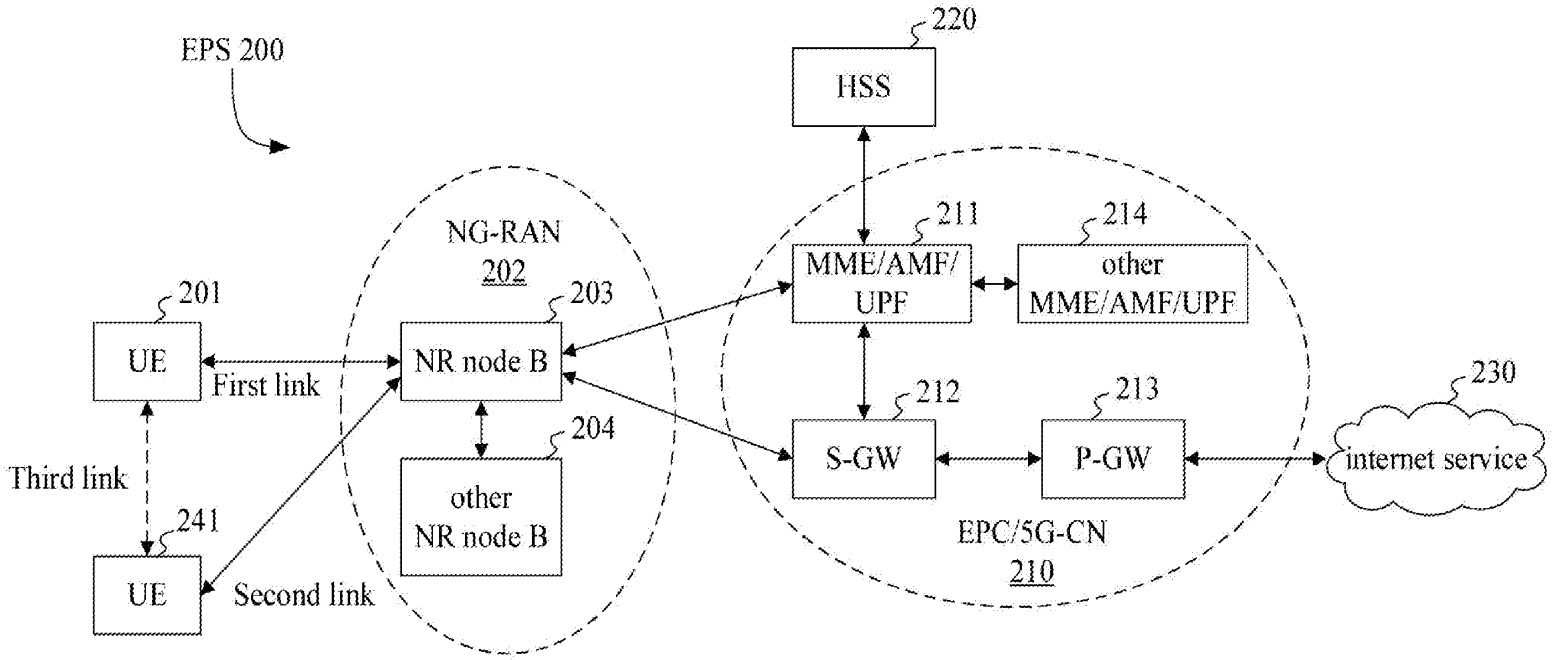

EPS 200
220
HSS
NG-RAN
202
211
MME/AMF/
UPF
214
other
MME/AMF/UPF
201
UE
First link
203
NR node B
212
S-GW
213
P-GW
230
internet service
Third link
204
other
NR node B
241
UE
Second link
EPC/5G-CN
210

Fig. 2

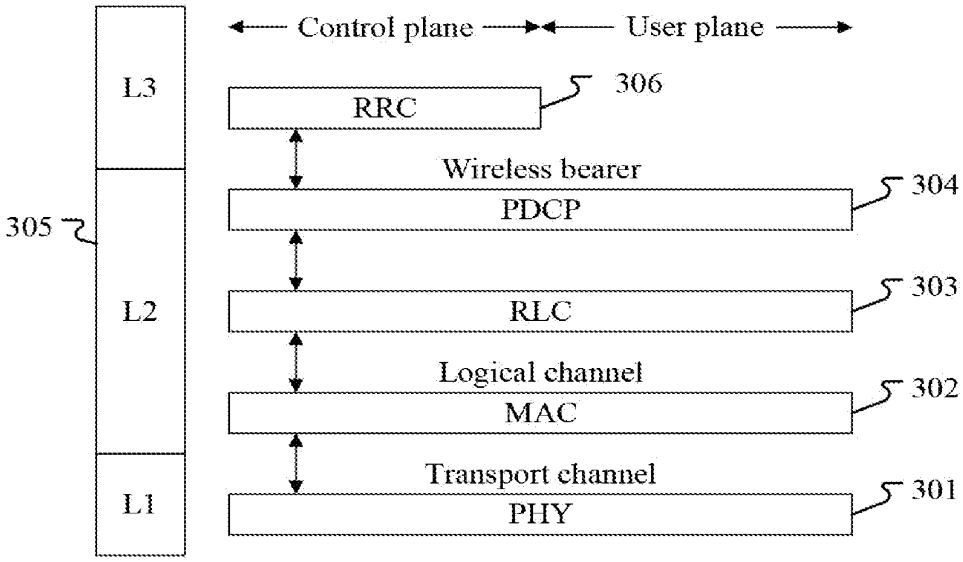

Control plane
User plane
L3
L2
L1
305
RRC
306
Wireless bearer
PDCP
304
RLC
303
Logical channel
MAC
302
Transport channel
PHY
301

Fig. 3

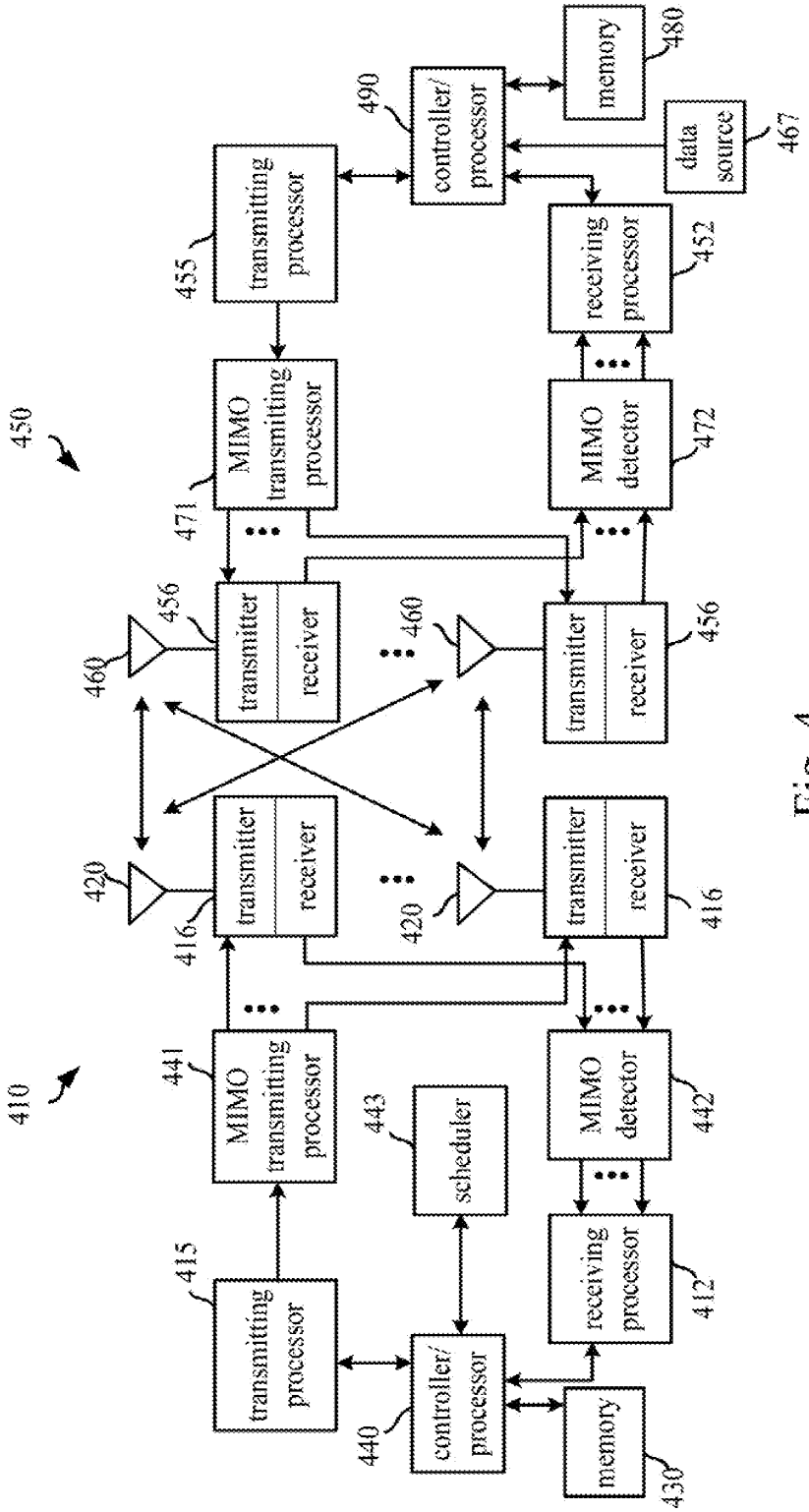

410
450
transmitting processor
415
MIMO transmitting processor
441
scheduler
443
controller/ processor
440
memory
430
receiving processor
412
MIMO detector
442
transmitter
receiver
416
420
460
transmitter
receiver
456
MIMO transmitting processor
471
transmitting processor
455
MIMO detector
472
receiving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

Fig. 4

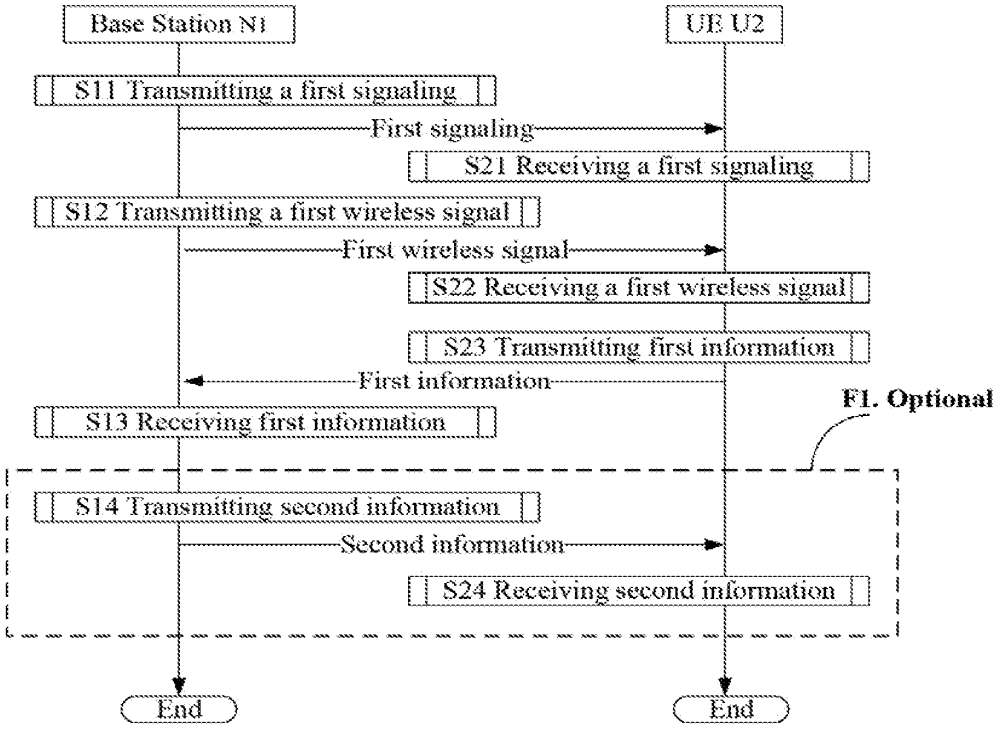

Base Station N1
UE U2
S11 Transmitting a first signaling
First signaling
S21 Receiving a first signaling
S12 Transmitting a first wireless signal
First wireless signal
S22 Receiving a first wireless signal
S23 Transmitting first information
First information
F1. Optional
S13 Receiving first information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

Fig. 5

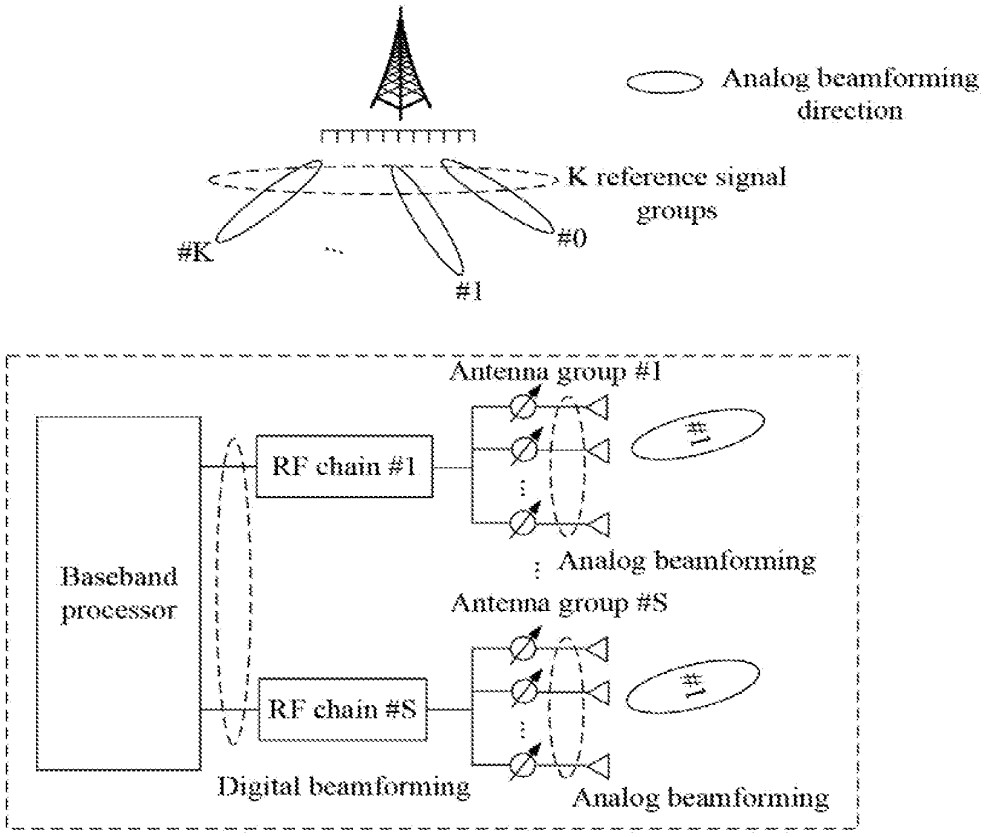

Analog beamforming direction
K reference signal groups
#K
#0
#1
Antenna group #1
RF chain #1
Baseband processor
Analog beamforming
Antenna group #S
RF chain #S
Digital beamforming
Analog beamforming
Antenna group

Fig. 6

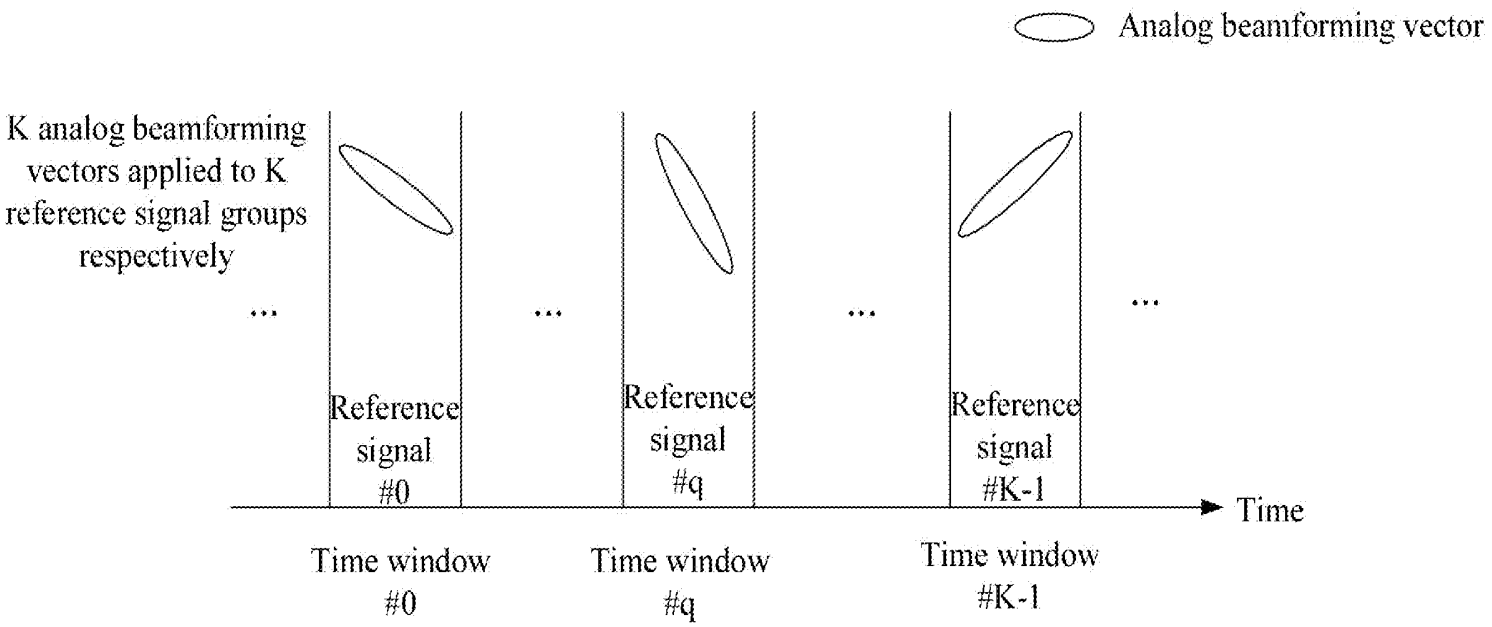

Analog beamforming vector
K analog beamforming vectors applied to K reference signal groups respectively
...
...
...
...
Reference signal #0
Reference signal #q
Reference signal #K-1
Time
Time window #0
Time window #q
Time window #K-1

FIG. 7

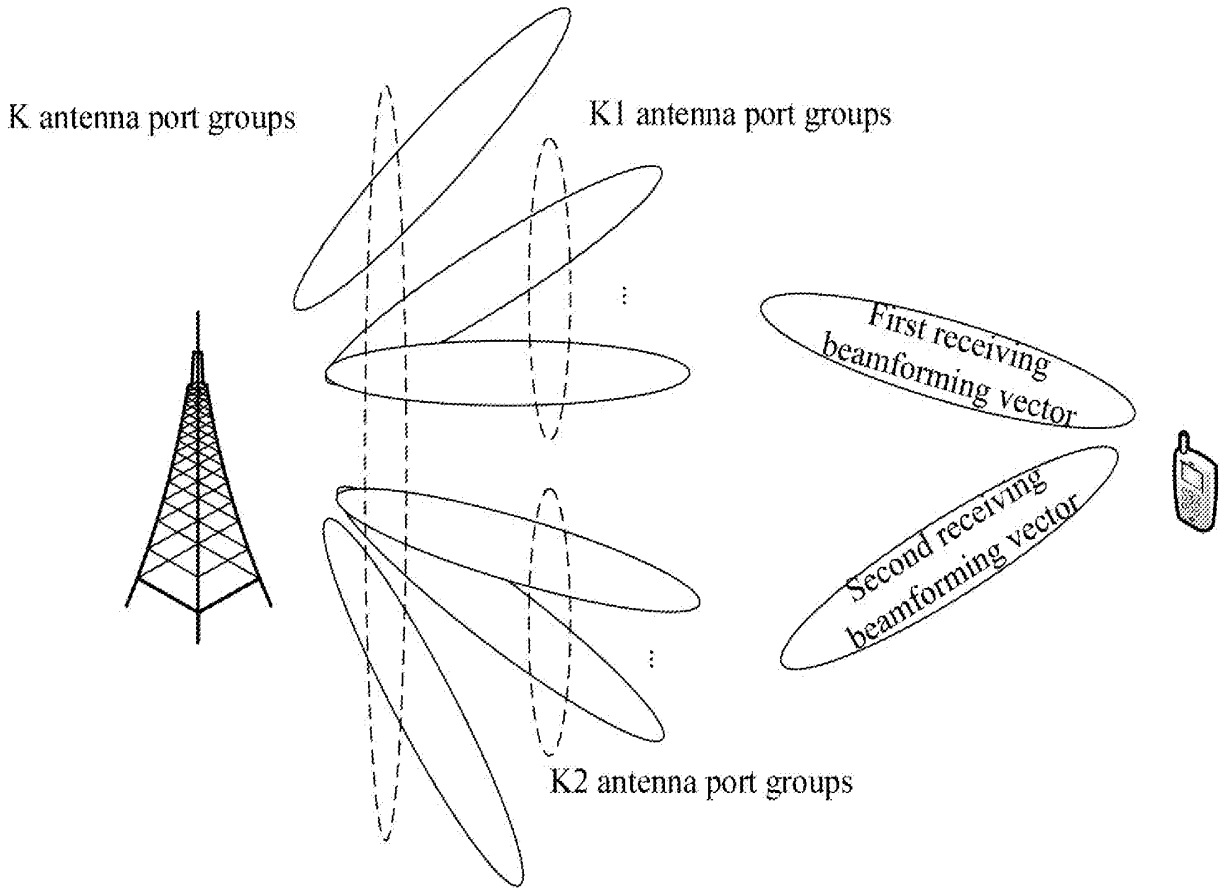

K antenna port groups
K1 antenna port groups
First receiving beamforming vector
Second receiving beamforming vector
K2 antenna port groups

FIG. 8

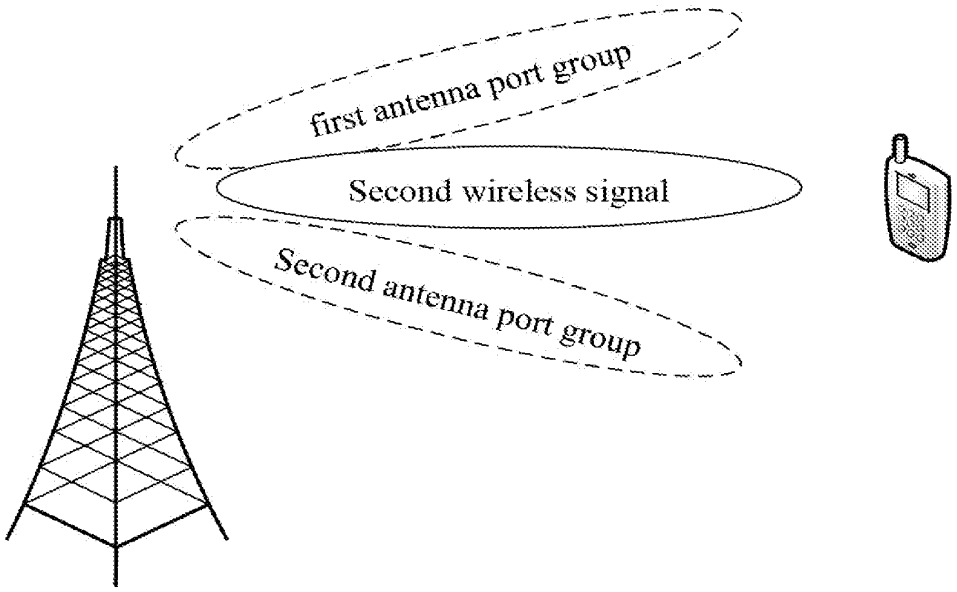

first antenna port group
Second wireless signal
Second antenna port group

Fig. 9

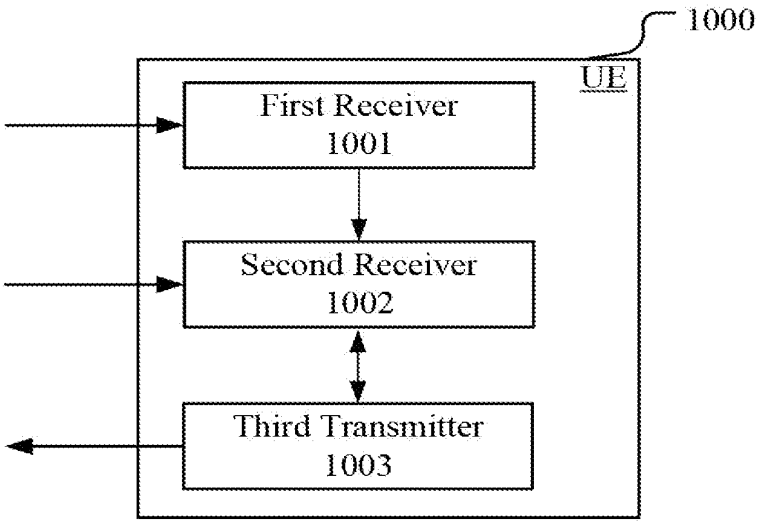

1000
UE
First Receiver
1001
Second Receiver
1002
Third Transmitter
1003

Fig. 10

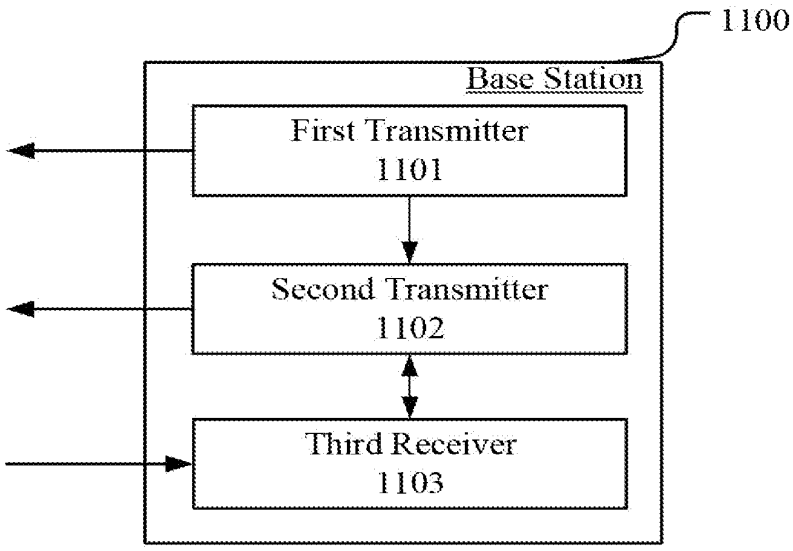

1100
Base Station
First Transmitter
1101
Second Transmitter
1102
Third Receiver
1103

Fig. 11

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

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of International Application No. PCT/CN2017/094209, filed July 25, 2017, claiming the priority benefit of Chinese Patent Application Serial Number 201611236923.2, filed on December 28, 2016, the full disclosure of which is incorporated herein by reference.

BACKGROUND

TECHNICAL FIELD

[0002] The present disclosure relates to a scheme for multi-antenna transmission 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 in a specific direction through beamforming. Massive MIMO can also form different directions through multiple antennas for serving multiple users to improve the throughput of massive MIMO systems and reduce transmission delay.

[0004] According to the discussion of 3rd Generation Partner Project (3GPP) Radio Access Network 1 (RAN1), a hybrid beamforming in combination of analog beamforming and digital precoding has become an important research topic for New Radio Technology (NR) systems.

SUMMARY

[0005] Through research, the inventors found that in a massive MIMO system, the base station can perform beam scanning over a period of time resources. The UE selects and reports the beam. However, due to the limitation of air interface resources, the number of beams used for beam scanning and the number of beams reported by the UE are limited. In addition, due to the uncertainty of the UE location, the beam used for beam scanning does not necessarily include the beam that best serves the UE. How to

use the information reported by the UE to form the best beam to serve the UE service is an urgent problem to be solved.

[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 embodiments in the user equipment (UE) and the features in the embodiments of the present disclosure can be applied to the base station, and vice versa. Further, in case of no conflicts, the embodiments of the present disclosure and the features of the embodiments may be arbitrarily combined with each other.

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

[0008] receiving a first signaling;

[0009] receiving a first wireless signal; and

[0010] transmitting first information;

[0011] wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine {the K1 antenna port groups, the first proportional sequence}; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

[0012] In the embodiment, the advantage of the foregoing method is that the base station may obtain a proportional relationship among reception qualities corresponding to multiple beams, and may generate a more accurate serving beam for the UE according to the proportional relationship, thereby improving transmission quality.

[0013] In one embodiment, the beams and the serving beam are analog beams.

[0014] In one embodiment, the antenna port is formed by superimposing multiple physical antennas through antenna virtualization. A mapping coefficient of the antenna port to the plurality of physical antennas constitutes a beamforming vector for the antenna virtualization to form a beam.

[0015] In one embodiment, the antenna virtualization includes analog beamforming and digital beamforming. The analog beamforming is a mapping of an RF link output to the plurality of physical antennas and is used to form an analog beam. The digital beamforming is a mapping of the antenna port to the RF link and is used to form a digital beam.

[0016] In one embodiment, the beamforming vector is a product of an analog beamforming matrix and a digital beamforming vector. The analog beamforming matrix is composed of one or more analog beamforming vectors.

[0017] In one embodiment, the beamforming vector is a Kronecker product of an analog beamforming vector and a digital beamforming vector.

[0018] In one embodiment, the antenna virtualization only includes analog beamforming.

[0019] In one embodiment, the antenna port group is composed of one antenna port.

[0020] In one embodiment, the antenna port group is composed of a plurality of antenna ports.

[0021] In one embodiment, the same analog beamforming vectors and different digital beamforming vectors are used for antenna virtualization of different antenna ports within the antenna port group.

[0022] In one embodiment, the K antenna port groups include two antenna port groups, and the numbers of the antenna ports included in the two antenna port groups are different.

[0023] In one embodiment, the antenna port corresponds to a reference signal. The reference signal is transmitted through the antenna port.

[0024] In one embodiment, the reference signal is a reference symbol.

[0025] In one embodiment, the reference signal includes a plurality of reference

symbols. One reference symbol occupies one Resource Element (RE).

[0026] In one embodiment, the reference signal is a Synchronization Signal (SS).

[0027] In one embodiment, the reference signal is a Primary Synchronization Signal (PSS).

[0028] In one embodiment, the reference signal is a Secondary Synchronization Signal (SSS).

[0029] In one embodiment, the reference signal is a Channel State Information Reference Signal (CSI-RS).

[0030] In one embodiment, the reference signal is a Demodulation Reference Signal (DMRS).

[0031] In one embodiment, the reference signal is a DMRS of a Physical Broadcast Channel (PBCH).

[0032] In one embodiment, the reference signal is a DMRS of a Physical Downlink Share Channel (PDSCH).

[0033] In one embodiment, the first wireless signal is a plurality of multi-carrier symbols.

[0034] In one embodiment, the first wireless signal is an SS burst. The SS burst includes a plurality of SS blocks. The SS blocks include at least one synchronization signal.

[0035] In one embodiment, the first wireless signal is an CSI-RS burst.

[0036] In one embodiment, the first wireless signal is one beam sweep. The beam scanning is an operation of covering a spatial area by a transmitted or received beam in a predetermined manner over a period of time.

[0037] In one embodiment, the K antenna port groups respectively correspond to K reference signal groups. The K reference signal groups are respectively transmitted through the K antenna port groups. The first wireless signal is composed of the K reference signal groups.

[0038] In one embodiment, K different analog beamforming vectors are used for analog beamforming of the K antenna port groups.

[0039] In one embodiment, the time-frequency pattern and the Orthogonal Cover

Code (OCC) of at least two reference signals of the K reference signal groups are the same in one time unit. The two reference signals are transmitted on different time resources.

[0040] In one embodiment, the time unit is a symbol.

[0041] In one embodiment, the time unit is a time slot.

[0042] In one embodiment, the time unit is a subframe.

[0043] In one embodiment, the time unit is a short Transmission Time Interval (sTTI).

[0044] In one embodiment, the first signaling explicitly indicates the K antenna port groups.

[0045] In one embodiment, the first signaling implicitly indicates the K antenna port groups.

[0046] In one embodiment, the first signaling is higher layer signaling.

[0047] In one embodiment, the first signaling is a Radio Resource Control (RRC) signaling.

[0048] In one embodiment, the first signaling is a MAC layer signaling.

[0049] In one embodiment, the first signaling is a MAC Control Element (MAC CE).

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

[0051] In one embodiment, the first signaling is carried by a Physical Downlink Control Channel (PDCCH).

[0052] In one embodiment, the first signaling is Downlink Control Information (DCI).

[0053] In one embodiment, the first signaling is common to the cell.

[0054] In one embodiment, the first signaling is UE-specific.

[0055] In one embodiment, the first signaling is UE group specific.

[0056] In one embodiment, the channel quality value is one of instantaneous Reference Signal Received Power (RSRP), long-term RSRP, SINR or SNR.

[0057] In one embodiment, the K channel quality values are wideband channel quality values.

[0058] In one embodiment, the first information explicitly indicates the K1 antenna port groups.

[0059] In one embodiment, the first information implicitly indicates the K1 antenna

port groups.

[0060] In one embodiment, the first information explicitly indicates the first proportional sequence.

[0061] In one embodiment, the first information implicitly indicates the first proportional sequence.

[0062] In one embodiment, the first information is carried by a Physical Uplink Shared Channel (PUSCH).

[0063] In one embodiment, the first information is carried by a Physical Uplink Control Channel (PUCCH).

[0064] In one embodiment, the first information is transmitted in a CSI report.

[0065] In one embodiment, the first information is transmitted in a plurality of messages.

[0066] In one embodiment, a bitmap is used to determine the K1 antenna port groups.

[0067] In one embodiment, the K1 antenna port groups correspond to the same receiving beamforming vector.

[0068] In one embodiment, the receiving beamforming vector is an analog receiving beamforming vector.

[0069] In one embodiment, the K antenna port groups are represented by a bit string of length K, the bit position corresponding to the K1 antenna port groups is 1, and the other bit positions are 0.

[0070] In one embodiment, the K1 is greater than 1.

[0071] In one embodiment, the K1 is equal to 1.

[0072] In one embodiment, the first proportional sequence includes K1-1 positive real number(s). The K1-1 positive real numbers is(are) a ratio(s) between the channel quality values other than the best channel quality value of the K1 channel quality values and the best channel quality value.

[0073] In one embodiment, the first proportional sequence is composed of quantized values corresponding to the K1-1 positive real number(s).

[0074] In one embodiment, when the K1 is equal to 1, the first proportional sequence is determined to be absent.

[0075] In one embodiment, the first proportional sequence is composed of K1 positive real numbers. The K1 positive real numbers are respectively ratios between the K1 channel quality values and the best channel quality value of the K1 channel quality values.

[0076] In one embodiment, the first proportional sequence is composed of quantized values corresponding to the K1 positive real numbers.

[0077] In one embodiment, the first proportional sequence is composed of K1 positive real numbers less than or equal to 1, and the first proportional sequence includes at least one 1.

[0078] In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a service beam for data transmission with the UE.

[0079] In one embodiment, the transmitter of the first wireless signal determines a correspondence between a service beam related to a relative position of the UE and a collection of the K1 antenna ports and the first proportional sequence according to the coverage space, and then determines the service beam according to the K1 antenna ports and the first proportional sequence reported by the UE.

[0080] In one embodiment, the first antenna port group and the second antenna port group are two antenna port groups of the K1 antenna port groups, and the K1 is equal to 2. A first beamforming vector is used for beamforming of the first antenna port group, and a second beamforming vector is used for beamforming of the second antenna port group. The first proportional sequence is composed of a first element and a second element, wherein the first element corresponds to the first antenna port group, and the second element corresponds to the second antenna port group. The first element is equal to 1, the second element is equal to a, and the a is a positive real number less than 1.

[0081] In one embodiment, a transmitter of the first wireless signal uses the first element and the second element to respectively weight the direction corresponding to the first beamforming vector and the direction corresponding to the second beamforming vector so as to obtain a direction corresponding to the service beam.

[0082] In one embodiment, a correspondence table is stored in the transmitter of the

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

[0083] In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a signal for the next beam scanning. The variables of the generation function of the plurality of beamforming vectors used by the signal are the K1 beamforming vectors and the first proportional sequence.

[0084] In one embodiment, a center of the coverage space of the plurality of beamforming vectors is determined by the K1 antenna port groups and the first proportional sequence.

[0085] In one embodiment, the K channel quality values are wideband channel quality values.

[0086] In one embodiment, the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence includes K1-1 positive real number(s), and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises a quantized value(s) corresponding to K1-1 positive real number(s).

[0087] In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2

antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

[0088] In the embodiments, the above methods have the advantages that multiple candidate service beams are generated for different receive beamforming vectors through different beamforming vectors and different proportional sequences of different antenna port groups respectively, thereby increasing the transmission diversity effects.

[0089] In one embodiment, the antenna ports in the K1 antenna port groups and the antenna ports in the K2 antenna port groups do not overlap.

[0090] In one embodiment, the K1 antenna port groups, and the first proportional sequence are used to generate a first transmitting beamforming vector, while the K2 antenna port groups and the second proportional sequence are used to generate a second transmitting beamforming vector. The first transmitting beamforming vector and the first receiving beamforming vector are used for beamforming of data transmission over a first time window; the second transmitting beamforming vector and the second receiving beamforming vector are used for beamforming of data transmission over a second time window. The first time window and the second time window are orthogonal in time domain.

[0091] In one embodiment, the first target channel quality is a function of the K1 channel quality values and the second target channel quality is a function of the K2 channel quality values. The first transmitting beamforming vector is used preferentially when the first target channel quality is higher than the second target channel quality.

[0092] In one embodiment, the first target channel quality and the second target channel quality are respectively a weighted average of the K1 channel quality values and the K2 channel quality values. The first proportional sequence and the second proportional sequence are used for the weighted average respectively.

[0093] In one embodiment, the first target channel quality and the second target channel quality are respectively an average of the K1 channel quality values and the K2 channel quality values.

[0094] In one embodiment, the transmitting beamforming vector and the receiving beamforming vector are analog beamforming vectors.

[0095] In one embodiment, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna port groups in the K1 antenna port groups are on a same carrier, and any two antenna port groups in the K2 antenna port groups are on a same carrier.

[0096] In the embodiments, an advantage of the above method is that the base station can utilize the first proportional sequence more efficiently by using the K1 antenna port groups to indicate the co-located (quasi-co-located) or co-carrier antenna ports.

[0097] In one embodiment, the first signaling is used to determine the co-located or QCL information.

[0098] In one embodiment, the first signaling explicitly indicates the co-located or QCL information.

[0099] In one embodiment, the first signaling implicitly indicates the co-located or QCL information.

[0100] In one embodiment, the first signaling is used to determine information of the co-carrier.

[0101] In one embodiment, the first signaling explicitly indicates the information of the co-carrier.

[0102] In one embodiment, the first signaling implicitly indicates the information of the co-carrier.

[0103] In one embodiment, the first signaling is also used to determine at least the last one of the K1, the K2 and the target threshold. A third channel quality is a best channel quality value of the K2 channel quality values. A fourth channel quality is the worst channel quality value of the K2 channel quality values. The ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

[0104] In the embodiments, the advantage of the above method is that the target threshold can be used to control the reporting overhead, thereby improving the reporting

efficiency.

[0105] In one embodiment, the unit of the target threshold is dB.

[0106] In one embodiment, the first signaling explicitly indicates at least the last of the K1, the K2 and the target threshold.

[0107] In one embodiment, the first signaling implicitly indicates at least the last of the K1, the K2 and the target threshold.

[0108] In one embodiment, the first signaling is transmitted in a plurality of messages.

[0109] In one embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

[0110] In the embodiments, the advantage of the above method is that the base station may approximately recover the K1 channel qualities (the K2 channel qualities) by using the first channel quality (the third channel quality) and the first proportional sequence (the second proportional sequence), thereby improving flexibility for beam generation and scheduling.

[0111] In one embodiment, the first information is transmitted in a plurality of messages.

[0112] In one embodiment, the portion of the first information used to determine the first channel quality (the third channel quality) is transmitted in a measurement report; the portion of the first information used to determine the K1 antenna port groups, and the first proportional sequence (the K2 antenna port groups and the second proportional sequence) is transmitted in a CSI report.

[0113] In one embodiment, the method for multi-antenna transmission in a UE further comprises:

[0114] receiving a second wireless signal;

[0115] wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

[0116] In the embodiment, the above method has the advantages that the beamforming vector corresponding to the K1 antenna port groups and the first proportional sequence ,

or the beamforming vector corresponding to the K2 antenna port groups and the second proportional sequence are used for beamforming of the second wireless signal to increase beamforming gain acting on the second wireless signal.

[0117] In one embodiment, the transmitting beamforming vector corresponding to the K1 antenna port groups is used to generate a transmitting beamforming vector of the second wireless signal.

[0118] In one embodiment, the transmitting beamforming vector corresponding to the K2 antenna port groups is used to generate a transmitting beamforming vector of the second wireless signal.

[0119] In one embodiment, when the transmitting beamforming vector corresponding to the K1 antenna port groups is used to generate a transmitting beamforming vector of the second wireless signal, the first receiving beamforming vector is used to receive the second a wireless signal; when the transmitting beamforming vector corresponding to the K2 antenna port groups is used to generate a transmit beamforming vector of the second wireless signal, the second receiving beamforming vector is used for receive the he second wireless signal.

[0120] In one embodiment, the transmitting beamforming vector and the receiving beamforming vector are analog beamforming vectors.

[0121] In one embodiment, the second wireless signal is a signal carried by a PDCCH.

[0122] In one embodiment, the second wireless signal is a signal carried by a PDSCH.

[0123] In one embodiment, the second wireless signal is a reference signal.

[0124] The present disclosure provides a method for multi-antenna transmission in a base station, including:

[0125] transmitting a first signaling;

[0126] transmitting a first wireless signal; and

[0127] receiving first information;

[0128] wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1

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

[0129] In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a service beam for data transmission with the UE.

[0130] In one embodiment, the base determines a correspondence between a service beam related to a relative position of the UE and the collection of the K1 antenna ports and the first proportional sequence according to the coverage space, and then determines the service beam according to the K1 antenna ports and the first proportional sequence reported by the UE.

[0131] In one embodiment, a correspondence table is stored in the base station. The correspondence table is used to determine a correspondence between a service beam of the UE and the collection of the K1 antenna ports and the first proportional sequence. The base station retrieves the correspondence table according to the first antenna port group, the second antenna port group and the first proportional sequence to obtain an analog beam direction for communication with the UE.

[0132] In one embodiment, the K1 beamforming vectors and the first proportional sequence respectively corresponding to the K1 antenna port groups are used to generate a signal for the next beam scanning. The variables of the generation function of the plurality of beamforming vectors used by the signal are the K1 beamforming vectors and the first proportional sequence.

[0133] In one embodiment, a center of the coverage space of the plurality of

beamforming vectors is determined by the K1 antenna port groups and the first proportional sequence.

[0134] In one embodiment, the K channel quality values are wideband channel quality values.

[0135] In one embodiment, the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; Or the first proportional sequence includes K1-1 positive real number(s), and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises a quantized value(s) corresponding to K1-1 positive real number(s).

[0136] In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

[0137] In one embodiment, the first information is further used by the base station to determine the first receive beamforming vector and the second receive beamforming vector.

[0138] In one embodiment, the first information explicitly indicates the first receive beamforming vector and the second receive beamforming vector.

[0139] In one embodiment, the first information implicitly indicates the first receive beamforming vector and the second receive beamforming vector.

[0140] In one embodiment, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2

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

[0141] In one embodiment, the base station generates a service beam by using a co-located (quasi-co-located) or a co-carrier beamforming vector and its corresponding proportional sequence.

[0142] In one embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold. A third channel quality is a best channel quality value among the K2 channel quality values. A fourth channel quality is a worse channel quality value among the K2 channel quality values. A ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold

[0143] In one embodiment, the base station controls reporting overhead by K1, the K2, and the target threshold.

[0144] In one embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

[0145] In one embodiment, the base station approximately recovers the K1 channel quality values in combination with the first channel quality, the K1 antenna port groups and the first proportional sequence for multi-user MIMO scheduling.

[0146] In one embodiment, the base station approximately recovers the K2 channel quality values in combination with the third channel quality, the K2 antenna port groups and the second proportional sequence for multi-user MIMO scheduling.

[0147] In one embodiment, the method for multi-antenna transmission in a base station further includes:

[0148] transmitting a second wireless signal;

[0149] wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and , or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

[0150] In one embodiment, the K1 beamforming vectors and corresponding to the

K1 antenna port groups are used to generate a target beamforming vector. The target beamforming vector is used for beamforming of the target antenna port group.

[0151] In one embodiment, the K2 beamforming vectors and corresponding to the K2 antenna port groups are used to generate a target beamforming vector. The target beamforming vector is used for beamforming of the target antenna port group.

[0152] The present disclosure provides a user equipment (UE) for multi-antenna transmission, including:

[0153] a first receiver, receiving a first signaling;

[0154] a second receiver, receiving a first wireless signal; and

[0155] a third transmitter, transmitting first information;

[0156] wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and ; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

[0157] In one embodiment of the above user equipment, the K channel quality values are broadband channel quality values.

[0158] In one embodiment of the above user equipment, includes K1 positive real numbers less than or equal to 1, and comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; the first proportional sequence comprises K1-1 positive real numbers, and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other

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

[0159] In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

[0160] In one embodiment of the above user equipment, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna port groups in the K1 antenna port groups are on a same carrier, and any two antenna port groups in the K2 antenna port groups are on a same carrier.

[0161] In one embodiment of the above user equipment, the first signaling is also used to determine at least the last one of the K1, the K2, or the target threshold. A third channel quality is a best channel quality value of the K2 channel quality values. A fourth channel quality is the worst channel quality value of the K2 channel quality values. The ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

[0162] In one embodiment of the above user equipment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

[0163] In one embodiment of the above user equipment, the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence; or the target antenna port

group is associated with the K2 antenna port groups and the first proportional sequence.

[0164] The present disclosure provides a base station for multi-antenna transmission, including:

[0165] a first transmitter, transmitting a first signaling;

[0166] a second transmitter, transmitting a first wireless signal; and

[0167] a third receiver, receiving first information;

[0168] wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence; the first signaling is used to determine a target threshold; the target threshold is a non-negative real number; a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values; a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.

[0169] In one embodiment of the above base station, the K channel quality values are broadband channel quality values.

[0170] In one embodiment of the above base station, the first proportional sequence includes K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; the first proportional sequence comprises K1-1 positive real numbers, and the K1-1 positive real numbers is(are) a ratio(ratios) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises a quantized value(s) corresponding to K1-

1 positive real number(s).

[0171] In one embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence corresponds to a ratio among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine K2 antenna port groups and the second proportional sequence.

[0172] In one embodiment of the above base station, any two antenna port groups in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna port groups in the K1 antenna port groups are on a same carrier, and any two antenna port groups in the K2 antenna port groups are on a same carrier.

[0173] In one embodiment of the above base station, the first signaling is also used to determine at least the last one of the K1, the K2, or the target threshold. A third channel quality is a best channel quality value of the K2 channel quality values. A fourth channel quality is the worst channel quality value of the K2 channel quality values. The ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

[0174] In one embodiment of the above base station, the first information is further used to determine at least one of the first channel quality or the third channel quality.

[0175] In one embodiment of the above base station, the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence; or the target antenna port group is associated with the K2 antenna port groups and the first proportional sequence.

[0176] Compared with the prior art, the present disclosure has the following

advantages:

[0177] The service beam may be generated and used more flexibly through reporting channel quality ratios to increase beamforming gain.

[0178] The robustness and flexibility of subsequent transmissions are increased by multiple sets of reports for varied receiving beamforming.

[0179] The flexibility of multi-user scheduling of the base station is increased by the reporting of the best channel quality, combined with the reporting of the channel quality ratio.

BRIEF DESCRIPTION OF THE DRAWINGS

[0180] Other features, objects, and advantages of the present disclosure will become more apparent from the detailed description of the accompanying drawings.

[0181] FIG.1 shows a flow chart of transmission of a first signaling, a first wireless signal, and first information in accordance with one embodiment of the present disclosure.

[0182] FIG. 2 shows a schematic diagram of a network architecture in accordance with one embodiment of the present disclosure.

[0183] FIG. 3 shows a schematic diagram of a radio protocol architecture of a user plane and a control plane according to an embodiment of the present disclosure.

[0184] FIG. 4 shows a schematic diagram of a base station device and a given user equipment according to an embodiment of the present disclosure.

[0185] FIG. 5 shows a flow chart of wireless transmission in accordance with one embodiment of the present disclosure.

[0186] FIG. 6 shows a schematic diagram of analog beamforming of K reference signal groups in accordance with an embodiment of the present disclosure.

[0187] FIG. 7 shows a timing diagram of K reference signal groups in accordance with one embodiment of the present disclosure.

[0188] FIG. 8 shows a schematic diagram of K1 antenna port groups and K2 antenna port groups in accordance with one embodiment of the present disclosure.

[0189] FIG. 9 shows a schematic diagram of a second wireless signal beamforming in

accordance with an embodiment of the present disclosure.

[0190] FIG. 10 shows a block diagram showing the structure of a processing device in a UE in accordance with an embodiment of the present disclosure.

[0191] FIG. 11 shows a block diagram showing the structure of a processing device in a base station in accordance with an embodiment of the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0192] Embodiment 1

[0193] Embodiment 1 illustrates a flow chart of transmission of a first signaling, a first wireless signal, and first information in accordance with one embodiment of the present disclosure, as shown in FIG. 1. In FIG. 1, each box represents a step. In Embodiment 1, the user equipment in this disclosure receives a first signaling, receives a first wireless signal, and transmits a first information in sequence. K antenna port groups are used to transmit the first wireless signal. The first signaling is used to determine the K antenna port groups. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. the K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0194] As a sub-embodiment, the first signaling is a higher layer signaling.

[0195] As a sub-embodiment, the first signaling is an RRC signaling.

[0196] As a sub-embodiment, the first signaling is used to determine configuration of Channel State Information report (CSI).

[0197] As a sub-embodiment, the first signaling is an RRC signaling for configuring CSI-RS.

[0198] As a sub-embodiment, the first signaling is an RRC signaling for configuring a beamformed CSI-RS (Beamformed CSI-RS).

[0199] As a sub-embodiment, the first signaling is a physical layer signaling.

[0200] As a sub-embodiment, the first signaling is carried by a PDCCH.

[0201] As a sub-embodiment, the first signaling is used to activate RRC pre-configuration.

[0202] As a sub-embodiment, the K antenna port groups respectively correspond to K reference signal groups.

[0203] As a sub-embodiment, the antenna port group includes only one antenna port.

[0204] As a sub-embodiment, the reference signal group includes only one reference signal.

[0205] As a sub-embodiment, the K is one of 2, 4, 8, 12, 16, 24, and 32.

[0206] As a sub-embodiment, the reference signal is CSI-RS.

[0207] As a sub-embodiment, the reference signal is SS.

[0208] As a sub-embodiment, the first wireless signal is composed of the K reference signal groups.

[0209] As a sub-embodiment, the first wireless signal is composed of K beam-formed CSI-RSs.

[0210] As a sub-embodiment, the channel quality value is one of RSRP, SINR, and SNR.

[0211] As a sub-embodiment, the channel quality values are wideband channel quality values.

[0212] As a sub-embodiment, a wideband channel measurement is used to determine the wideband channel quality values.

[0213] As a sub-embodiment, the wideband channel measurement refers to a channel measurement value for the entire system bandwidth obtained by measuring a channel on the entire system bandwidth.

[0214] As a sub-embodiment, the wideband channel measurement refers to a channel measurement value for the entire subcarrier bandwidth obtained by measuring a channel on the entire sub-carrier bandwidth.

[0215] As a sub-embodiment, the broadband is composed of a plurality of sub-bands, and the sub-bands are composed of one or more Resource Blocks (RBs).

[0216] As a sub-embodiment, one RB includes 12 subcarriers.

[0217] As a sub-embodiment, one sub-band includes 5 RBs.

[0218] As a sub-embodiment, the wideband includes 10 sub-bands.

[0219] As a sub-embodiment, the K1 is smaller than the K.

[0220] As a sub-embodiment, the K1 is one of 2, 3, and 4.

[0221] As a sub-embodiment, the first signaling is used to determine the K.

[0222] As a sub-embodiment, the first signaling is used to determine the K1.

[0223] As a sub-embodiment, the K1 channel quality values are a best channel quality values among the K channel quality values.

[0224] As a sub-embodiment, the first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0225] As a sub-embodiment, the first proportional sequence is composed of K1 non-negative real numbers not greater than one.

[0226] As a sub-embodiment, the first proportional sequence is composed of K1 positive real numbers not greater than one.

[0227] As a sub-embodiment, the first information is used to determine K1-1 non-negative real number(s), and the K1-1 positive real number(s) is(are) a ratio(s) between the channel quality values other than the best channel quality value among the K1 channel quality values and the best channel quality value.

[0228] As a sub-embodiment, the first information is used to determine quantized values corresponding to the K1-1 non-negative real number(s).

[0229] As a sub-embodiment, any one of the K1-1 non-negative real number(s) is not less than 0 and not greater than 1.

[0230] As a sub-embodiment, the K1-1 non-negative real number(s) is(are) used to determine the first proportional sequence.

[0231] As a sub-embodiment, the first information is carried by a PUCCH.

[0232] As a sub-embodiment, the first signal is carried by a PUSCH.

[0233] As a sub-embodiment, the first information is Uplink Control Information (UCI).

[0234] Embodiment 2

[0235] Embodiment 2 illustrates a schematic diagram of a network architecture in accordance with the present disclosure, as shown in FIG. 2. FIG. 2 illustrates a network structure 200 of NR 5G, long-term evolution (LTE) and long-term evolution advanced (LTE-A) systems. The network architecture 200 of NR 5G or LTE may be referred to as an evolve packet system (EPS) 200 or some other suitable terminology. The EPS 200 may include one or more UEs 201, an NG-RAN 902, an Evolved Packet Core (EPC)/5G-Core Network(5G-CN) 210, a home subscriber server (HSS) 220 and an internet service 230. The EPS 200 may be interconnected with other access networks, but for the sake of simplicity, these entities/interfaces are not shown. As shown in FIG. 2, the EPS provides packet switching services. Those skilled in the art would readily appreciate that the various concepts presented throughout this disclosure can be extended to networks or other cellular networks that provide circuit switching services. The NG-RAN comprises an NR Node B (gNB) 203 and other gNBs 204. The gNB 203 provides user and control plane protocol terminations for the UE 201. The gNB 203 can be connected to other gNBs 204 via an Xn interface (e.g., a backhaul). The gNB 203 may also be referred to as a base station, a base transceiver station, a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), a transmission and reception point (TRP), or some other suitable terminology. The gNB 203 provides the UE201 with an access point to the EPC/5G-CN 210. In the embodiment, the UE201 comprises cellular telephones, smart phones, Session Initiation Protocol (SIP) phones, laptop computers, personal digital assistants (PDAs), satellite radios, non-ground base station communications, satellite mobile communications, global positioning systems, multimedia devices, video devices, digital audio player (e.g. MP3 players), cameras, game consoles, drones, aircrafts, narrowband physical network devices, machine type communication devices, land vehicles, cars, wearable devices, or any other similar to functional devices. A person skilled in the art may also refer to UE 201 as a mobile station, a subscriber station, a mobile unit, a subscriber unit, a radio unit, a remote unit, a mobile device, a radio device, a radio communication device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a radio terminal, remote terminal, handset, user agent, mobile client, client or some other suitable term. The gNB 203 is connected to the EPC/5G-CN 210 through an S1/NG interface. The EPC/5G-CN 210 comprises an

MME/AMF/UPF 211, other MMEs/AMFs/UPFs 214, a Service Gateway (S-GW) 212 and a Packet Date Network Gateway (P-GW) 213. The MME/AMF/UPF 211 is a control node that handles a signaling between the UE 201 and the EPC/5G-CN 210. In general, the MME/AMF/UPF 211 provides carrier and connection management. All User Internet Protocol (IP) packets are transmitted through the S-GW 212, and the S-GW 212 itself is connected to the P-GW 213. The P-GW 213 provides UE IP address allocation as well as other functions. The P-GW 213 is connected to the internet service 230. The internet service 230 includes an operator-compatible internet protocol service, and may specifically include the Internet, an intranet, an IP Multimedia Subsystem (IMS), and a PS streaming service (PSS).

[0236] As a sub-embodiment, the UE 201 corresponds to the user equipment in this disclosure.

[0237] As a sub-embodiment, the gNB 203 corresponds to the base station in the present disclosure.

[0238] As a sub-embodiment, the UE 201 supports multi-antenna transmission.

[0239] As a sub-embodiment, the UE 201 supports wideband channel measurement.

[0240] As a sub-embodiment, the gNB 203 supports multi-antenna transmission.

[0241] As a sub-embodiment, the gNB 203 supports wideband beamforming.

[0242] Embodiment 3

[0243] Embodiment 3 illustrates a schematic diagram of a radio protocol architecture of a user plane and a control plane according to an embodiment of the present disclosure, as shown in FIG. 3. FIG. 3 is a schematic diagram illustrating an embodiment of a radio protocol architecture for a user plane and a control plane, and FIG. 3 illustrates a radio protocol architecture for the UE and the base station equipment (gNB or eNB) in three layers: layer 1, layer 2 and layer 3. The Layer 1 (L1 layer) is the lowest layer and implements various signal processing functions of the physical layer (i.e., PHY) . The L1 layer will be referred to herein as PHY 301. The Layer 2 (L2 layer) 305 is above PHY 301 and is responsible for the link between the UE and the gNB through PHY 301. In the user plane, L2 layer 305 comprises a media access control (MAC) sub-layer 302, a radio link control (RLC) sub-layer 303 and a packet data convergence protocol (PDCP) sub-layer 304, and these sub-layers terminate at the gNB

of the network side. Although not illustrated in FIG. 3, the UE may have several upper layers above the L2 layer 305, including a network layer (i.e., an IP layer) terminated at the P-GW of the network side and an application layer terminated at the other side of the connection (i.e., a peer UE, server, etc.). The PDCP sub-layer 304 provides multiplexing between different radio bearers and logical channels. The PDCP sublayer 304 also provides header compression for an upper layer packet to reduce a radio transmission overhead, provides security by encrypting a packet, and provides support for UE handover between gNBs. The RLC sublayer 303 provides segmentation and reassembling of an upper layer data packet, retransmission of a lost packets and reordering of a packet to compensate for the disordered reception resulted from the hybrid automatic repeat request (HARQ). The MAC sublayer 302 provides multiplexing between a logical channel and a transport channel. The MAC sublayer 302 is also responsible for allocating various radio resources (i.e., resource blocks) in one cell between UEs. The MAC sublayer 302 is also responsible for HARQ operation. In the control plane, the radio protocol architecture for the UE and gNB is substantially the same as the radio protocol architecture in the user plane on the physical layer 301 and the L2 layer 305, but there is no header compression function for the control plane. The control plane also comprises a Radio Resource Control (RRC) sublayer 306 in Layer 3 (L3 layer). The RRC sublayer 306 is responsible for obtaining radio resources (i.e. radio bearers) and configuring the lower layer using an RRC signaling between the gNB and the UE.

[0244] In one embodiment, the radio protocol architecture of FIG. 3 is applicable to the user equipment in this disclosure.

[0245] In one embodiment, the radio protocol architecture of FIG. 3 is applicable to the base station in this disclosure.

[0246] As a sub-embodiment, the first signaling in the present disclosure is generated in the RRC sublayer 306.

[0247] As a sub-embodiment, the first signaling in the present disclosure is generated by the PHY 301.

[0248] As a sub-embodiment, the first wireless signal in the present disclosure is generated by the PHY 301.

[0249] As a sub-embodiment, the first information in the present disclosure is

generated by the PHY 301.

[0250] Embodiment 4

[0251] Embodiment 4 shows a schematic diagram of a base station device and a given user equipment according to the present disclosure, as shown in FIG. 4. FIG. 4 is a block diagram of a gNB 410 in communication with a UE450 in an access network.

[0252] The base station (410) may comprise a controller/processor 440, a scheduler 443, a memory 430, a receiving processor 412, a transmitting processor 415, a MIMO transmitting processor 441, a MIMO detector 442, a transmitter/receiver 416, and an antenna 420.

[0253] The user equipment (UE450) may comprise a controller/processor 490, a memory 480, a data source 467, a transmitting processor 455, a receiving processor 452, a MIMO transmitting processor 471, a MIMO detector 472, a transmitter/receiver 466, and an antenna 460.

[0254] In Downlink (DL) transmission, the processing associated with the base station (410) may include the following operations:

[0255] The upper layer packet is provided to the controller/processor 440. The controller/processor 440 provides header compression, encryption, packet segmentation and reordering, and multiplexing between a logical channel and a transport channel so as to implement L2 layer protocols for the user plane and the control plane. The upper layer packet may include data or control information, such as a Downlink Shared Channel (DL-SCH).

[0256] The controller/processor 440 can be associated with the memory 430 that stores program codes and data. The memory 430 can be a computer readable medium.

[0257] The controller/processor 440 notifies the scheduler 443 to transmit the demand. The scheduler 443 is configured to schedule the air interface resource corresponding to the transmission requirement, and notify the controller/processor 440 of the scheduling result.

[0258] The transmitting processor 415 receives the output bitstream of controller/processor 440, and implements various signal transmission processing functions for the L1 layer (i.e., the physical layer), including encoding, interleaving,

scrambling, modulation, power control/allocation and generation of physical layer control signaling (including PBCH, PDCCH, PHICH, PCFICH, a reference signal), etc.

[0259] The MIMO transmitting processor 441 performs spatial processing for data symbols, control symbols or reference signal symbols (such as precoding, beam shaping), and outputs baseband signals to the transmitter 416.

[0260] The transmitter 416 is configured to convert the baseband signal provided by the MIMO transmitting processor 441 into a radio frequency signal and to transmit the radio frequency signal via the antenna 420. Each transmitter 416 samples the respective input symbol streams to obtain a respective sampled signal stream. Each transmitter 416 performs further processing (e.g., digital to analog conversion, amplification, filtering, upconversion, etc.) on a respective sampled stream to obtain a downlink signal.

[0261] In Downlink (DL) transmission, the processing associated with the user equipment (UE450) may include the following operations:

[0262] The receiver 456 is configured to convert the radio frequency signal received through the antenna 460 into a baseband signal and provide the baseband signal to the MIMO detector 472.

[0263] The MIMO detector 472 is configured to perform MIMO detection on the signal received from the receiver 456, and provide the MIMO-detected baseband signal to the receiving processor 452.

[0264] The receiving processor 452 implements various signal receiving processing functions for the L1 layer (i.e., the physical layer) including decoding, deinterleaving, descrambling, demodulation, and physical layer control signaling extraction, etc.

[0265] The controller/processor 490 receives the bitstream output by the receive processor 452. The controller/processor 490 provides header compression, encryption, packet segmentation and reordering, and multiplexing between a logical channel and a transport channel to implement L2 layer protocols for the user plane and the control plane.

[0266] 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.

[0267] The first signaling in the present disclosure may be generated by the transmitting processor 415 or transmitted to the controller/processor 440 by higher

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

[0268] The first wireless signal in the present disclosure is K reference signal groups generated by the transmitting processor 415. The MIMO transmitting processor 441 performs beamforming processing on the K reference signal groups output by the transmitting processor, and transmits the K reference signal groups to the K antenna port groups for transmission. The transmitter 416 converts the baseband signal provided by the MIMO transmitting processor 441 into a radio frequency signal and transmits the radio frequency signal via the antenna 420. The receiver 456 converts the radio frequency signal received by the antenna 460 and the first radio signal into a baseband signal and provides the first radio signal to the MIMO detector 472. The MIMO detector 472 performs MIMO detection on the signal received from the receiver 456. The receiving processor 452 performs channel measurement based on the baseband signal output by the MIMO detector 472 and the K reference signal groups to obtain the K channel quality values.

[0269] In Uplink (UL) transmission, the processing associated with the user equipment (UE450) may include the following operations:

[0270] The data source 467 provides an upper layer packet to the controller/processor 490. The controller/processor 490 provides header compression, encryption, packet segmentation and reordering, and multiplexing between logical and transport channels to implement L2 layer protocols for the user plane and the control plane. The upper layer packet may include data or control information, such as an Uplink Shared Channel (UL-SCH).

[0271] 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.

[0272] The transmitting processor 455 receives the bitstream output by the controller/processor 490, and implements various signal transmission processing functions for the L1 layer (i.e., the physical layer), including encoding, interleaving, scrambling, modulation, power control/allocation and generation of physical layer control signaling (including PUCCH, Sounding Reference Signal (SRS)), etc.

[0273] The MIMO transmitting processor 471 performs spatial processing for data symbols, control symbols or reference signal symbols (such as precoding, beam shaping), and outputs baseband signals to the transmitter 456.

[0274] The transmitter 456 is configured to convert the baseband signal provided by the MIMO transmitting processor 471 into a radio frequency signal and to transmit the radio frequency signal via the antenna 460. Each transmitter 456 samples the respective input symbol streams to obtain a respective sampled signal stream. Each transmitter 456 performs further processing (e.g., digital to analog conversion, amplification, filtering, upconversion, etc.) on the respective sample stream to obtain an uplink signal.

[0275] In Uplink (UL) transmission, the processing associated with the base station (410) may include the following operations:

[0276] 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.

[0277] The MIMO detector 442 is configured to perform MIMO detection on the signal received from the receiver 416, and provide the MIMO-detected baseband signal to the receiving processor 442.

[0278] The receiving processor 412 implements various signal receiving processing functions for the L1 layer (i.e., the physical layer) including decoding, deinterleaving, descrambling, demodulation, and physical layer control signaling extraction, etc.

[0279] The controller/processor 440 receives the bitstream output by the receiving processor 412. The controller/processor 490 provides header compression, encryption, packet segmentation and reordering, and multiplexing between a logical channel and a

transport channel to implement L2 layer protocols for the user plane and the control plane.

[0280] The controller/processor 440 can be associated with the memory 430 that stores program codes and data. The memory 430 can be a computer readable medium.

[0281] The first information in the present disclosure may be generated by the transmitting processor 455 to the controller/processor 490. The MIMO transmitting processor 471 performs multi-antenna precoding processing on the symbols output by the transmitting processor. The transmitter 456 converts the baseband signal provided by the MIMO transmitting processor 471 into a radio frequency signal and transmits the radio frequency signal via the antenna 460. The receiver 416 converts the radio frequency signal related to the first information received by the antenna 420 into a baseband signal and provides the baseband signal to the MIMO detector 442. The MIMO detector 442 performs MIMO detection on the signal received from the receiver 416. The receiving processor 412 processes the baseband signal output by the MIMO detector 442 to obtain the first information.

[0282] As a sub-embodiment, the UE 450 includes: at least one processor and at least one memory. The at least one memory includes computer program code. The at least one memory and the computer program code are configured to use with the at least one processor together. The UE450 at least: receives a first signaling; receives a first wireless signal; and transmits first information; wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0283] As a sub-embodiment, the UE 450 includes: a memory storing a computer readable instruction program that, when executed by at least one processor, performs operations. The operations include: receiving a first signaling; receiving a first wireless signal; and transmitting first information; wherein, K antenna port groups are used to

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

[0284] As a sub-embodiment, the gNB410 includes: at least one processor and at least one memory. The at least one memory includes computer program code. The at least one memory and the computer program code are configured to use with the at least one processor together. The UE450 at least: transmits a first signaling; transmits a first wireless signal; and receives first information; wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0285] As a sub-embodiment, the UE 450 includes: a memory storing a computer readable instruction program that, when executed by at least one processor, performs operations. The operations include: transmitting a first signaling; transmitting a first wireless signal; and receiving first information; wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K; a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values; the first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0286] As a sub-embodiment, the UE 450 corresponds to the user equipment in this disclosure.

[0287] As a sub-embodiment, the gNB 410 corresponds to the base station in the present disclosure.

[0288] As a sub-embodiment, at least the first three of the receiver 456, the MIMO detector 472, the receiving processor 452, and the controller/processor 490 are used to receive the first signaling in the present disclosure.

[0289] As a sub-embodiment, at least the first three of the transmitter 416, the MIMO transmitter 441, the transmitting processor 415, and the controller/processor 440 are used to transmit the first signaling in this disclosure.

[0290] As a sub-embodiment, the receiver 456, the MIMO detector 472 and the receiving processor 452 are used to receive the first wireless signal in the present disclosure.

[0291] As a sub-embodiment, the transmitter 416, the MIMO transmitter 441 and the transmit processor 415 are used to transmit the first wireless signal in this disclosure.

[0292] As a sub-embodiment, at least the first three of the transmitter/receiver 456, the MIMO transmitter 471, the transmitting processor 455, and the controller/processor 490 are used to transmit the first information in this disclosure.

[0293] As a sub-embodiment, the receiver 416, the MIMO detector 442, and the receiving processor 412 are used to receive the first information in this disclosure.

[0294] Embodiment 5

[0295] Embodiment 5 illustrates a flow chart of wireless transmission, as shown in FIG. 5. In FIG. 5, the base station N1 is a maintaining base station for the serving cell of the UE U2. In FIG. 5, the steps in block F1 are optional.

[0296] For N1, the first signaling is transmitted in step S11; the first wireless signal is transmitted in step S12; the first information is received in step S13; and the second signal is transmitted in step S14.

[0297] For U2, the first signaling is received in step S21; the first wireless signal is received in step S22; the first information is transmitted in step S23; and the second signal is received in step S24.

[0298] In Embodiment 5, K antenna port groups are used to transmit the first wireless signal. the first signaling is used to determine the K antenna port groups by U2. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. the K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0299] As a sub-embodiment, K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values. The K2 is a positive integer less than or equal to the K. a second proportional sequence corresponds to a ratio among the K2 channel quality values. A first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups by U@. A second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups by U2. The first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

[0300] As a sub-embodiment, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are on the same carrier.

[0301] As a sub-embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold by U2. The target threshold is a non-negative real number. The first channel quality is the best channel quality value of the K1 channel quality values. The second channel quality is the worst channel quality value of the K1 channel quality values. The third channel quality is the best channel quality value of the K2 channel quality values. The fourth channel quality is the worst channel quality value of the K2 channel quality values. At least one of a ratio between the second channel quality and the first channel quality, or a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

[0302] As a sub-embodiment, the first information is further used by U2 to determine at least one of the first channel quality or the third channel quality.

[0303] As a sub-embodiment, the target antenna port group is used by N1 to transmit the second wireless signal.

[0304] As a sub-embodiment, the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence. The K1 antenna port groups correspond to K1 analog beamforming vectors. The K1 analog beam vectors and the first proportional sequence are used by N1 to generate a first target analog beamforming vector. The first target analog beamforming vector is used for analog beamforming of the target antenna port group. The first receive beamforming vector is used by U2 to receive the second wireless signal.

[0305] As a sub-embodiment, the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence. The K2 antenna port groups correspond to K2 analog beamforming vectors. The K2 analog beam vectors and the second proportional sequence are used by N1 to generate a second target analog beamforming vector. The second target analog beamforming vector is used for analog beamforming of the target antenna port group. The second receive beamforming vector is used by U2 to receive the second wireless signal.

[0306] Embodiment 6

[0307] Embodiment 6 illustrates a schematic diagram of analog beamforming of K reference signal groups, as shown in FIG. 6.

[0308] In Embodiment 6, the K reference signal groups and the K antenna port groups are in one-to-one correspondence. The number of the reference signals in the reference signal group is equal to the number of the antenna ports in the corresponding antenna port group.

[0309] In Embodiment 6, a physical antenna corresponding to one antenna port is divided into S antenna groups, and each of the antenna groups includes a plurality of antennas. The S is a positive integer. The antenna port is formed by superposing multiple antennas in the S antenna groups through antenna virtualization. The mapping coefficients of the plurality of antennas in the S antenna groups to the antenna port constitute a beamforming vector. One antenna group is connected to the baseband processor via a radio frequency (RF) link. One beamforming vector is composed of an

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

[0310] As a sub-embodiment, the reference signal group includes only one reference signal, and the reference signal in the reference signal group is transmitted by an antenna port in a corresponding transmitting antenna port group.

[0311] As a sub-embodiment, the reference signal group includes only a plurality of the reference signals, and the plurality of reference signals in the reference signal group are respectively sent by multiple antenna ports in the corresponding transmitting antenna port group. Different antenna ports in one antenna port group correspond to one same analog beamforming vector.

[0312] As a sub-embodiment, different antenna ports in one antenna port group correspond to the different digital beamforming vectors.

[0313] As a sub-embodiment, the K antenna port groups are a subset of M antenna port groups. The UE transmits auxiliary information according to the measurement in the M antenna port groups. The base station determines, according to the auxiliary information, and configures the K antenna port groups for the UE.

[0314] Embodiment 7

[0315] Embodiment 7 illustrates a timing diagram of K reference signal groups, as shown in FIG. 7.

[0316] In Embodiment 7, the K antenna port groups correspond to K reference signal groups. The time domain resources occupied by any two antenna port groups in the K reference signal groups are orthogonal. The analog beamforming vectors corresponding to any two reference signal groups in the K reference signal groups cannot be considered to be the same. The K reference signal groups occupy K time windows. The K time windows are orthogonal in the time domain.

[0317] As a sub-embodiment, FIG. 7 depicts one transmission of the K reference signal groups. The K reference signal groups are transmitted periodically.

[0318] As a sub-embodiment, the reference signal adopts a pattern of CSI-RS within a time window.

[0319] As a sub-embodiment, the reference signal adopts a pattern of SS within a time window.

[0320] As a sub-embodiment, the time window in FIG. 7 includes Q1 OFDM symbols, and the Q1 is one of 2, 4, 7 and 14.

[0321] Embodiment 8

[0322] Embodiment 8 illustrates a schematic diagram of K1 antenna port groups and K2 antenna port groups, as shown FIG. 8. In Embodiment 8, the K antenna port groups are used to transmit the first wireless signal. The K analog beamforming vectors are used for transmitting analog beamforming of the K antenna port groups respectively. The K antenna port groups respectively correspond to K channel quality values. The best K1+K2 channel quality values of the K channel quality values respectively correspond to the first receive beamforming vector and the second receive beamforming vector. The first receiving beamforming vector performs receiving analog beamforming on the signals transmitted through the K1 antenna port groups. The second receiving beamforming vector performs receiving analog beamforming on the signals transmitted through the K2 antenna port groups.

[0323] Embodiment 9

[0324] Embodiment 9 illustrates a schematic diagram of a second wireless signal beamforming, as shown in FIG. 9. In FIG. 9, the dotted ellipse represents an analog beam for transmitting a first wireless signal, and the solid ellipse represents an analog beam for transmitting a second wireless signal.

[0325] In Embodiment 9, the UE receives the first wireless signal transmitted through the K antenna port groups. The K antenna port groups correspond to the K channel quality values. The UE receives the first signaling to determine that K1 is equal to 2. The first antenna port group and the second antenna port group are two antenna port groups of the K antenna port groups. The first antenna port group corresponds to the first channel quality. The second antenna port group is corresponding to the second channel quality. The first channel quality is a best channel quality value of the K channel quality values. The second channel quality is a second best channel quality value of the K channel quality values. The UE reports {the first antenna port group, the second

antenna port group, and the first proportional sequence} to the base station. The first proportional sequence is composed of 1, ratio of the second channel quality and the first channel quality. The first analog beamforming vector is used for analog beamforming of the first antenna port group. The second analog beamforming vector is used for analog beamforming of the second antenna port group. The base station generates a target analog beamforming vector by using a direction corresponding to the first analog beamforming vector, a direction corresponding to the second analog beamforming vector, and the first proportional sequence according to the UE report. The beam direction corresponding to the target analog beamforming vector is between a beam direction corresponding to the first analog beamforming vector and a beam direction corresponding to the second analog beamforming vector. The target analog beamforming vector is used for analog beamforming of the target antenna port group. The target antenna port group is used to transmit the second wireless signal.

[0326] Embodiment 10

[0327] Embodiment 10 illustrates a block diagram showing the structure of a processing device in a UE. In FIG. 10, a UE 1000 is composed of a first receiver 1001, a second receiver 1002, and a third transmitter 1003.

[0328] In Embodiment 10, the first receiver 1001 is configured to receive the first signaling; the second receiver 1002 is configured to receive the first wireless signal; and the third transmitter 1003 is configured to send the first information.

[0329] In Embodiment 10, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. The K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0330] As a sub-embodiment, the K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values. The K2 is a positive integer less than or equal to the K. A second proportional sequence corresponds

to a ratio among the K2 channel quality values. A first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups. A second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups. The first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

[0331] As a sub-embodiment, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or, any two antenna port groups in the K1 antenna port groups and any two antenna port groups in the K2 antenna port groups are on the same carrier.

[0332] As a sub-embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold. The target threshold is a non-negative real number. The first channel quality is a best channel quality value of the K1 channel quality values. The second channel quality is the worst channel quality value of the K1 channel quality values. The third channel quality is a best channel quality value of the K2 channel quality values. The fourth channel quality is the worst channel quality value of the K2 channel quality values. At least one of a ratio between the second channel quality and the first channel quality or a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

[0333] As a sub-embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

[0334] As a sub-embodiment, the second receiver 1002 is also used to receive a second wireless signal. The target antenna port group is used to transmit the second wireless signal. The target antenna port group is associated with the K1 antenna port groups and the first proportional sequence; or, the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

[0335] Embodiment 11

[0336] Embodiment 11 illustrates a block diagram showing the structure of a processing device in a base station, as shown in FIG. 11.

[0337] In FIG. 11, the base station 1100 includes a first transmitter 1101, a second transmitter 1102, and a third receiver 1103.

[0338] In Embodiment 11, the first transmitter 1101 is configured to transmit the first signaling; the second transmitter 1102 is configured to transmit the first wireless signal; and the third receiver 1103 is configured to receive the first information.

[0339] In Embodiment 11, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups. The K is a positive integer greater than 1. The K antenna port groups respectively correspond to K channel quality values. The K channel quality values are K non-negative real numbers. K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values. The K1 is a positive integer less than or equal to the K. A first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. The first information is used to determine the K1 antenna port groups and the first proportional sequence.

[0340] As a sub-embodiment, the K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values. The K2 is a positive integer less than or equal to the K. A second proportional sequence corresponds to a ratio among the K2 channel quality values. A first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups. A second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups. The first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

[0341] As a sub-embodiment, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are co-located or quasi-co-located (QCL); or, any two antenna port groups in the K1 antenna port groups, and any two antenna port groups in the K2 antenna port groups are on the same carrier.

[0342] As a sub-embodiment, the first signaling is further used to determine at least the last one of the K1, the K2, or the target threshold. The target threshold is a non-negative real number. The first channel quality is a best channel quality value of the K1 channel quality values. The second channel quality is the worst channel quality value

of the K1 channel quality values. The third channel quality is a best channel quality value of the K2 channel quality values. The fourth channel quality is the worst channel quality value of the K2 channel quality values. At least one of a ratio between the second channel quality and the first channel quality or a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold.

[0343] As a sub-embodiment, the first information is further used to determine at least one of the first channel quality or the third channel quality.

[0344] As a sub-embodiment, the second transmitter is further configured to transmit a second wireless signal. The target antenna port group is used to transmit the second wireless signal. The target antenna port group is associated with the K1 antenna port group and the first proportional sequence; or the target antenna port group is associated with the K2 antenna port group and the second proportional sequence.

[0345] The ordinary skill in the art may understand that all or part of steps in the above method may be implemented by instructing related hardware through a program. The program may be stored in a computer readable storage medium, for example Read-Only-Memory (ROM), hard disk or compact disc, etc. Optionally, all or part of steps in the above embodiments also may be implemented by one or more integrated circuits. Correspondingly, each module unit in the above embodiment may be implemented in the form of hardware, or in the form of software function modules. The present disclosure is not limited to any combination of hardware and software in specific forms. The UE and terminal in the present disclosure include but are not limited to unmanned aerial vehicles, communication modules on unmanned aerial vehicles, telecontrolled aircrafts, aircrafts, diminutive airplanes, mobile phones, tablet computers, notebooks, vehicle-mounted communication equipment, radio sensor, network cards, terminals for Internet of Things (IOT), RFID terminals, NB-IOT terminals, Machine Type Communication (MTC) terminals, enhanced MTC (eMTC) terminals, data cards, low-cost mobile phones, low-cost tablet computers, etc. The base station in the present disclosure includes but is not limited to macro-cellular base stations, micro-cellular base stations, home base stations, relay base station, gNB (NR node B), Transmitter Receiver Point (TRP), and other radio communication equipment.

[0346] 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.

CLAIMS

WHAT IS CLAIMED IS:

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

receiving a first signaling;

receiving a first wireless signal; and

transmitting first information;

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

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

3. The method according to claim 1, wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values;

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

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

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

receiving a second wireless signal;

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

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

transmitting a first signaling;

transmitting a first wireless signal; and

receiving first information;

wherein, K antenna port groups are used to transmit the first wireless signal; the first signaling is used to determine the K antenna port groups; the K is a positive integer greater than 1; the K antenna port groups respectively correspond to K channel

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

7. The method according to claim 6, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

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

9. The method according to claim 8, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in

the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.

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

transmitting a second wireless signal;

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

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

a first receiver, receiving a first signaling;

a second receiver, receiving a first wireless signal; and

a third transmitter, transmitting first information;

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

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

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

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

15. The user equipment to claim 13, wherein the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna

port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.

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

a first transmitter, transmitting a first signaling;

a second transmitter, transmitting a first radio signal; and

a third receiver, receiving first information;

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

17. The base station to claim 16, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

18. The base station to claim 16, wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; a second proportional sequence

corresponds to a ratio(ratios) among the K2 channel quality values; a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

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

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

ABSTRACT

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

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Filer:	Qi Zhou
Attorney Docket Number:	20160102-PCT-US

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

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

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

Electronic Acknowledgement Receipt	
EFS ID:	36424932
Application Number:	16454075
International Application Number:	
Confirmation Number:	3768
Title of Invention:	Method and Device for Multi-Antenna Transmission in UE and Base Station
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Customer Number:	157297
Filer:	Qi Zhou
Filer Authorized By:	
Attorney Docket Number:	20160102-PCT-US
Receipt Date:	27-JUN-2019
Filing Date:	
Time Stamp:	03:52:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	CARD
Payment was successfully received in RAM	$1015
RAM confirmation Number	062719INTEFSW03560800
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	Application Data Sheet	WebADS.pdf	114419 8219e9ee86261de96b76ae3b5a69c45fbb4b374d	no	7
Warnings:					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73	20160102-PCT-US_APP_Assignment.pdf	1721349 5ee791ffd5d1998ae20239005e55863f3376ce27	no	2
Warnings:					
Information:					
3	Oath or Declaration filed	20160102-PCT-US_APP_Declaration.pdf	2991250 c5262a59d88a4af7053096de25d6848bbebb14fb	no	2
Warnings:					
Information:					
4	Non Patent Literature	CN2016112369232_1st_Office_Action.pdf	201185 a08ec31817331065c68f89baf53ee05e57a11694	no	4
Warnings:					
Information:					
5	Non Patent Literature	CN2016112369232_1st_Search_report.pdf	51441 fb34e759cfc623240f37a448ea8d0e617342c95a	no	2
Warnings:					
Information:					
6	Non Patent Literature	CN2016112369232_Notice_of_Allowance.pdf	646034 b6cc64b8b6031ec3d5610c569fc341d369f43f64	no	1
Warnings:					
Information:					

7	Foreign Reference	IDS_R1_CN106034360A.pdf	1342357 008839d90f4bd7be11b2a1ab9b814b1d366ff8e4	no	16
Warnings:					
Information:					
8	Foreign Reference	IDS_R2_CN106209195A.pdf	2236844 82ca5e63f232e1b24aff2989ebb779c2787a0854	no	28
Warnings:					
Information:					
9	Foreign Reference	IDS_R3_CN105474556A.pdf	2748941 95b0359db01008aa93c2ad73b19c174f65c0e0aa	no	34
Warnings:					
Information:					
10	Foreign Reference	IDS_R4_CN105580468A.pdf	2212682 e05fcd62ff9c4e328e3ec5a6d1dbc75e0d229f24	no	24
Warnings:					
Information:					
11	Foreign Reference	IDS_R5_CN106211338A.pdf	880018 680ad198483892e0857615fc3842821f26d3a88f	no	9
Warnings:					
Information:					
12	Information Disclosure Statement (IDS) Form (SB08)	20160102-PCT-US_APP_IDS.pdf	612505 0aaf0e72315a44a66c07db2e78bd62d2e67b3d95	no	4
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
13	Drawings-only black and white line drawings	20160102-PCT-US_APP_FIG_VF.pdf	1138628 f6566c51dff8cc3ae355b7d19c7a8ed7c94f6573	no	10

Warnings:					
Information:					
14		20160102-PCT-US_APP_SPEC_VF.pdf	366027 26038951cd5bd560fe8c55eed64b6d7ac5a81153	yes	50
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Specification		1	42	
	Claims		43	49	
	Abstract		50	50	
Warnings:					
Information:					
15	Fee Worksheet (SB06)	fee-info.pdf	36842 2853f144ec5a843fc4d2016016e4f34b8f983e02	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	17300522		

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<u>New Applications Under 35 U.S.C. 111</u>
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.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
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	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

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

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xiaobo		ZHANG	

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

City	Shanghai	Country of Residence i	CN

Mailing Address of Inventor:

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

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

Correspondence Information:

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

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

Customer Number	157297		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station		
Attorney Docket Number	20160102-PCT-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	10	**Suggested Figure for Publication (if any)**	10

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Filing By Reference:

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

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

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

Publication Information:

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

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

Representative Information:

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

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

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Domestic Benefit/National Stage Information:

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

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/CN2017/094209	2017-07-25

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)
201611236923.2	CN	2016-12-28	0770

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	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Applicant Information:

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

Applicant 1

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

Clear

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

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

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

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

Mailing Address Information For Applicant:

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Assignee Information including Non-Applicant Assignee Information:

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

Assignee 1

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

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

Organization Name	SHANGHAI LANGBO COMMUNICATION TECHNOLOGY COMPANY LIMITED

Mailing Address Information For Assignee including Non-Applicant Assignee:

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

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20160102-PCT-US
	Application Number	
Title of Invention	Method and Device for Multi-Antenna Transmission in UE and Base Station	

Signature:

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

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

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

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

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

ASSIGNMENT

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

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

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

Inventor:

XiaoBo ZHANG

XiaoBo ZHANG

Date: Jun. 12 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/CN2017/094209 filed on July 25, 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.

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LEGAL NAME OF INVENTOR

Inventor: XiaoBo ZHANG Date (Optional): Jun. 12 2019

Signature: XiaoBo ZHANG

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Multi-user superposition transmission method and apparatus thereof

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Abstract of CN106034360 (A)

The invention discloses a multi-user superposition transmission method and an apparatus thereof. In an embodiment, the method comprises the following steps that step 1, UE receives a first signaling and respectively receives K1 dynamic signalings according to K1 groups of auxiliary information, wherein the K1 groups of auxiliary information are indicated by the first signaling, and the K1 groups of auxiliary information correspond to the K1 dynamic signaling respectively; step 2, according to scheduling information in the K1 dynamic signalings, receiving K1 wireless signals respectively, and according to scheduling information of the first signaling, receiving a first wireless signal, wherein a time-frequency resource occupied by each wireless signal of the K1 wireless signals is completely or partially superimposed with a time-frequency resource occupied by the first wireless signal. In the invention, a condition of repeated transmissions of the same group of scheduling information is avoided, and an air-interface resource is saved. In addition, a number of times of performing BD by the UE is reduced.

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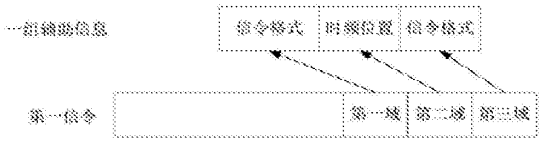
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(54)发明名称

一种多用户叠加的传输方法和装置

(57)摘要

本发明公开了一种多用户叠加的传输方法和装置。作为一个实施例，UE在步骤一中接收第一信令，根据K1组辅助信息分别接收K1个动态信令。所述K1组辅助信息由第一信令指示，所述K1组辅助信息和所述K1个动态信令一一对应。在步骤二中根据所述K1个动态信令中的调度信息分别接收K1个无线信号，根据第一信令的调度信息接收第一无线信号。其中，所述K1个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，本发明避免了同一组调度信息的多次发送，节省了空口资源。此外，本发明降低了UE执行BD的次数。



CN 106034360 A

1. 一种支持多用户叠加的 UE 中的方法，其中，包括如下步骤：

- 步骤 A. 接收第一信令，根据 K1 组辅助信息分别接收 K1 个动态信令。所述 K1 组辅助信息由第一信令指示，所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括｛信令标识，时频位置，信令格式｝中的一个或者多个

- 步骤 B. 根据所述 K1 个动态信令中的调度信息分别接收 K1 个无线信号，根据第一信令的调度信息接收第一无线信号。

其中，所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。所述信令格式包括｛是否包括 CIF，是否包括 SRS 请求，DCI 格式，传输模式｝中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

2. 根据权利要求 1 所述的方法，其特征在于，第一无线信号是由 DMRS 天线端口发送，所述 UE 假定所述 K1 个无线信号都是由 DMRS 天线端口发送。

3. 根据权利要求 1 所述的方法，其特征在于，第一无线信号是由 CRS 天线端口发送，所述辅助信息包括所述信令格式。

4. 根据权利要求 1 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A1. 接收第一高层信令确定 K3 个 EPDCCH-PRB-set。

其中，对于目标动态信令，相应辅助信息中的所述时频位置包括以下至少之一：

- 第一索引．目标 EPDCCH-PRB-set 在所述 K3 个 EPDCCH-PRB-set 中的索引

- 第二索引．所述目标动态信令占用的 EPDCCH 候选在所述目标 EPDCCH-PRB-set 中的索引。

所述目标动态信令是所述 K1 个动态信令中在 EPDCCH 上传输的每一个动态信令，所述目标动态信令占用的 EPDCCH 候选所属的 EPDCCH-PRB-set，所述 K3 是正整数。

5. 根据权利要求 1，4 所述的方法，其特征在于，对于给定动态信令，相应辅助信息中的所述时频位置包括所述给定动态信令占用的 PDCCH 在目标 PDCCH 候选集合中的索引，所述目标 PDCCH 候选集合由所述 UE 在所述给定动态信令的传输子帧和传输载波上监测的所有 PDCCH 候选所组成。其中，所述给定动态信令是所述 K1 个动态信令中在 PDCCH 上传输的每一个动态信令。

6. 根据权利要求 1 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A2. 接收第二高层信令确定第一整数，第一整数用于生成 DMRS 序列的初始值，所述 DMRS 序列的初始值由第一信令和所述 K1 组信令中所有在 EPDCCH 上传输的信令所共享。

7. 根据权利要求 1 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A3. 接收第三高层信令确定第二整数集合，第二整数集合中包括多个彼此互不相同的整数元素。

其中，所述 K1 组辅助信息中全部或者部分辅助信息中还包括 DMRS 关联整数，所述 DMRS 关联整数用于生成相应动态信令的 DMRS 序列的初始值，所述 DMRS 关联整数在第二整数集合中的索引由第一信令指示。

8. 一种支持多用户叠加的基站中的方法，其中，包括如下步骤：

- 步骤 A. 发送第一信令和 K1 个动态信令。第一信令中指示 K1 组辅助信息。所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括｛信令标识，时频位置，信令

格式｝中的一个或者多个

- 步骤 B. 发送 K1 个无线信号和第一无线信号。

其中，第一信令包括第一无线信号的调度信息，所述 K1 个动态信令中的调度信息分别用于调度所述 K1 个无线信号。所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。所述信令格式包括｛是否包括 CIF，是否包括 SRS 请求，DCI 格式，传输模式｝中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

9. 根据权利要求 8 所述的方法，其特征在于，第一无线信号是由 DMRS 天线端口发送，所述 UE 假定所述 K1 个无线信号都是由 DMRS 天线端口发送。

10. 根据权利要求 8 所述的方法，其特征在于，第一无线信号是由 CRS 天线端口发送，所述辅助信息包括所述信令格式。

11. 根据权利要求 8 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A1. 发送第一高层信令指示 K3 个 EPDCCH-PRB-set。

其中，对于目标动态信令，相应辅助信息中的所述时频位置包括以下至少之一：

- 第一索引．目标 EPDCCH-PRB-set 在所述 K3 个 EPDCCH-PRB-set 中的索引

- 第二索引．所述目标动态信令占用的 EPDCCH 候选在所述目标 EPDCCH-PRB-set 中的索引。

所述目标动态信令是所述 K1 个动态信令中在 EPDCCH 上传输的每一个动态信令，所述目标动态信令占用的 EPDCCH 候选所属的 EPDCCH-PRB-set，所述 K3 是正整数。

12. 根据权利要求 8，11 所述的方法，其特征在于，对于给定动态信令，相应辅助信息中的所述时频位置包括所述给定动态信令占用的 PDCCH 在目标 PDCCH 候选集合中的索引，所述目标 PDCCH 候选集合由第一信令的目标 UE 在所述给定动态信令的传输子帧和传输载波上监测的所有 PDCCH 候选所组成。其中，所述给定动态信令是所述 K1 个动态信令中在 PDCCH 上传输的每一个动态信令。

13. 根据权利要求 8 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A2. 发送第二高层信令指示第一整数，第一整数用于生成 DMRS 序列的初始值，所述 DMRS 序列的初始值由第一信令和所述 K1 组信令中所有在 EPDCCH 上传输的信令所共享。

14. 根据权利要求 8 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A3. 发送第三高层信令指示第二整数集合，第二整数集合中包括多个彼此互不相同的整数元素。

其中，所述 K1 组辅助信息中全部或者部分辅助信息中还包括 DMRS 关联整数，所述 DMRS 关联整数用于生成相应动态信令的 DMRS 序列的初始值，所述 DMRS 关联整数在第二整数集合中的索引由第一信令指示。

15. 一种支持多用户叠加的用户设备，其中，包括如下模块：

第一模块：用于接收第一信令，根据 K1 组辅助信息分别接收 K1 个动态信令。所述 K1 组辅助信息由第一信令指示，所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括｛信令标识，时频位置，信令格式｝中的一个或者多个

第二模块：用于根据所述 K1 个动态信令中的调度信息分别接收 K1 个无线信号，根据第

一信令的调度信息接收第一无线信号。

其中，所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述K1 是正整数。第一信令和所述K1 个动态信令都是物理层信令。所述信令格式包括｛是否包括 CIF，是否包括 SRS 请求，DCI 格式，传输模式｝中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

16. 一种支持多用户叠加的基站设备，其中，包括如下模块：

第一模块：用于发送第一信令和 K1 个动态信令。第一信令中指示 K1 组辅助信息。所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括｛信令标识，时频位置，信令格式｝中的一个或者多个

第二模块：用于发送 K1 个无线信号和第一无线信号。

其中，第一信令包括第一无线信号的调度信息，所述 K1 个动态信令中的调度信息分别用于调度所述 K1 个无线信号。所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。所述信令格式包括｛是否包括CIF，是否包括 SRS 请求，DCI 格式，传输模式｝中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

一种多用户叠加的传输方法和装置

技术领域

[0001] 本发明涉及无线通信系统中调度信令的方案，特别是涉及基于长期演进(LTE-Long Term Evolution)的针对多用户叠加(Superposition)的下行调度信令的方法和装置。

背景技术

[0002] 传统的3GPP(3rd Generation Partner Project，第三代合作伙伴项目）蜂窝系统中，多用户的下行无线信号是通过{TDM(Time Division Multiplexing，时分复用)，FDM(Frequency Division Multiplexing，频分复用)，CDM(Code Division Multiplexing，码分复用)}中的一种或者多种方式来实现。3GPP R(Release，版本)13中引入了一个新的研究课题(RP-150496)，即下行多用户叠加，其本质是利用发送功率的不同区分两个用户的下行无线信号。所述两个用户通常包括一个近用户（即距离基站近）和一个远用户（即距离基站远)，基站为针对近用户的第一信号分配较低的发送功率，同时为针对远用户的第二信号分配较高的发送功率。远用户直接解调第二信号（即将第一信号当噪声处理)，而近用户首先解调第二信号（考虑到近用户较远用户具备更低的路径损耗，译码成功的可能性很高)，然后从接收信号中去除第二信号的影响得到剩余信号，对剩余信号译码获得第一信号，这就是SIC(Successive Interference Cancellation，连续干扰消除）算法。

[0003] 为了执行SIC，近用户需要获得第一信号和第二信号的调度信息-而远用户只需要获得第二信号的调度信息。传统的LTE动态调度中，用户根据在PDCCH(Physical Downlink Control Channel，物理下行控制信道）或者EPDCCH(Enhanced PDCCH，增强的PDCCH)中传输的DCI(Downlink Control Information，下行控制信息）获得PDSCH(Physical Downlink Shared Channel，物理下行控制信道）的调度信息。因此，一个直观的想法是基站在针对近用户的DCI中发送第一信号和第二信号的调度信息，而针对远用户的DCI中发送第二信号的调度信息。

发明内容

[0004] 发明人通过研究发现，上述直观的方法可能会面临如下问题：

[0005] -. 第二信号的调度信息发送了两遍，降低了传输效率

[0006] -. 针对近用户的DCI的可能的负载尺寸(Payload Size，即信息比特数）可能较多。DCI的负载尺寸由DCI格式确定，即针对近用户的DCI的负载尺寸不光受到第一信号的调度格式的影响，还受到针对远用户的DCI格式的影响。过多可能的负载尺寸会导致BD(Blind Decoding，盲译码）次数的增加，进而增加UE的复杂度。

[0007] 发明人通过进一步研究发现，近用户被调度的时频资源上可能存在不止一个远用户被调度（远用户之间是非叠加的)，而为了执行SIC，针对近用户的DCI中可能要包括针对多个远用户的调度信息。这样就进一步恶化了上述问题。

[0008] 针对上述问题，本发明提供了解决方案。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。

[0009] 本发明公开了一种支持多用户叠加的 UE 中的方法，其中，包括如下步骤：

[0010] - 步骤 A. 接收第一信令，根据 K1 组辅助信息分别接收 K1 个动态信令。所述 K1 组辅助信息由第一信令指示，所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括 { 信令标识，PDCCH/EPDCCH 标识位，时频位置，信令格式 } 中的一个或者多个

[0011] - 步骤 B. 根据所述 K1 个动态信令中的调度信息分别接收 K1 个无线信号，根据第一信令的调度信息接收第一无线信号。

[0012] 其中，所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

[0013] 上述方面的本质是，UE 要首先接收多个物理层信令，然后才能接收无线信号。上述本质违背了现有蜂窝网中的公知常识，因为所述多个物理层信令中有 1 个不能正确接收就会导致 UE 无法接收下行无线信号。发明人通过研究发现，上述公知常识在多用户叠加场景中不再成立，因为近用户正确接收针对针对远用户的给定 DCI 的概率要大于远用户正确接收所述给定 DCI 的概率。

[0014] 作为一个实施例，所述信令标识用于确定对应动态信令的 {CRC 扰码，PDCCH UE 特定的搜索空间，EPDCCH UE 特定的搜索空间 } 中的一种或者多种。

[0015] 作为一个实施例，所述信令标识是 RNTI(Radio Network Temporary Identity，无线网络暂定标识）。

[0016] 作为一个实施例，针对所述 K1 个无线信号采用 SIC 算法获得第一无线信号。作为一个实施例，上述方法的其特征在于，还包括如下步骤：- 步骤 C. 将第一无线信号传递给高层，丢弃所述 K1 个无线信号。

[0017] 由于所述 K1 个动态信令不是针对所述 UE 的，所述 UE 需要获得额外的信息（即所述 K1 组辅助信息）之后才能接收所述 K1 个动态信令。进一步的，对于 PDCCH 和 EPDCCH，所述 UE 所需要的额外的信息可能是不同的。因此：

[0018] 作为一个实施例，如果所述 PDCCH/EPDCCH 标识位为第一状态 (0 或 1) 时，对应的动态信令在 PDCCH 上传输，对应的所述辅助信息是针对 PDCCH。如果所述 PDCCH/EPDCCH 标识位为和第一状态相反的状态，对应的动态信令在 EPDCCH 上传输，对应的所述辅助信息是针对 EPDCCH。

[0019] 传统的 LTE 中，UE（针对每一种可能的负载尺寸）通过 BD 确定 DCI 所占用的 PDCCH 或者 EPDCCH。而过多的 BD 次数可能会增加虚警概率，而所述辅助信息中的所述时频位置和所述信令格示能减少 UE 针对所述 K1 个动态信令所执行的 BD 次数。

[0020] 传统的 LTE 中，基站通过高层信令为 UE 配置当前的 TM（传输模式），DCI 中是否包括 CIF(Carrier Indicator Field，载波指示域），DCI 中是否包括 SRS(Sounding Reference Signal，侦听参考信号）等高层信息，UE 根据所述辅助信息能确定给定 DCI 格式的负载尺寸。而本发明中，UE 如果仅仅知道所述 K1 个动态信令的负载尺寸，而不知道对应的所述高层信令，UE 可能无法确定 DCI 格式，即出现多个 DCI 格式的负载尺寸冲突的场景。一个方法是通过高层信令为 UE 配置所有需要的高层信令。然而该方法可能带来大量的冗余度开

销。发明人通过研究发现，当第一无线信号是基于DMRS(Demodulation Reference Signal，解调参考信号）的传输时，所述K1个无线信号也只能是基于DMRS的传输，否则所述K1个无线信号的目标UE无法针对DMRS执行速率匹配，或者所述K1个无线信号的目标UE不兼容传统UE。而基于DMRS的DCI格式不会出现负载尺寸冲突的场景。因此：

[0021] 具体的，根据本发明的一个方面，其特征在于，第一无线信号是由DMRS天线端口发送，所述UE假定所述K1个无线信号都是由DMRS天线端口发送。

[0022] 作为一个实施例，所述辅助信息不包括所述信令格式，所述UE盲译码确定所述信令格式。上述方面能有效减少第一信令的负载尺寸。

[0023] 当第一无线信号是基于CRS(Cell Reference Signal，小区参考信号）的传输时，所述K1个无线信号中的每一个无线信号都可能是基于CRS的传输或者是基于DMRS的传输。此时，所述负载尺寸冲突的场景可能出现。因此：

[0024] 具体的，根据本发明的一个方面，其特征在于，第一无线信号是由CRS天线端口发送，所述辅助信息包括所述信令格式。

[0025] 作为一个实施例，所述UE假定所述K1个无线信号中的每一个无线信号是由DMRS天线端口发送或者是由和第一无线信号相同的CRS天线端口发送。

[0026] 作为一个实施例，所述UE根据所述格式执行确定相应动态信令的可能的负载尺寸，进而执行译码操作，所述可能的负载尺寸是一种或者多种。

[0027] 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：

[0028] -步骤A1. 接收第一高层信令确定K3个EPDCCH-PRB-set。

[0029] 其中，对于目标动态信令，相应辅助信息中的所述时频位置包括以下至少之一：

[0030] -第一索引. 目标EPDCCH-PRB-set在所述K3个EPDCCH-PRB-set中的索引

[0031] -第二索引. 所述目标动态信令占用的EPDCCH候选在所述目标EPDCCH-PRB-set中的索引。

[0032] 所述目标动态信令是所述K1个动态信令中在EPDCCH上传输的每一个动态信令，所述目标动态信令占用的EPDCCH候选所属的EPDCCH-PRB-set，所述K3是正整数。

[0033] 第二索引能额外减少BD次数，然而可能增加第一信令的负载尺寸。

[0034] 作为一个实施例，第一高层信令是RRC信令。作为一个实施例，所述K3个EPDCCH-PRB-set是子帧特定的（即第一高层信令只对当前子帧有效），或者是子帧集合特定的（即第一高层信令只对特定子帧集合有效）。作为一个实施例，所述目标动态信令相应辅助信息中的所述时频位置还指示所述目标动态信令占用的EPDCCH候选是分布式(Distributed)的还是集中式的(Localized)。

[0035] 作为一个实施例，所述K3大于2。

[0036] 作为一个实施例，所述K3个EPDCCH-PRB-set共享相同的用于EPDCCH资源映射参数，所述EPDCCH资源映射参数指示EPDCCH RE(Resource Element，资源粒子）映射时应当执行速率匹配（以避免占用）的RE。作为一个子实施例，所述K3个EPDCCH-PRB-set包括{pdsch-Start-r11，crs-PortsCount-r11，crs-PortsCount-r11，csi-RS-ConfigZPId-r11}。

[0037] 具体的，根据本发明的一个方面，其特征在于，对于给定动态信令，相应辅助信息中的所述时频位置包括所述给定动态信令占用的PDCCH在目标PDCCH候选集合中的索引，

所述目标 PDCCH 候选集合由所述 UE 在所述给定动态信令的传输子帧和传输载波上监测的所有 PDCCH 候选所组成。其中，所述给定动态信令是所述 K1 个动态信令中在 PDCCH 上传输的每一个动态信令。

[0038] 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：

[0039] - 步骤 A2. 接收第二高层信令确定第一整数，第一整数用于生成 DMRS 序列的初始值，所述 DMRS 序列的初始值由第一信令和所述 K1 组信令中所有在 EPDCCH 上传输的信令所共享。

[0040] 作为一个实施例，第一整数是小于 504 的非负整数。作为一个实施例，所述 DMRS 序列的初始值和第一整数的映射关系重用 EPDCCH 中 DMRS 伪随机序列生成器的初始值和高层信令 dmrs-ScramblingSequenceInt 所配置的整数之间的映射关系，即：

[0041]

$$\text{DMRS序列初始值} = \left(\left\lfloor n_s/2 \right\rfloor + 1\right)\cdot\left(2n_{ID,i}^{EPDCCH} + 1\right)\cdot 2^{16} + \text{第一整数}。$$

[0042] 上述方面强制所述 K1 个动态信令和第一信令采用相同的 EPDCCH DMRS 序列，优点是降低了第一信令的负载尺寸。

[0043] 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：

[0044] - 步骤 A3. 接收第三高层信令确定第二整数集合，第二整数集合中包括多个彼此互不相同的整数元素。

[0045] 其中，所述 K1 组辅助信息中全部或者部分辅助信息中还包括 DMRS 关联整数，所述 DMRS 关联整数用于生成相应动态信令的 DMRS 序列的初始值，所述 DMRS 关联整数在第二整数集合中的索引由第一信令指示。

[0046] 作为一个实施例，所述整数元素是小于 504 的非负整数。

[0047] 作为一个实施例，所述 DMRS 序列的初始值和对应的所述 DMRS 关联整数的映射关系重用 EPDCCH 中 DMRS 伪随机序列生成器的初始值和高层信令 dmrs-ScramblingSequenceInt 所配置的整数之间的映射关系。

[0048] 上述方面使得所述 K1 个动态信令和第一信令可能采用可变的 EPDCCH DMRS 序列，代价是增加了第一信令的负载尺寸。

[0049] 本发明公开了一种支持多用户叠加的基站中的方法，其中，包括如下步骤：

[0050] - 步骤 A. 发送第一信令和 K1 个动态信令。第一信令中指示 K1 组辅助信息。所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括{信令标识，时频位置，信令格式}中的一个或者多个

[0051] - 步骤 B. 发送 K1 个无线信号和第一无线信号。

[0052] 其中，第一信令包括第一无线信号的调度信息，所述 K1 个动态信令中的调度信息分别用于调度所述 K1 个无线信号。所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。所述信令格式包括{是否包括 CIF，是否包括 SRS 请求，DCI 格式，传输模式}中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

[0053] 作为一个实施例，所述 DCI 格式和所述传输模式不同时出现。

[0054] 具体的，根据本发明的一个方面，其特征在于，第一无线信号是由 DMRS 天线端口发送，所述 UE 假定所述 K1 个无线信号都是由 DMRS 天线端口发送。

[0055] 作为一个实施例，所述辅助信息不包括所述信令格式，所述 UE 盲译码确定所述信令格式。

[0056] 作为一个实施例，第一无线信号是由 DMRS 天线端口发送，所述动态信令是 DCI 格式 {2B,2C} 中的一种。

[0057] 具体的，根据本发明的一个方面，其特征在于，第一无线信号是由 CRS 天线端口发送，所述辅助信息包括所述信令格式。

[0058] 作为一个实施例，第一无线信号是由 CRS 天线端口发送，所述动态信令是 DCI 格式 {1,1A,1B,1C,1D,2,2A,2B,2C} 中的一种。

[0059] 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：

[0060] - 步骤 A1. 发送第一高层信令指示 K3 个 EPDCCH-PRB-set。

[0061] 其中，对于目标动态信令，相应辅助信息中的所述时频位置包括以下至少之一：

[0062] - 第一索引．目标 EPDCCH-PRB-set 在所述 K3 个 EPDCCH-PRB-set 中的索引

[0063] - 第二索引．所述目标动态信令占用的 EPDCCH 候选在所述目标 EPDCCH-PRB-set 中的索引。

[0064] 所述目标动态信令是所述 K1 个动态信令中在 EPDCCH 上传输的每一个动态信令，所述目标动态信令占用的 EPDCCH 候选所属的 EPDCCH-PRB-set，所述 K3 是正整数。

[0065] 具体的，根据本发明的一个方面，其特征在于，对于给定动态信令，相应辅助信息中的所述时频位置包括所述给定动态信令占用的 PDCCH 在目标 PDCCH 候选集合中的索引，所述目标 PDCCH 候选集合由第一信令的目标 UE 在所述给定动态信令的传输子帧和传输载波上监测的所有 PDCCH 候选所组成。其中，所述给定动态信令是所述 K1 个动态信令中在 PDCCH 上传输的每一个动态信令

[0066] 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：

[0067] - 步骤 A2. 发送第二高层信令指示第一整数，第一整数用于生成 DMRS 序列的初始值，所述 DMRS 序列的初始值由第一信令和所述 K1 组信令中所有在 EPDCCH 上传输的信令所共享。

[0068] 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：

[0069] - 步骤 A3. 发送第三高层信令指示第二整数集合，第二整数集合中包括多个彼此互不相同的整数元素。

[0070] 其中，所述 K1 组辅助信息中全部或者部分辅助信息中还包括 DMRS 关联整数，所述 DMRS 关联整数用于生成相应动态信令的 DMRS 序列的初始值，所述 DMRS 关联整数在第二整数集合中的索引由第一信令指示。

[0071] 本发明公开了一种支持多用户叠加的用户设备，其中，包括如下模块：

[0072] 第一模块：用于接收第一信令，根据 K1 组辅助信息分别接收 K1 个动态信令。所述 K1 组辅助信息由第一信令指示，所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括 { 信令标识，时频位置，信令格式 } 中的一个或者多个

[0073] 第二模块：用于根据所述 K1 个动态信令中的调度信息分别接收 K1 个无线信号，根据第一信令的调度信息接收第一无线信号。

[0074] 其中，所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。所述信令格式包括｛是否包括 CIF，是否包括 SRS 请求，DCI 格式，传输模式｝中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

[0075] 本发明公开了一种支持多用户叠加的基站设备，其中，包括如下模块：

[0076] 第一模块：用于发送第一信令和 K1 个动态信令。第一信令中指示 K1 组辅助信息。所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括｛信令标识，时频位置，信令格式｝中的一个或者多个

[0077] 第二模块：用于发送 K1 个无线信号和第一无线信号。

[0078] 其中，第一信令包括第一无线信号的调度信息，所述 K1 个动态信令中的调度信息分别用于调度所述 K1 个无线信号。所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。所述信令格式包括｛是否包括 CIF，是否包括 SRS 请求，DCI 格式，传输模式｝中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

[0079] 相比现有公开技术，本发明具有如下技术优势：

[0080] -. 避免了同一组调度信息的多次发送，节省了空口资源

[0081] -. 降低了 UE 执行 BD 的次数，降低了 UE 的复杂度，同时避免了过多的 BD 次数导致的虚警增加。

附图说明

[0082] 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：

[0083] 图 1 示出了根据本发明的一个实施例的下行多用户叠加的调度流程图；

[0084] 图 2 示出了根据本发明的一个实施例的第一信令指示一组辅助信息的示意图；

[0085] 图 3 示出了根据本发明的一个实施例的下行多用户叠加的资源分配示意图；

[0086] 图 4 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；

[0087] 图 5 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

[0088] 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。

[0089] 实施例 1

[0090] 实施例 1 示例了下行多用户叠加的调度流程图，如附图 1 所示。附图 1 中，基站 N1 是 UE U2 的服务小区的维持基站，其中方框 F1 中的步骤是可选步骤。

[0091] 对于基站 N1，在步骤 S11 中发送第一信令和 K1 个动态信令。第一信令中指示 K1 组辅助信息。所述 K1 组辅助信息和所述 K1 个动态信令一一对应。在步骤 S13 中发送 K1 个无线信号和第一无线信号。对于 UE U2，在步骤 S21 中接收第一信令，根据 K1 组辅助信

息分别接收 K1 个动态信令。在步骤 S23 中根据所述 K1 个动态信令中的调度信息分别接收 K1 个无线信号，根据第一信令的调度信息接收第一无线信号。

[0092] 实施例 1 中，第一信令包括第一无线信号的调度信息，所述 K1 个动态信令中的调度信息分别用于调度所述 K1 个无线信号。所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是物理层信令。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

[0093] 作为实施例 1 的子实施例 1，所述辅助信息包括｛信令标识，时频位置，信令格式｝。所述信令格式包括｛是否包括 CIF，DCI 格式或传输模式｝。

[0094] 作为实施例 1 的子实施例 2，基站 N1 在步骤 S12 中发送第一高层信令指示 K3 个 EPDCCH-PRB-set。UE U2 在步骤 S22 中接收第一高层信令。其中，对于目标动态信令，相应辅助信息中包括以下至少之一：

[0095] - 第一索引．目标 EPDCCH-PRB-set 在所述 K3 个 EPDCCH-PRB-set 中的索引

[0096] - 第二索引．所述目标动态信令占用的 EPDCCH 候选在所述目标 EPDCCH-PRB-set 中的索引。

[0097] 所述目标动态信令是所述 K1 个动态信令中在 EPDCCH 上传输的每一个动态信令，所述目标动态信令占用的 EPDCCH 候选所属的 EPDCCH-PRB-set，所述 K3 是正整数。

[0098] 作为实施例 1 的子实施例 3，所述 K1 为 1 或者 2。

[0099] 作为实施例 1 的子实施例 4，所述 K1 组辅助信息中部分组的辅助信息包括｛信令标识，时频位置，信令格式｝，部分组的辅助信息包括｛信令标识，信令格式｝。

[0100] 作为实施例 1 的子实施例 5，如果第一无线信号是由 DMRS 天线端口发送，所述 UE 假定所述 K1 个无线信号都是由 DMRS 天线端口发送，所述辅助信息不包括所述信令格式。如果第一无线信号是由 CRS 天线端口发送，所述辅助信息包括所述信令格式。

[0101] 实施例 2

[0102] 实施例 2 示例了第一信令指示一组辅助信息的示意图，如附图 2 所示。附图 2 示例了一组辅助信息在第一信令中的映射，并不排除第一信令指示多组辅助信息。

[0103] 实施例 2 中，一组辅助信息包括｛信令标识，时频位置，信令格式｝，分别映射到第一信令中的｛第一域，第二域，第三域｝。

[0104] 作为实施例 2 的子实施例 1，所述信令标识是 RNTI，第一域所包含的比特数小于 16，第一域和 RNTI 之间的映射由高层信令配置。本子实施例能有效降低第一信令的负载尺寸。

[0105] 作为实施例 2 的子实施例 2，EPDCCH 对应的第二域中的比特数大于 PDCCH 对应的第二域中的比特数。

[0106] 作为实施例 2 的子实施例 3，如果第一无线信号的传输载波是 FDD 载波，第三域中的比特数是 {2,3,4,5,6} 中的一个。

[0107] 实施例 3

[0108] 实施例 3 示例了下行多用户叠加的资源分配示意图，如附图 3 所示。

[0109] 实施例 3 中，基站首先发送第一信令和 2 个动态信令。第一信令中指示 2 组辅助信息。所述 2 组辅助信息和所述 2 个动态信令一一对应。然后基站发送 2 个无线信号（即

第二无线信号和第三无线信号）和第一无线信号。UE 首先接收第一信令，根据所述 2 组辅助信息分别接收所述 2 个动态信令。然后 UE 根据所述 2 个动态信令中的调度信息分别接收第二无线信号和第三无线信号，然后从接收信号中消除第二无线信号和第三无线信号的分量之后再根据第一信令的调度信息接收第一无线信号。

[0110] 实施例 3 中，第一信令包括第一无线信号的调度信息，所述 2 个动态信令中的调度信息分别用于调度所述 2 个无线信号。所述 2 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的频域资源部分重叠。第一信令和所述 2 个动态信令都是物理层信令。第二无线信号和第三无线信号在频域资源上是正交的。第二无线信号和第三无线信号的功率谱密度大于第一无线信号的功率谱密度。

[0111] 实施例 4

[0112] 实施例 4 示例了一个 UE 中的处理装置的结构框图，如附图 4 所示。附图 4 中，UE 处理装置 200 主要由接收模块 201 和接收模块 202 组成。

[0113] 接收模块 201 用于接收第一信令，根据 K1 组辅助信息分别接收 K1 个动态信令。所述 K1 组辅助信息由第一信令指示，所述 K1 组辅助信息和所述 K1 个动态信令一一对应，所述辅助信息包括｛信令标识，时频位置，信令格式｝。接收模块 202 用于根据所述 K1 个动态信令中的调度信息分别接收 K1 个无线信号，根据第一信令的调度信息接收第一无线信号。

[0114] 实施例 4 中，所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一信令和所述 K1 个动态信令都是用于调度下行传输的 DCI。所述信令格式包括｛是否包括 CIF，是否包括 SRS 请求，DCI 格式，传输模式｝中的一个或者多个。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两正交的。

[0115] 作为实施例 4 的子实施例 1，接收模块 201 还用于以下之一：

[0116] -. 接收第二高层信令确定第一整数，第一整数用于生成 DMRS 序列的初始值，所述 DMRS 序列的初始值由第一信令和所述 K1 组信令中所有在 EPDCCH 上传输的信令所共享。

[0117] -. 接收第三高层信令确定第二整数集合，第二整数集合中包括多个彼此互不相同的整数元素。其中，所述 K1 组辅助信息中对应 EPDCCH 的辅助信息中还包括 DMRS 关联整数，所述 DMRS 关联整数用于生成相应动态信令的 DMRS 序列的初始值，所述 DMRS 关联整数在第二整数集合中的索引由第一信令指示。

[0118] 作为实施例 4 的子实施例 1，第一信令是新的 DCI 格式，所述动态信令是 DCI 格式 {1，1A，1B，1C，1D，2，2A，2B，2C，2D} 中的一种。

[0119] 实施例 5

[0120] 实施例 5 示例了一个基站中的处理装置的结构框图，如附图 5 所示。附图 5 中，基站处理装置 300 主要由发送模块 301 和发送模块 302 组成。

[0121] 发送模块 301 用于发送第一信令和 K1 个动态信令。第一信令中指示 K1 组辅助信息。所述 K1 组辅助信息和所述 K1 个动态信令一一对应。发送模块 302 用于发送 K1 个无线信号和第一无线信号。

[0122] 实施例 5 中，第一信令包括第一无线信号的调度信息，所述 K1 个动态信令中的调度信息分别用于调度所述 K1 个无线信号。所述 K1 个无线信号中的每一个无线信号所占用的时频资源和第一无线信号所占用的时频资源完全或者部分重叠，所述 K1 是正整数。第一

信令和所述 K1 个动态信令都是用于调度下行传输的 DCI。如果所述 K1 大于 1，所述 K1 个无线信号在时频资源上是两两互不重叠的。

[0123] 作为实施例 5 的子实施例 1，发送模块 301 还用于发送 RRC 信令指示 K3 个 EPDCCH-PRB-set。其中，对于所述 K1 个动态信令中在 EPDCCH 上传输的目标动态信令，相应辅助信息包括第一索引，即所述目标动态信令所属的 EPDCCH-PRB-set 在所述 K3 个 EPDCCH-PRB-set 中的索引。对于所述 K1 个动态信令中在 PDCCH 上传输的给定动态信令，相应辅助信息中包括所述给定动态信令占用的 PDCCH 在目标 PDCCH 候选集合中的索引，所述目标 PDCCH 候选集合由第一信令的目标 UE 在所述给定动态信令的传输子帧和传输载波上监测的所有 PDCCH 候选所组成。

[0124] 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 包括但不限于手机，平板电脑，笔记本，上网卡等无线通信设备。本发明中的基站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。

[0125] 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。

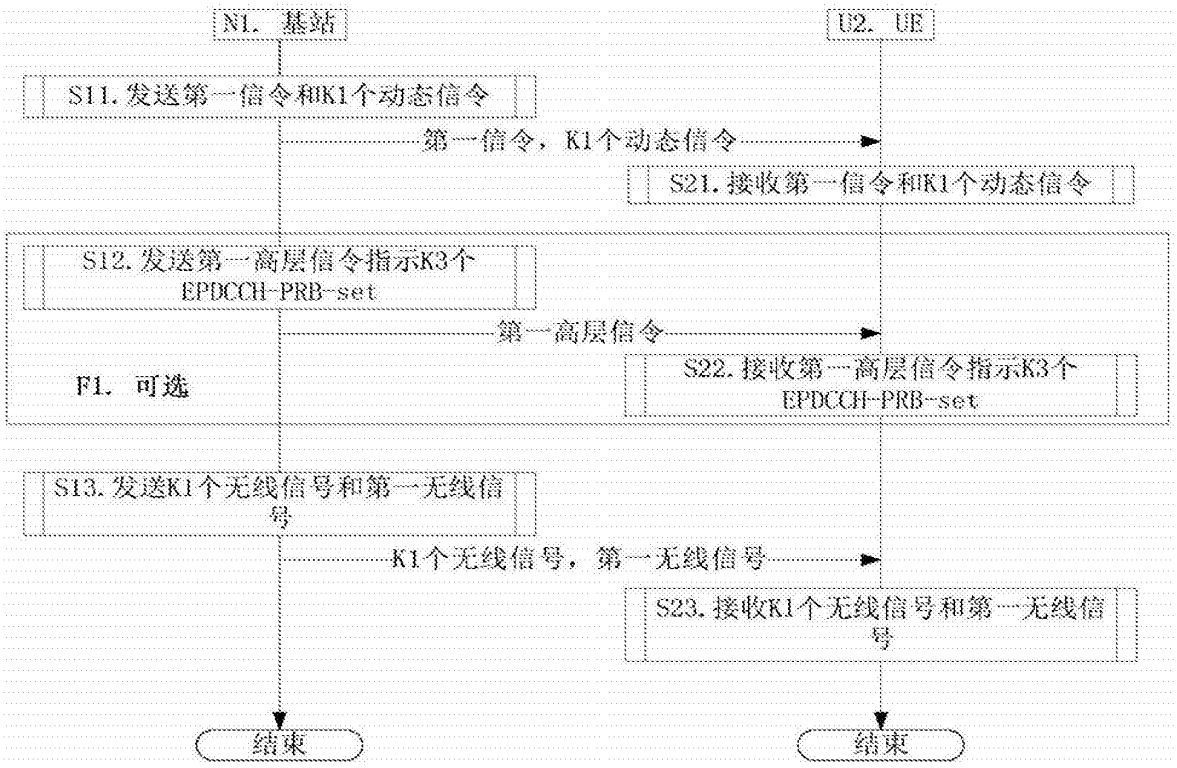

N1. 基站
U2. UE
S11. 发送第一信令和K1个动态信令
第一信令，K1个动态信令
S21. 接收第一信令和K1个动态信令
S12. 发送第一高层信令指示K3个EPDCCH-PRB-set
第一高层信令
S22. 接收第一高层信令指示K3个EPDCCH-PRB-set
F1. 可选
S13. 发送K1个无线信号和第一无线信号
K1个无线信号，第一无线信号
S23. 接收K1个无线信号和第一无线信号
结束
结束

图 1

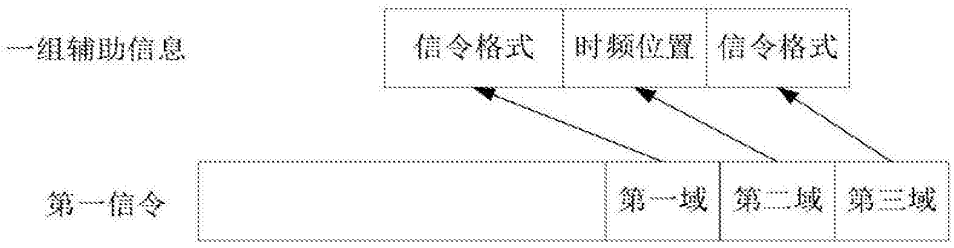

一组辅助信息
信令格式
时频位置
信令格式
第一信令
第一域
第二域
第三域

图 2

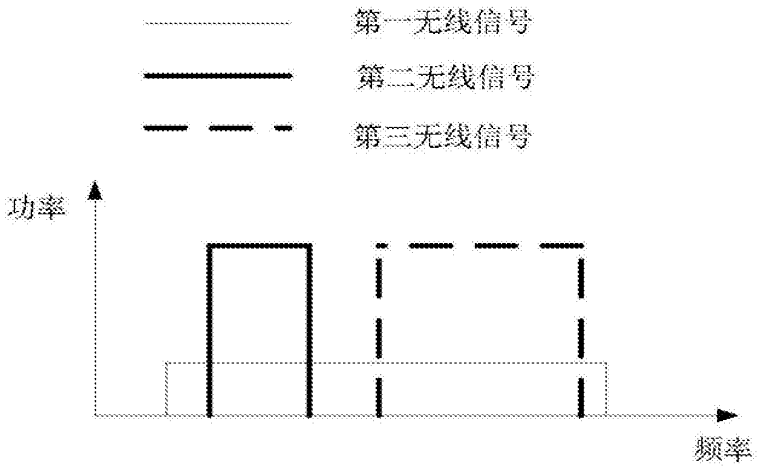

第一无线信号
第二无线信号
第三无线信号
功率
频率

图 3

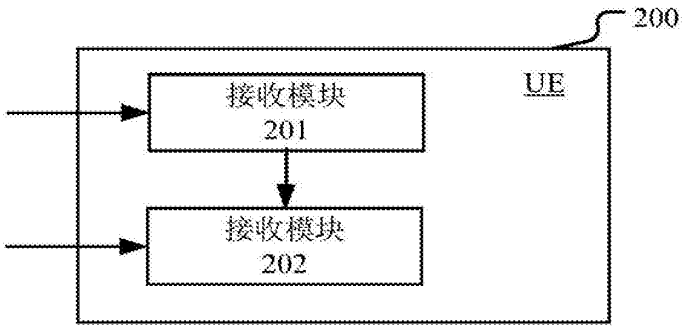

200
UE
接收模块
201
接收模块
202

图 4

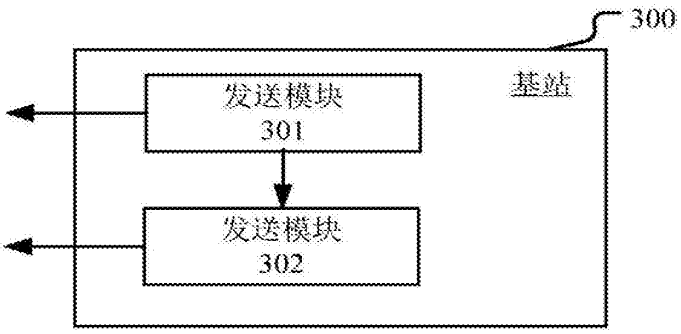

300
基站
发送模块
301
发送模块
302

图 5

Espacenet

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Channel state information acquisition state, channel state information feedback method and apparatus

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Abstract of CN106209195 (A)

The invention discloses a channel state information acquisition state, a channel state information feedback method and an apparatus. The channel state information feedback method comprises the steps that: a terminal carries out channel estimation according to received pilot signals to obtain channel estimated values of A antenna ports, wherein the A antenna ports are A antenna ports of network equipment, which send the pilot signals; the terminal determines Q antenna ports according to the channel estimated values of the A antenna ports, wherein Q is smaller than or equal to A and greater than or equal to L, L is a value of RI (Rank Indication) adopted when the network equipment sends downlink data to the terminal, or L is a value of channel RI determined by the terminal; and the terminal determines a first level of pre-coding matrix indication information according to the Q antenna ports and feeds back CSI (Channel State Information) comprising the first level of pre-coding matrix indication information to the network equipment, wherein the first level of pre-coding matrix indication information is used for indicating indexes of the Q antenna ports in the A antenna ports which send the pilot signals.

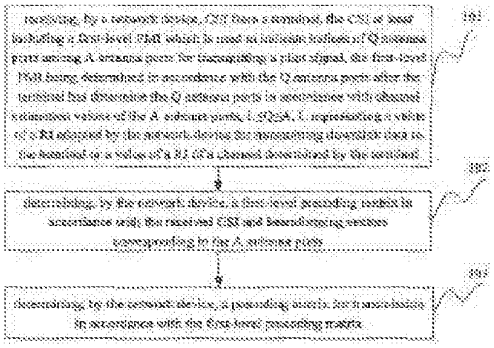


Fig. 1

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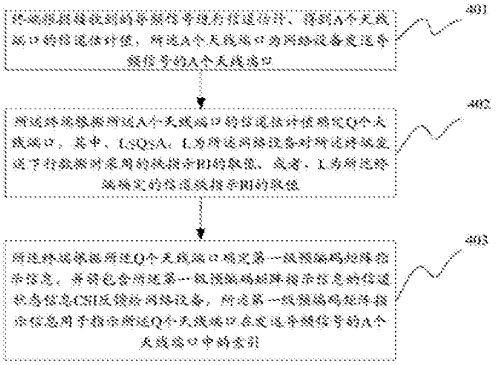
权利要求书5页 说明书16页 附图5页

(54)发明名称

信道状态信息获取方法、信道状态信息反馈方法及装置

(57)摘要

本发明公开了信道状态信息获取方法、信道状态信息反馈方法及装置，包括：终端根据接收到的导频信号进行信道估计，得到A个天线端口的信道估计值，所述A个天线端口为网络设备发送导频信号的A个天线端口；所述终端根据所述A个天线端口的信道估计值确定Q个天线端口，其中，L≤Q≤A，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；所述终端根据所述Q个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息CSI反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述Q个天线端口在发送导频信号的A个天线端口中的索引。



CN 106209195 A

1. 一种信道状态信息反馈方法，其特征在于，该方法包括：

终端根据接收到的导频信号进行信道估计，得到A个天线端口的信道估计值，所述A个天线端口为网络设备发送导频信号的A个天线端口；

所述终端根据所述A个天线端口的信道估计值确定Q个天线端口，其中，$L \leqslant Q \leqslant A$，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；

所述终端根据所述Q个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息CSI反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述Q个天线端口在发送导频信号的A个天线端口中的索引。

2. 根据权利要求1所述的方法，其特征在于，所述终端反馈给网络设备的CSI还包括以下信息之一或组合：

第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

RI；

信道质量指示CQI。

3. 根据权利要求2所述的方法，其特征在于，所述CQI是根据以下方式确定出来的：

根据所述第一级预编码矩阵指示信息确定所述Q个天线端口对应的Q个信道估计值所构成的第一等效信道；

根据所述第二级预编码矩阵指示和所述RI确定第二级预编码矩阵；

根据所述第一等效信道和所述第二级预编码矩阵确定第二等效信道；

根据所述第二等效信道、干扰信号的功率以及噪声信号的功率确定信干噪比SINR；

根据所述SINR确定所述CQI。

4. 根据权利要求1至3中任一项所述的方法，其特征在于，所述终端根据所述A个天线端口的信道估计值确定Q个天线端口，包括：

所述终端在天线端口的数量的取值范围内，确定所有可能的天线端口组合，并在所述所有可能的天线端口组合中确定使得所述终端与所述网络设备之间的信道吞吐量或容量或所述终端的导频信号接收功率最大的Q个天线端口，其中，每种可能的天线端口组合对应的信道吞吐量或容量或所述终端的导频信号接收功率根据该种可能的天线端口组合对应的信道估计值确定。

5. 根据权利要求4所述的方法，其特征在于，所述终端在天线端口的数量的取值范围内，确定所有可能的天线端口组合，并在所述所有可能的天线端口组合中确定使得所述终端与所述网络设备之间的信道吞吐量或容量或所述终端的导频信号接收功率最大的Q个天线端口，包括以下步骤：

步骤A、确定用于CSI测量的天线端口的数量的取值范围；

步骤B、设 $k = 1, T_0 = 0$；

步骤C、计算出从A个天线端口中选择k个天线端口时，确定每一种可能的天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，并选择其中吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合；

步骤D、若 $k<Q_{max}$，则转入步骤E，否则转入步骤G，Q_{max}为所述取值范围的上限，

$L \leqslant Q_{max} \leqslant A$；

步骤E、若$T_k > T_{k-1}$，则转入步骤F，否则，转入步骤G；其中，T_k为从A个天线端口中选择k个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，T_{k-1}为从A个天线端口中选择k-1个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率；

步骤F、设k＝k+1，并转入步骤C；

步骤G、将当前确定出的吞吐量或容量或所述终端的导频信号接收功率最大的天线端口组合中的天线端口，确定为用于CSI测量的天线端口。

6.一种信道状态信息获取方法，其特征在于，该方法包括：

网络设备接收终端反馈的信道状态信息CSI，其中，所述CSI至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示Q个天线端口在发送导频信号的A个天线端口中的索引，所述第一级预编码矩阵指示信息是根据A个天线端口的信道估计值确定的Q个天线端口后，根据所述Q个天线端口确定出的，$L \leqslant Q \leqslant A$，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；

所述网络设备根据接收到的所述CSI以及所述A个天线端口对应的波束赋形向量确定第一级预编码矩阵；

所述网络设备根据所述第一级预编码矩阵确定发送预编码矩阵。

7.根据权利要求6所述的方法，其特征在于，所述网络设备接收到的CSI还包括以下信息之一或组合：

第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

RI；

信道质量指示CQI。

8.根据权利要求6或7所述的方法，其特征在于，所述网络设备根据所述第一级预编码矩阵确定发送预编码矩阵，包括：

所述网络设备根据以下公式确定所述发送预编码矩阵：

$$\mathbf{W} = P^{-\frac{1}{2}}\mathbf{W}_1\mathbf{V}_L$$

其中，W为所述发送预编码矩阵，W_1为所述第一级预编码矩阵，V_L为第二级预编码矩阵，所述第二级预编码矩阵是由所述第二级预编码矩阵指示所指示出的矩阵，$P^{-\frac{1}{2}}$为功率归一化因子。

9.根据权利要求6所述的方法，其特征在于，所述网络设备接收终端反馈的CSI之前，还包括：

所述网络设备确定发送导频信号的A个天线端口、每个天线端口对应的发射天线、空间波束以及发送导频信号所用的资源，其中，每个天线端口对应一个空间波束；

所述网络设备针对所述A个天线端口中的每个天线端口，确定每个天线端口对应的空间波束在第一维度上的波束赋形向量，以及在第二维度上的波束赋形向量，并根据所述第

一维度上的波束赋形向量和所述第二维度上的波束赋形向量确定天线端口对应的波束的三维空间波束赋形向量；

所述网络设备根据所述A天线端口中的每个天线端口的三维空间波束赋形向量以及导频信号所用的资源，对导频信号进行波束赋形并在全部或部分发射天线发送。

10.根据权利要求9所述的方法，其特征在于，所述网络设备确定每个天线端口对应的空间波束，包括：

所述网络设备根据终端的分布，确定每个天线端口对应的空间波束的方向、各个方向的波束数量以及波束宽度。

11.一种终端，其特征在于，包括：

信道估计单元，用于根据接收到的导频信号进行信道估计，得到A个天线端口的信道估计值，所述A个天线端口为网络设备发送导频信号的A个天线端口；

确定单元，用于根据所述A个天线端口的信道估计值确定Q个天线端口，其中，$L \leq Q \leq A$，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；

发送单元，用于根据所述Q个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息CSI反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述Q个天线端口在发送导频信号的A个天线端口中的索引。

12.根据权利要求11所述的终端，其特征在于，所述发送单元反馈给网络设备的CSI还包括以下信息之一或组合：

第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

RI；

信道质量指示CQI。

13.根据权利要求12所述的终端，其特征在于，所述CQI是根据以下方式确定出来的：

根据所述第一级预编码矩阵指示信息确定所述Q个天线端口对应的Q个信道估计值所构成的第一等效信道；

根据所述第二级预编码矩阵指示和所述RI确定第二级预编码矩阵；

根据所述第一等效信道和所述第二级预编码矩阵确定第二等效信道；

根据所述第二等效信道、干扰信号的功率以及噪声信号的功率确定信干噪比SINR；

根据所述SINR确定所述CQI。

14.根据权利要求11至13中任一项所述的终端，其特征在于，所述确定单元具体用于：

在天线端口的数量的取值范围内，确定所有可能的天线端口组合，并在所述所有可能的天线端口组合中确定使得所述终端与所述网络设备之间的信道吞吐量或容量或所述终端的导频信号接收功率最大的Q个天线端口，其中，每种可能的天线端口组合对应的信道吞吐量或容量或所述终端的导频信号接收功率根据该种可能的天线端口组合对应的信道估计值确定。

15.根据权利要求14所述的终端，其特征在于，所述确定单元具体用于：根据以下步骤确定Q个天线端口：

步骤A、确定用于CSI测量的天线端口的数量的取值范围；

步骤B、设k＝1，T_0＝0；

步骤C、计算出从A个天线端口中选择k个天线端口时，确定每一种可能的天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，并选择其中吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合；

步骤D、若k<Q_{max}，则转入步骤E，否则转入步骤G，Q_{max}为所述取值范围的上限，L≤Q_{max}≤A；

步骤E、若T_k>T_{k-1}，则转入步骤F，否则，转入步骤G；其中，T_k为从A个天线端口中选择k个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，T_{k-1}为从A个天线端口中选择k-1个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率；

步骤F、设k＝k+1，并转入步骤C；

步骤G、将当前确定出的吞吐量或容量或所述终端的导频信号接收功率最大的天线端口组合中的天线端口，确定为用于CSI测量的天线端口。

16.一种网络设备，其特征在于，包括：

接收单元，用于接收终端反馈的信道状态信息CSI，其中，所述CSI至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示Q个天线端口在发送导频信号的A个天线端口中的索引，所述第一级预编码矩阵指示信息是根据A个天线端口的信道估计值确定的Q个天线端口后，根据所述Q个天线端口确定出的，L≤Q≤A，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；

第一确定单元，用于根据接收到的所述CSI以及所述A个天线端口对应的波束赋形向量确定第一级预编码矩阵；

第二确定单元，用于根据所述第一级预编码矩阵确定发送预编码矩阵。

17.根据权利要求16所述的网络设备，其特征在于，所述接收单元接收到的CSI还包括以下信息之一或组合：

第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

RI；

信道质量指示CQI。

18.根据权利要求16或17所述的网络设备，其特征在于，所述第二确定单元具体用于：

根据以下公式确定所述发送预编码矩阵：

$$\mathbf{W}=P^{-\frac{1}{2}}\mathbf{W}_1\mathbf{V}_L$$

其中，W为所述发送预编码矩阵，W_1为所述第一级预编码矩阵，V_L为第二级预编码矩阵，所述第二级预编码矩阵是由所述第二级预编码矩阵指示所指示出的矩阵，$P^{-\frac{1}{2}}$为功率归一化因子。

19. 根据权利要求 16 所述的网络设备，其特征在于，所述接收单元还用于：

确定发送导频信号的 A 个天线端口、每个天线端口对应的发射天线、空间波束以及发送导频信号所用的资源，其中，每个天线端口对应一个空间波束；

针对所述 A 个天线端口中的每个天线端口，确定每个天线端口对应的空间波束在第一维度上的波束赋形向量，以及在第二维度上的波束赋形向量，并根据所述第一维度上的波束赋形向量和所述第二维度上的波束赋形向量确定天线端口对应的波束的三维空间波束赋形向量；

根据所述 A 天线端口中的每个天线端口的三维空间波束赋形向量以及导频信号所用的资源，对导频信号进行波束赋形并在全部或部分发射天线发送。

20. 根据权利要求 19 所述的网络设备，其特征在于，所述第一确定单元具体用于：

根据终端的分布，确定每个天线端口对应的空间波束的方向、各个方向的波束数量以及波束宽度。

信道状态信息获取方法、信道状态信息反馈方法及装置

技术领域

[0001] 本发明涉及通信技术领域，尤其涉及信道状态信息获取方法、信道状态信息反馈方法及装置。

背景技术

[0002] 现有基于频分双工（FDD，Frequency Division Duplexing）的多输入多输出（MIMO，Multi-input Multi-output）天线系统中，网络设备的天线数目比较少，终端测量完整的MIMO信道矩阵不成问题。用于测量信道状态信息（CSI，Channel State Information）的导频通常为每根天线配置一个天线端口（antenna port）发送导频信号。

[0003] 在LTE-Advanced(LTE-Advanced是LTE的演进，LTE是Long Term Evolution的英文缩写，中文为长期演进）系统中将用于测量CSI的导频称之为参考信号，包括小区参考信号（CRS，Cell Reference Signal）和信道状态信息参考信号（CSI-RS）。终端基于测量的CSI确定最优的信道秩指示（RI，Rank Indication）、预编码矩阵指示（PMI，Precoding Matrix Indicator）和信道质量指示（CQI，Channel Quality Indicator）等，并通过反馈信道报告给网络设备。

[0004] 大规模MIMO技术通过在网络设备架设大规模天线阵列，通常为成百上千根天线，能够有效提高空间分辨率，提升系统容量。当天线布置为二维均匀矩形阵列（URA，Uniform Rectangular Array）时，便可实现很高的三维空间（水平和垂直方向）分辨率。

[0005] 目前，针对大规模MIMO系统尚未有CSI反馈以及获取的技术方案。

发明内容

[0006] 本发明实施例提供了一种信道状态信息获取方法、信道状态信息反馈方法及装置，用以实现信道状态信息的反馈和获取。

[0007] 本发明实施例提供的一种信道状态信息反馈方法包括：

[0008] 终端根据接收到的导频信号进行信道估计，得到A个天线端口的信道估计值，所述A个天线端口为网络设备发送导频信号的A个天线端口；

[0009] 所述终端根据所述A个天线端口的信道估计值确定Q个天线端口，其中，$L \leqslant Q \leqslant A$，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；

[0010] 所述终端根据所述Q个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息CSI反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述Q个天线端口在发送导频信号的A个天线端口中的索引。

[0011] 本发明实施例提供一种终端，包括：

[0012] 信道估计单元，用于根据接收到的导频信号进行信道估计，得到A个天线端口的信道估计值，所述A个天线端口为网络设备发送导频信号的A个天线端口；

[0013] 确定单元，用于根据所述A个天线端口的信道估计值确定Q个天线端口，其中，

L ≤ Q ≤ A，L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者，L 为所述终端确定的信道秩指示 RI 的取值；

[0014] 发送单元，用于根据所述 Q 个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息 CSI 反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述 Q 个天线端口在发送导频信号的 A 个天线端口中的索引。

[0015] 根据本发明实施例提供的信道状态信息反馈方法、终端，终端通过对接收到的导频信号进行信道估计，并根据估计出的等效信道从网络设备的 A 个天线端口中确定出 Q 个用于信道状态信息测量的天线端口，从而获得信道状态信息。将上述实施例应用于 MIMO 信道矩阵测量过程中时，终端将 MIMO 信道矩阵的测量转化为从网络设备的 A 个天线端口中确定 Q 个用于信道状态信息测量的天线端口，等价于对网络设备所有导频天线端口信号的测量和天线端口的选择，从而确定出终端的信道状态信息。

[0016] 本发明实施例提供一种信道状态信息获取方法，该方法包括：

[0017] 网络设备接收终端反馈的信道状态信息 CSI，其中，所述 CSI 至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示 Q 个天线端口在发送导频信号的 A 个天线端口中的索引，所述第一级预编码矩阵指示信息是根据 A 个天线端口的信道估计值确定的 Q 个天线端口后，根据所述 Q 个天线端口确定出的，L ≤ Q ≤ A，L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者，L 为所述终端确定的信道秩指示 RI 的取值；

[0018] 所述网络设备根据接收到的所述 CSI 以及所述 A 个天线端口对应的波束赋形向量确定第一级预编码矩阵；

[0019] 所述网络设备根据所述第一级预编码矩阵确定发送预编码矩阵。

[0020] 本发明实施例提供一种网络设备，包括：

[0021] 接收单元，用于接收终端反馈的信道状态信息 CSI，其中，所述 CSI 至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示 Q 个天线端口在发送导频信号的 A 个天线端口中的索引，所述第一级预编码矩阵指示信息是根据 A 个天线端口的信道估计值确定的 Q 个天线端口后，根据所述 Q 个天线端口确定出的，L ≤ Q ≤ A，L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者，L 为所述终端确定的信道秩指示 RI 的取值；

[0022] 第一确定单元，用于根据接收到的所述 CSI 以及所述 A 个天线端口对应的波束赋形向量确定第一级预编码矩阵；

[0023] 第二确定单元，用于根据所述第一级预编码矩阵确定发送预编码矩阵。

[0024] 根据本发明实施例提供的信道状态信息获取方法、网络设备，网络设备接收到的终端反馈的信道状态信息中至少包括第一级预编码矩阵指示信息，该第一级预编码矩阵指示信息是由终端根据 A 个天线端口的信道估计值确定的 Q 个天线端口确定出的，能够在一定程度上反映每个终端的信道状态信息，从而使得将上述实施例应用于大规模 MIMO 系统时，利用大规模 MIMO 系统的特点，简化大规模 MIMO 系统的设计实现。

附图说明

[0025] 图 1 为本发明实施例提供的一种信道状态信息获取方法流程示意图；

[0026] 图 2 为空间波束方向应该覆盖的空间范围示意图；

[0027] 图 3 为本发明实施例中网络设备中天线端口在所有天线上发送导频信号的过程示意图；

[0028] 图 4 为本发明实施例提供的一种信道状态信息反馈方法流程示意图；

[0029] 图 5 为本发明实施例提供的一种获取信道状态信息的方法的流程示意图；

[0030] 图 6 为本发明实施例提供的一种网络设备的结构图；

[0031] 图 7 为本发明实施例提供的一种终端的结构图；

[0032] 图 8 为本发明实施例提供的一种基站的结构图；

[0033] 图 9 为本发明实施例提供的一种用户设备的结构图。

具体实施方式

[0034] 本发明实施例中以正交频分复用 (OFDM, Orthogonal Frequency Division Multiplexing) 系统为例进行描述，例如 LTE-Advanced 系统，在没有特别说明的情况下所有描述均针对一个子载波。本发明实施例中，小写粗体字母表示列向量，大写粗体字母表示矩阵，“⊗”表示克罗内克 (Kronecker) 积，上标“T”表示矩阵或向量的转置，上标“H”表示矩阵或向量的共轭转置。

[0035] 如图 1 所示，本发明实施例提供的一种信道状态信息获取方法，该方法包括：

[0036] 步骤 101：网络设备接收终端反馈的 CSI，其中，所述 CSI 至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示 Q 个天线端口在发送导频信号的 A 个天线端口中的索引，所述第一级预编码矩阵指示信息是根据 A 个天线端口的信道估计值确定的 Q 个天线端口后，根据所述 Q 个天线端口确定出的，$L \leq Q \leq A$，L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者，L 为所述终端确定的信道秩指示 RI 的取值。

[0037] 需要说明的是，终端确定出的 RI 的取值的方法有多种，本发明实施例对此并不限定。终端在确定出 RI 的取值之后，还可能会将 RI 的取值作为 CSI 的一部分发送给网络设备，网络设备可以根据接收到 RI 的取值确定对终端发送下行数据时采用的数据层 (Layer) 及数据层数。

[0038] L 的取值可以根据实际情况确定。

[0039] 举例来说，在 SU-MIMO(Single-UserMIMO，单用户 MIMO) 系统中，网络设备对终端发送下行数据时采用的数据层及数据层数一般与终端发送的为 RI 的取值相等，此时 L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者 L 为所述终端确定的信道秩指示 RI 的取值。

[0040] 举例来说，在 MU-MIMO(Multi-UserMIMO，多用户 MIMO) 系统中，网络设备对终端发送下行数据时采用的数据层及数据层数有可能与终端发送的 RI 的取值不相等，此时 L 为所述终端确定的信道秩指示 RI 的取值。

[0041] 步骤 102：所述网络设备根据接收到的所述 CSI 以及所述 A 个天线端口对应的波束赋形向量确定第一级预编码矩阵。

[0042] 步骤 103：所述网络设备根据所述第一级预编码矩阵确定发送预编码矩阵。

[0043] 步骤 101 之前，网络设备通过 A 个天线端口发送导频信号给终端。

[0044] 优选地，网络设备通过 A 个天线端口发送导频信号给终端的过程如下：

[0045] 步骤一、网络设备确定发送导频信号的 A 个天线端口、每个天线端口对应的空间波束方向以及发送导频信号所用的资源，其中，每个天线端口对应一个空间波束方向。

[0046] 具体的，在步骤一中，网络设备在确定出发送导频信号所用的 A 个天线端口的同时，需要确定每个天线端口发送导频信号所对应的天线以及所需的时频资源。每个天线端口对应网络设备的所有或部分天线，如果需要形成的空间波束方向多于可配置的天线端口数，可以设置多组导频进程，如 LTE 的 CSI-RS 进程 (CSI-RS process) 以通过正交的时频资源发送所有导频进程。同时，所有导频进程包含的天线端口对应的所有空间波束方向应该尽量覆盖整个需要覆盖的空间，具体如图 2 所示。图 2 中虚线 201 为所有空间波束方向应该覆盖的空间范围，实线 202 为一个空间波束方向覆盖的空间范围。

[0047] 网络设备可根据终端的分布，确定每个天线端口对应的空间波束方向、各个方向的波束数量以及波束宽度。每个天线端口占用至少一个时频资源，当多个天线端口采用码分复用 (CDM，Code Division Multiple) 方式时，每个天线端口占用的时频资源可大于 1 个。

[0048] 步骤二、网络设备针对 A 个天线端口中的每个天线端口，确定每个天线端口对应的空间波束方向在第一维度上的波束赋形向量，以及在第二维度上的波束赋形向量，并根据第一维度上的波束赋形向量和所述第二维度上的波束赋形向量确定天线端口对应的波束的三维空间波束赋形向量。

[0049] 在大规模 MIMO 系统下，网络设备布置的天线阵列一般为二维均匀矩形阵列，共包含 N_T根发射天线，第一维度上和第二维度上分别有 N_x和 N_y根天线，则有 $N_T = N_x N_y$，其中，第一维度为垂直维度、第二维度为水平维度，或者，第一维度为水平维度、第二维度为垂直维度。

[0050] 在步骤二中，网络设备发送导频信号时，所有导频进程包含的 A 个天线端口的集合为 $\omega_A = \{1, 2, \cdots, A\}$，对于任意天线端口 $a \in \omega_A$占用 $M \geq 1$ 个时频资源。下面以天线端口 $a \in \omega_A$，且天线端口 a 对应的天线为网络设备的所有天线为例进行描述。

[0051] 天线端口 a 对应的天线为网络设备的所有天线时，天线端口 a 对应的空间波束方向在第一维度上的空间波束赋形向量为：

[0052] $$\mathbf{w}_x^{(a)} = [w_{x,1}^{(a)}, w_{x,2}^{(a)}, \cdots, w_{x,N_x}^{(a)}]^T \quad \cdots\cdots (1)$$

[0053] 其中，$w_{x,u}^{(a)}$为第一维度上第 u 个天线在天线端口 a 中对应的赋形权重，$1 \leq u \leq N_x$。

[0054] 天线端口 a 对应的空间波束方向在第二维度上的空间波束赋形向量为：

[0055] $$\mathbf{w}_y^{(a)} = [w_{y,1}^{(a)}, w_{y,2}^{(a)}, \cdots, w_{y,N_y}^{(a)}]^T \quad \cdots\cdots (2)$$

[0056] 其中，$w_{y,u}^{(a)}$为第二维度上第 u 个天线在天线端口 a 中对应的赋形权重，$1 \leq u \leq N_y$。

[0057] 那么该天线端口 a 对应的波束的三维空间波束赋形向量为：

[0058] $$\mathbf{w}^{(a)} = \mathbf{w}_x^{(a)} \otimes \mathbf{w}_y^{(a)} \quad \cdots\cdots (3)$$

[0059] 那么该天线端口 a 在第 m 个时频资源上发送的经过所有天线波束赋形的导频信号向量为 $s^{(a,m)} = w^{(a)} p^{(a,m)}$，其中，$p^{(a,m)}$为在第 m 个时频资源上的导频符号。

[0060] 具体的，如图3所示，图3示意出了网络设备中天线端口a在所有N_T个天线上发送导频信号的过程。图3中，天线端口a在第m个时频资源上的导频符号$p^{(a,m)}$，映射到每根天线时，每根天线会根据赋形权重系数对导频符号$p^{(a,m)}$进行相乘运算，形成经过所有天线波束赋形的导频信号向量。图3中，$w_j^{(a)}$为第j个天线在天线端口a中对应的赋形权重系数，$s_j^{(a,m)}=w_j^{(a)}p^{(a,m)}$为第j个天线在天线端口a中对应的时频资源上发送的导频信号，$1\leqslant j\leqslant N_T$。

[0061] 在步骤二中，天线端口a在第m个时频资源上发送的导频信号，也可以通过形成该天线端口a对应的空间波束方向上的部分天线发送，例如，针对交叉极化二维均匀矩形天线阵列的天线端口的一种设计实现中，全部或部分相同极化方向的天线。

[0062] 当天线端口a对应的天线为网络设备的部分天线时，波束赋形向量$w^{(a)}$仅在对应的部分天线上存在赋形权重系数$w_j^{(a)}$，其中，$w_j^{(a)}$为第j个参与形成天线端口a的天线的赋形权重系数，可以认为其它未参与形成天线端口a的天线的赋形权重系数为0。例如交叉极化二维均匀矩形天线阵列的天线端口的设计实现中，任意天线端口$a_i,a_j\in\omega_A$由相同极化方向的天线发送形成对应的空间波束方向，波束赋形向量可以写作如下形式：

[0063]
$$\mathbf{w}^{(a_i)}=[(\mathbf{w}_{i,x}^{(a_i)}\otimes\mathbf{w}_{i,y}^{(a_i)})^T,0,\cdots,0]^T \quad \cdots\cdots\cdots\

在第二级码本集合中的索引。第二级预编码矩阵是功率归一化的Q×L维的矩阵，本发明实施例中采用V_L表示。第二级预编码矩阵V_L可以由计算奇异值分解(Singular Value Decomposition,SVD)获得，对应最大L个奇异值的L个奇异向量组成的矩阵并进行功率归一化和量化处理得到，也可以根据第二级预编码矩阵指示与RI从第二级码本集合中指示出。

[0072] -RI，该RI为终端上报给网络设备的信道秩指示，终端通过上报RI使得网络设备能够确定终端支持的物理下行共享信道(Physical Downlink Shared Channel，PDSCH)的有效的数据层数。终端确定出上报给网络设备的秩指示的方法有多种，本发明实施例对此并不限定，在此不再赘述。

[0073] -信道质量指示CQI，CQI为信干噪比(Signal to Interference plus Noise Ratio，SINR)的量化值。根据以下方式确定所述CQI：根据第一级预编码矩阵指示信息确定所述Q个天线端口对应的Q个信道估计值所构成的第一等效信道，根据所述第二级预编码矩阵指示和RI确定第二级预编码矩阵，根据所述第一等效信道和所述第二级预编码矩阵确定第二等效信道，根据所述第二等效信道、干扰信号的功率以及噪声信号的功率确定SINR，根据所述SINR确定出所述CQI。

[0074] 当秩为1时，终端选择的Q个天线端口为$a_1, a_2, \cdots, a_Q$，第二级预编码矩阵为Q×1维的列向量v_1，其中N_R是终端的接收天线数，SINR可根据以下公式计算得到：

[0075] $$\gamma_1 = \left\| (Q)^{-\frac{1}{2}} \hat{\mathbf{H}} \mathbf{v}_1 \right\|^2 / (\sigma_i^2 + \sigma_n^2) \quad \cdots\cdots (6)$$

[0076] 其中，γ_1为计算得到的SINR，σ_i^2为干扰信号的功率，σ_n^2为噪声信号的功率，$\|\cdot\|$表示矩阵的范数，$\hat{\mathbf{H}} = [\hat{\mathbf{H}}^{(\omega_1)}, \hat{\mathbf{H}}^{(\omega_2)}, \cdots, \hat{\mathbf{H}}^{(\omega_Q)}]$为第一等效信道，维数为$N_R \times Q$，它是由终端通过对A个天线端口直接测量并选择而获得的，其中$\hat{\mathbf{H}}^{(a)} = \mathbf{H}\mathbf{w}^{(a)}$为第a($a \in \omega_A$)个天线端口的信道估计值，维数为$N_R \times 1$。H为一个子载波上的信道矩阵，维数是$N_R \times N_T$。

[0077] 一般情况下，网络设备接收到的终端反馈的CSI包括第一级预编码矩阵指示信息、终端选择的天线端口的数量Q、第二级预编码矩阵指示、RI、CQI等。当网络设备指定了网络设备对所述终端发送下行数据时采用的秩指示RI的取值为1，且指定了终端在测量A个天线端口后只能选择1个天线端口，即Q = 1，此时终端反馈的CSI中可以不包括终端选择的天线端口的数量Q，以及第二级预编码矩阵指示。

[0078] 在步骤102中，网络设备在接收到终端发送的包括第一级预编码矩阵指示信息的CSI之后，根据第一级预编码矩阵指示信息，确定出在发送导频信号的A个天线端口中，终端选择的Q个天线端口，并根据终端选择的Q个天线端口所对应的Q个波束赋形向量形成第一级预编码矩阵。

[0079] 具体的，第一级预编码矩阵指示信息指示的终端选取的Q个天线端口为$a_1, a_2, \cdots, a_Q$，那么网络设备获得的第一级预编码矩阵为：

[0080] $$\mathbf{W}_1 = [\mathbf{w}^{(a_1)} \quad \mathbf{w}^{(a_2)} \quad \cdots \quad \mathbf{w}^{(a_Q)}] \quad \cdots\cdots (7)$$

[0081] 其中，W_1为第一级预编码矩阵，$w^{(a)}$为天线端口a($a \in \omega_A$)对应的波束赋形向量。

[0082] 在交叉极化二维均匀矩形天线阵列的天线端口的设计实现中，任意一个天线端口

由相同极化方向的天线发送形成对应的空间波束方向，且天线序号按一个极化方向上的某一维度排序，然后是另一个极化方向上的相同维度排序，第一级预编码矩阵可以进一步写为以下形式：

[0083]

$$\mathbf{W}_1=[\mathbf{w}^{(a_1)}\quad \mathbf{w}^{(a_2)}\quad \cdots\quad \mathbf{w}^{(a_Q)}]$$
$$=\begin{bmatrix}\mathbf{w}^{(a_1)} & \cdots & \mathbf{w}^{(a_i)} & \mathbf{0} & \cdots & \mathbf{0}\\ \mathbf{0} & \cdots & \mathbf{0} & \mathbf{w}^{(a_{i+1})} & \cdots & \mathbf{w}^{(a_Q)}\end{bmatrix} \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (8)$$

[0084] 这里，天线端口 $a_1,\cdots,a_i$ 对应一个极化方向，天线端口 $a_{i+1},\cdots,a_Q$ 对应另一个极化方向。

[0085] 在步骤 103 中，网络设备根据第一级预编码矩阵确定发送预编码矩阵。

[0086] 具体的，网络设备可根据以下公式确定发送预编码矩阵：

[0087] $$\mathbf{W}=P^{-\frac{1}{2}}\mathbf{W}_1\mathbf{V}_L \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (9)$$

[0088] 其中，W 为发送预编码矩阵，W_1 为第一级预编码矩阵，维数为 $N_T\times Q$，V_L 为第二级预编码矩阵，维数为 $Q\times L$，其中 L 为 RI 的值，$P^{-\frac{1}{2}}$ 为功率归一化因子。

[0089] 网络设备确定出发送预编码矩阵之后，可以根据发送预编码矩阵重构网络设备到终端的信道矩阵。当网络设备需要重构网络设备到终端的信道矩阵时，网络设备可根据以下公式确定网络设备到终端的信道矩阵：

[0090] $$\tilde{\mathbf{H}}=\mathbf{W}^H \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (10)$$

[0091] 其中，$\tilde{\mathbf{H}}$ 为信道矩阵，W 为发送预编码矩阵。

[0092] 基于上面描述的网络设备在 A 个天线端口中发送的导频信号，每个天线端口对应一个空间波束方向，因此终端可以将 MIMO 信道矩阵测量转化为测量每个终端所处的空间波束方向的问题。终端可以根据实际情况选择多个空间波束方向，并可根据选择的多个空间波束计算信道质量（CQI）。通常终端选择的空间波束的数目远远小于网络设备的大规模天线数，因此可以降低终端 CSI 测量导频开销。

[0093] 如图 4 所示，本发明实施例提供一种信道状态信息反馈方法，该方法包括：

[0094] 步骤 401：终端根据接收到的导频信号进行信道估计，得到 A 个天线端口的信道估计值，所述 A 个天线端口为网络设备发送导频信号的 A 个天线端口。

[0095] 步骤 402：所述终端根据所述 A 个天线端口的信道估计值确定 Q 个天线端口，其中，$L\leq Q\leq A$，L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者，L 为所述终端确定的信道秩指示 RI 的取值。

[0096] 需要说明的是，终端确定出的 RI 的取值的方法有多种，本发明实施例对此并不限定。

[0097] L 的取值可以参考步骤 101 中的描述，在此不再赘述。

[0098] 步骤 403：所述终端根据所述 Q 个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的 CSI 反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述 Q 个天线端口在发送导频信号的 A 个天线端口中的索引。

[0099] 上述流程中，网络设备发送导频信号的过程可如前述图 1 所述，也可采用其它方式发送导频信号，本发明实施例对此不作限制。

[0100] 本发明实施例中，终端的接收天线数为 N_R，N_R大于等于 1，同时，占用第 m 个时频资源的天线端口 a 属于网络设备的 A 个天线端口的集合 $\omega_A = \{1, 2, \cdots, A\}$，且天线端口 a 对应的天线为网络设备中所有的 N_T根发射天线，该 N_T根发射天线为同极化的二维均匀矩形阵列；或者发射天线为交叉极化二维均匀矩形阵列，天线端口 a 对应的天线为网络设备中相同的极化方向天线。同时，天线端口 a 对应的导频符号为归一化功率。

[0101] 在步骤 401 中，终端接收到的导频信号为网络设备通过 A 个天线端口发送，其中，A 个天线端口中的每个天线端口对应一个空间波束方向，每个天线端口占用至少一个时频资源，当多个天线端口采用码分复用方式时，每个天线端口占用的时频资源可大于 1 个。同时每个天线端口对应的空间波束方向对应的三维空间波束赋形向量是根据该天线端口在第一维度上的波束赋形向量，以及在第二维度上的波束赋形向量确定的，其中，第一维度为垂直维度、第二维度为水平维度，或者，第一维度为水平维度、第二维度为垂直维度。

[0102] 天线端口 $a(a \in \omega_A)$ 在第 m 个时频资源上发送的经过所有天线波束赋形的导频信号向量为 $s^{(a,m)} = w^{(a)} p^{(a,m)}$，其中，$w^{(a)}$为天线端口 a 对应的波束的三维空间波束赋形向量，$p^{(a,m)}$为在第 m 个时频资源上的导频符号。此时，网络设备到终端在一个子载波上的信道矩阵为 $N_R \times N_T$维的矩阵 H。终端在天线端口 a 占用的第 m 个时频资源上，接收到的导频信号为 $N_R \times 1$ 维的向量：

[0103] $$\mathbf{r}^{(a,m)} = \mathbf{H}\mathbf{s}^{(a,m)} + \mathbf{i}^{(a,m)} + \mathbf{n}^{(a,m)} = \mathbf{H}\mathbf{w}^{(a)} p^{(a,m)} + \mathbf{i}^{(a,m)} + \mathbf{n}^{(a,m)} \quad \cdots\cdots\cdots\cdots \quad (11)$$

[0104] 其中，$s^{(a,m)}$为天线端口 a 在第 m 个时频资源上发送的经过所有天线波束赋形的 $N_T \times 1$ 维的导频信号向量，$i^{(a,m)}$、$n^{(a,m)}$分别为 $N_R \times 1$ 维的干扰信号向量和噪声信号向量。

[0105] 综合每个天线端口占用的时频资源的上的导频信号，终端得到网络设备发送导频信号的 A 个天线端口对应的 A 个信道估计值。天线端口 a 的信道估计值为：

[0106] $$\hat{\mathbf{H}}^{(a)} = \mathbf{H}\mathbf{w}^{(a)} + \mathbf{E}^{(a)} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (12)$$

[0107] 其中，$w^{(a)}$为天线端口 a 的三维空间波束赋形向量，$E^{(a)}$为天线端口 a 的信道估计误差矩阵，$a \in \omega_A$。终端得到 A 个天线端口的信道估计值 $\hat{\mathbf{H}}^{(1)}$，$\hat{\mathbf{H}}^{(2)}$，…，$\hat{\mathbf{H}}^{(A)}$。

[0108] 在步骤 402 中，终端需要根据 A 个天线端口的信道估计值，从 A 个天线端口中选择 Q 个天线端口，以便确定出 CSI 反馈给网络设备。

[0109] 考虑到终端在根据选择的 Q 个天线端口确定 CSI 的计算复杂度，终端可以只选择一个天线端口去确定 CSI。但是，考虑到传播路径上存在的很多散射体，终端接收到的导频信号很可能是经过多条传播路径的信号的叠加，因此为了获得准确性较高的 CSI，需要终端在天线端口的数量的取值范围内，确定所有可能的天线端口组合，并在所有可能的天线端口组合中确定使得终端与网络设备之间的信道吞吐量或容量或终端的导频信号接收功率最大的 Q 个天线端口，其中，每种可能的天线端口组合对应的信道吞吐量或容量或所述终端的导频信号接收功率根据该种可能的天线端口组合对应的信道估计值确定。

[0110] 天线端口的数量的取值范围内一般为大于或等于信道的秩 L，且小于或等于 A，网络设备也可以指定天线端口的数量的取值范围的上限。例如，网络设备指定天线端口的数量的取值范围为 Q_{max}。

[0111] 同时，网络设备也可以为终端指定出需要选择的天线端口的数量，例如，指定的天线端口的数量为Q，且 $L \leq Q \leq A$，此时终端只需在A个天线端口中选择出使得终端与网络设备之间的信道吞吐量或容量或终端的信号接收功率最大时的Q个天线端口组合。网络设备未指定需要选择的天线端口的数量或天线端口的数量的取值范围的上限时，终端选择的天线端口的数量的取值范围的下限为大于或等于L，取值范围的上限为网络设备发送导频信号的天线端口数量，即小于或等于A。

[0112] 无论网络设备是否为终端指定出需要选择的天线端口的数量，在A个天线端口中都有很多种天线端口的组合供终端选择。下面以计算终端与网络设备之间的吞吐量或容量为例，终端在A个天线端口中选择出吞吐量或容量最大的Q个天线端口的集合 ω_Q 根据以下方法确定：

[0113]

$$\omega_Q = \underset{\omega_Q' \in \{\Omega_L, \Omega_{L+1}, \cdots, \Omega_{Q_{max}}\}}{\arg\max} f((P')^{-\frac{1}{2}} \hat{\mathbf{H}}_{\omega_Q'} \mathbf{V}_L, \mathbf{i}+\mathbf{n}) \quad \cdots\cdots (13)$$

[0114] 其中，$f((P')^{-\frac{1}{2}} \hat{\mathbf{H}}_{\omega_Q'} \mathbf{V}_L, \mathbf{i}+\mathbf{n})$ 为计算终端与网络设备之间的吞吐量或容量的函数，该函数为本领域技术人员公知的函数，在此不再详细描述该函数，只描述该函数的功能，Q_{max} 为终端选择的天线端口的数量的取值范围的上限，$L \leq Q_{max} \leq A$，ω_k 表示在A个天线端口中选择k个天线端口的集合，Ω_k 表示在A个天线端口中选择k个天线端口时所有可能的 ω_k 的集合，$L \leq k \leq Q_{max}$，$\hat{\mathbf{H}}_{\omega_Q'}$ 表示在A个天线端口中选择的k个天线端口对应的信道估计值构成的第一等效信道，V_L 可以由计算 $\hat{\mathbf{H}}_{\omega_Q'}$ 的奇异值分解获得，对应最大L个奇异值的L个奇异向量组成的矩阵并进行功率归一化和量化处理得到，也可以从第二级码本集合中选择，i为干扰信号向量，n为噪声信号向量，P′为预编码矩阵的功率归一化因子。

[0115] 当 $L = 1$ 时，第二级预编码矩阵退化为 $Q \times 1$ 的列向量。当 $L = 1$ 且网络设备指定 $Q_{max} = 1$ 时，第二级预编码矩阵则进一步退化为标量 $v_1 = 1$，此时，上述问题便可简化为从A个天线端口中选择信道估计值的范数平方最大，即接收功率最大的天线端口。

[0116] 终端通过计算每个A个天线端口中每个可能的天线端口组合，然后选择一个使得终端与网络设备之间的信道吞吐量或容量或终端的信号接收功率最大时的Q个天线端口组合，这个过程的计算量非常大。为了降低计算复杂度，本发明实施例中采用贪婪法进行搜索，其基本思想是逐一增加使用的天线端口的数量，直到吞吐量或容量或所述终端的导频信号接收功率不再增加或达到最大的可选择秩为止。具体的，贪婪法的详细描述如下。

[0117] 如图5所示，本发明实施例提供的贪婪法流程示意图，包括以下步骤：

[0118] 步骤501、确定用于CSI测量的天线端口的数量的取值范围；

[0119] 步骤502、设 $k = 1, T_0 = 0$；

[0120] 步骤503、计算出从A个天线端口中选择k个天线端口时，确定每一种可能的天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，并选择其中吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合；

[0121] 步骤504、若 $k<Q_{max}$，则转入步骤505，否则转入步骤507，Q_{max} 为所述取值范围的上

限，$L \leqslant Q_{max} \leqslant A$；

[0122] 步骤 505、若 $T_k > T_{k-1}$，则转入步骤 506，否则，转入步骤 507；其中，T_k为从 A 个天线端口中选择 k 个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，T_{k-1}为从 A 个天线端口中选择 k-1 个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率；

[0123] 步骤 506、设 k ＝ k+1，并转入步骤 503；

[0124] 步骤 507、将当前确定出的吞吐量或容量或所述终端的导频信号接收功率最大的天线端口组合中的天线端口，确定为用于 CSI 测量的天线端口。

[0125] 终端确定出用于 CSI 测量的 Q 个天线端口之后，便可以确定反馈给网络设备的 CSI。具体的，在步骤 403 中，终端确定出的 CSI 中至少包括第一级预编码矩阵指示信息，第一级预编码矩阵指示信息用于指示所述用于 CSI 测量的 Q 个天线端口在发送导频信号的 A 个天线端口中的索引。进一步地，终端确定出的 CSI 中还可以包括以下信息之一或组合：

[0126] - 第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；第二级预编码矩阵 V_L是功率归一化的 Q×L 维的矩阵。第二级预编码矩阵 V_L可以由计算奇异值分解获得，对应最大 L 个奇异值的 L 个奇异向量组成的矩阵并进行功率归一化和量化处理得到，也可以从第二级码本集合中选择。

[0127] -RI，该 RI 为终端上报给网络设备的信道秩指示，终端通过上报 RI 通过网络设备终端支持的 PDSCH 的有效的数据层数。

[0128] -CQI。可以根据以下方式确定所述 CQI：根据第一级预编码矩阵指示信息确定所述 Q 个天线端口对应的 Q 个信道估计值所构成的第一等效信道，根据所述第二级预编码矩阵指示和所述 RI 确定第二级预编码矩阵，根据所述第一等效信道和所述第二级预编码矩阵确定第二等效信道，根据所述第二等效信道、干扰信号的功率以及噪声信号的功率确定 SINR，根据所述 SINR 确定出所述 CQI。

[0129] 一般情况下，终端反馈的 CSI 包括第一级预编码矩阵指示信息、终端选择的天线端口的数量 Q、第二级预编码矩阵指示、RI、信道质量指示 CQI 等。当网络设备指定了网络设备对所述终端发送下行数据时采用的 RI 的取值为 1，且指定了终端在 A 个天线端口中只能选择 1 个天线端口进行 CSI 测量时，终端反馈给网络设备的 CSI 中可以不包括终端选择的天线端口的数量 Q，以及第二级预编码矩阵指示。

[0130] 针对上述方法流程，本发明实施例还提供一种网络设备和一种终端，该网络设备和终端的具体内容可以参照上述方法实施，在此不再赘述。

[0131] 如图 6 所示，本发明实施例提供一种网络设备，包括：

[0132] 接收单元 601，用于接收终端反馈的信道状态信息 CSI，其中，所述 CSI 至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示 Q 个天线端口在发送导频信号的 A 个天线端口中的索引，所述第一级预编码矩阵指示信息是根据 A 个天线端口的信道估计值确定的 Q 个天线端口后，根据所述 Q 个天线端口确定出的，$L \leqslant Q \leqslant A$，L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者，L 为所述终端确定的信道秩指示 RI 的取值；

[0133] 第一确定单元 602，用于根据接收到的所述 CSI 以及所述 A 个天线端口对应的波束

赋形向量确定第一级预编码矩阵；

[0134] 第二确定单元603，用于根据所述第一级预编码矩阵确定发送预编码矩阵。

[0135] 较佳的，所述接收单元601接收到的CSI还包括以下信息之一或组合：

[0136] 第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

[0137] RI；

[0138] 信道质量指示CQI。

[0139] 较佳的，所述第二确定单元603具体用于：

[0140] 根据以下公式确定所述发送预编码矩阵：

[0141] $$\mathbf{W}=P^{-\frac{1}{2}}\mathbf{W}_1\mathbf{V}_L$$

[0142] 其中，W为所述发送预编码矩阵，W_1为所述第一级预编码矩阵，V_L为第二级预编码矩阵，所述第二级预编码矩阵是由所述第二级预编码矩阵指示所指示出的矩阵，$P^{-\frac{1}{2}}$为功率归一化因子。

[0143] 较佳的，所述接收单元601还用于：

[0144] 所述网络设备确定发送导频信号的A个天线端口、每个天线端口对应的发射天线、空间波束以及发送导频信号所用的资源，其中，每个天线端口对应一个空间波束；

[0145] 所述网络设备针对所述A个天线端口中的每个天线端口，确定每个天线端口对应的空间波束在第一维度上的波束赋形向量，以及在第二维度上的波束赋形向量，并根据所述第一维度上的波束赋形向量和所述第二维度上的波束赋形向量确定天线端口对应的波束的三维空间波束赋形向量；

[0146] 所述网络设备根据所述A天线端口中的每个天线端口的三维空间波束赋形向量以及导频信号所用的资源，对导频信号进行波束赋形并在全部或部分发射天线发送。

[0147] 较佳的，所述第一确定单元702具体用于：

[0148] 根据终端的分布，确定每个天线端口对应的空间波束的方向、各个方向的波束数量以及波束宽度。

[0149] 如图7所示，本发明实施例提供一种终端，包括：

[0150] 信道估计单元701，用于根据接收到的导频信号进行信道估计，得到A个天线端口的信道估计值，所述A个天线端口为网络设备发送导频信号的A个天线端口；

[0151] 确定单元702，用于根据所述A个天线端口的信道估计值确定Q个天线端口，其中，$L \leqslant Q \leqslant A$，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；

[0152] 发送单元703，用于根据所述Q个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息CSI反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述Q个天线端口在发送导频信号的A个天线端口中的索引。

[0153] 较佳的，所述发送单元703反馈给网络设备的CSI还包括以下信息之一或组合：

[0154] 第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

[0155] RI；

[0156] 信道质量指示 CQI。

[0157] 较佳的，所述 CQI 是根据以下方式确定出来的：

[0158] 根据所述第一级预编码矩阵指示信息确定所述 Q 个天线端口对应的 Q 个信道估计值所构成的第一等效信道；

[0159] 根据所述第二级预编码矩阵指示和所述 RI 确定第二级预编码矩阵；

[0160] 根据所述第一等效信道和所述第二级预编码矩阵确定第二等效信道；

[0161] 根据所述第二等效信道、干扰信号的功率以及噪声信号的功率确定信干噪比 SINR；

[0162] 根据所述 SINR 确定所述 CQI。

[0163] 较佳的，所述确定单元 702 具体用于：

[0164] 在天线端口的数量的取值范围内，确定所有可能的天线端口组合，并在所述所有可能的天线端口组合中确定使得所述终端与所述网络设备之间的信道吞吐量或容量或所述终端的导频信号接收功率最大的 Q 个天线端口，其中，每种可能的天线端口组合对应的信道吞吐量或容量或所述终端的导频信号接收功率根据该种可能的天线端口组合对应的信道估计值确定。

[0165] 较佳的，所述确定单元 702 具体用于：

[0166] 根据以下步骤确定 Q 个天线端口：

[0167] 步骤 A、确定用于 CSI 测量的天线端口的数量的取值范围；

[0168] 步骤 B、设 $k = 1, T_0 = 0$；

[0169] 步骤 C、计算出从 A 个天线端口中选择 k 个天线端口时，确定每一种可能的天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，并选择其中吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合；

[0170] 步骤 D、若 $k<Q_{max}$，则转入步骤 E，否则转入步骤 G，Q_{max}为所述取值范围的上限，$L \leqslant Q_{max} \leqslant A$；

[0171] 步骤 E、若 $T_k>T_{k-1}$，则转入步骤 F，否则，转入步骤 G；其中，T_k为从 A 个天线端口中选择 k 个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，T_{k-1}为从 A 个天线端口中选择 k-1 个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率；

[0172] 步骤 F、设 $k = k+1$，并转入步骤 C；

[0173] 步骤 G、将当前确定出的吞吐量或容量或所述终端的导频信号接收功率最大的天线端口组合中的天线端口，确定为用于 CSI 测量的天线端口。

[0174] 针对上述方法流程，本发明实施例还提供一种网络设备和一种终端，该网络设备和终端的具体内容可以参照上述方法实施，在此不再赘述。

[0175] 如图 8 所示，本发明实施例提供一种网络设备，包括：

[0176] 处理器 800，用于用于读取存储器 820 中的程序，执行下列过程：用于接收终端反馈的信道状态信息 CSI，其中，所述 CSI 至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示 Q 个天线端口在发送导频信号的 A 个天线端口中的索引，所述第一级预编码矩阵指示信息是根据 A 个天线端口的信道估计值确定的 Q 个天线端口后，

根据所述 Q 个天线端口确定出的，L ≤ Q ≤ A，L 为所述网络设备对所述终端发送下行数据时采用的秩指示 RI 的取值，或者，L 为所述终端确定的信道秩指示 RI 的取值；用于根据接收到的所述 CSI 以及所述 A 个天线端口对应的波束赋形向量确定第一级预编码矩阵；根据所述第一级预编码矩阵确定发送预编码矩阵；

[0177] 收发机 810，用于在处理器 800 的控制下接收和发送数据。

[0178] 较佳的，所述收发机 810 接收到的 CSI 还包括以下信息之一或组合：

[0179] 第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

[0180] RI；

[0181] 信道质量指示 CQI。

[0182] 较佳的，所述处理器 800 具体用于：

[0183] 根据以下公式确定所述发送预编码矩阵：

[0184] $\mathbf{W}=P^{-\frac{1}{2}}\mathbf{W}_1\mathbf{V}_L$

[0185] 其中，W 为所述发送预编码矩阵，W_1为所述第一级预编码矩阵，V_L为第二级预编码矩阵，所述第二级预编码矩阵是由所述第二级预编码矩阵指示所指示出的矩阵，$P^{-\frac{1}{2}}$为功率归一化因子。

[0186] 较佳的，所述处理器 800 还用于：

[0187] 所述网络设备确定发送导频信号的 A 个天线端口、每个天线端口对应的发射天线、空间波束以及发送导频信号所用的资源，其中，每个天线端口对应一个空间波束；

[0188] 所述网络设备针对所述 A 个天线端口中的每个天线端口，确定每个天线端口对应的空间波束在第一维度上的波束赋形向量，以及在第二维度上的波束赋形向量，并根据所述第一维度上的波束赋形向量和所述第二维度上的波束赋形向量确定天线端口对应的波束的三维空间波束赋形向量；

[0189] 所述网络设备根据所述 A 天线端口中的每个天线端口的三维空间波束赋形向量以及导频信号所用的资源，对导频信号进行波束赋形并在全部或部分发射天线发送。

[0190] 较佳的，所述处理器 800 具体用于：

[0191] 根据终端的分布，确定每个天线端口对应的空间波束的方向、各个方向的波束数量以及波束宽度。

[0192] 其中，在图 8 中，总线架构可以包括任意数量的互联的总线和桥，具体由处理器 800 代表的一个或多个处理器和存储器 820 代表的存储器的各种电路链接在一起。总线架构还可以将诸如外围设备、稳压器和功率管理电路等之类的各种其他电路链接在一起，这些都是本领域所公知的，因此，本文不再对其进行进一步描述。总线接口提供接口。收发机 810 可以是多个元件，即包括发送机和收发机，提供用于在传输介质上与各种其他装置通信的单元。处理器 800 负责管理总线架构和通常的处理，存储器 820 可以存储处理器 800 在执行操作时所使用的数据。

[0193] 如图 9 所示，本发明实施例提供一种终端，包括：

[0194] 处理器 900，用于读取存储器 920 中的程序，执行下列过程：用于根据接收到的导频信号进行信道估计，得到 A 个天线端口的信道估计值，所述 A 个天线端口为网络设备发送

导频信号的A个天线端口；用于根据所述A个天线端口的信道估计值确定Q个天线端口，其中，L ≤ Q ≤ A，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值；用于根据所述Q个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息CSI反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述Q个天线端口在发送导频信号的A个天线端口中的索引；

[0195] 收发机910，用于在处理器900的控制下接收和发送数据。

[0196] 较佳的，所述收发机910反馈给网络设备的CSI还包括以下信息之一或组合：

[0197] 第二级预编码矩阵指示，所述第二级预编码矩阵指示用于指示第二级预编码矩阵在第二级码本集合中的索引；

[0198] RI；

[0199] 信道质量指示CQI。

[0200] 较佳的，所述CQI是根据以下方式确定出来的：

[0201] 根据所述第一级预编码矩阵指示信息确定所述Q个天线端口对应的Q个信道估计值所构成的第一等效信道；

[0202] 根据所述第二级预编码矩阵指示和所述RI确定第二级预编码矩阵；

[0203] 根据所述第一等效信道和所述第二级预编码矩阵确定第二等效信道；

[0204] 根据所述第二等效信道、干扰信号的功率以及噪声信号的功率确定信干噪比SINR；

[0205] 根据所述SINR确定所述CQI。

[0206] 较佳的，所述处理器900具体用于：

[0207] 在天线端口的数量的取值范围内，确定所有可能的天线端口组合，并在所述所有可能的天线端口组合中确定使得所述终端与所述网络设备之间的信道吞吐量或容量或所述终端的导频信号接收功率最大的Q个天线端口，其中，每种可能的天线端口组合对应的信道吞吐量或容量或所述终端的导频信号接收功率根据该种可能的天线端口组合对应的信道估计值确定。

[0208] 较佳的，所述处理器900具体用于：

[0209] 根据以下步骤确定Q个天线端口：

[0210] 步骤A、确定用于CSI测量的天线端口的数量的取值范围；

[0211] 步骤B、设 $k = 1, T_0 = 0$；

[0212] 步骤C、计算出从A个天线端口中选择k个天线端口时，确定每一种可能的天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，并选择其中吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合；

[0213] 步骤D、若 $k<Q_{max}$，则转入步骤E，否则转入步骤G，Q_{max}为所述取值范围的上限，$L \leq Q_{max} \leq A$；

[0214] 步骤E、若 $T_k>T_{k-1}$，则转入步骤F，否则，转入步骤G；其中，T_k为从A个天线端口中选择k个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对应的吞吐量或容量或所述终端的导频信号接收功率，T_{k-1}为从A个天线端口中选择k-1个天线端口时，吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合对

应的吞吐量或容量或所述终端的导频信号接收功率；

[0215] 步骤F、设k = k+1，并转入步骤C；

[0216] 步骤G、将当前确定出的吞吐量或容量或所述终端的导频信号接收功率最大的天线端口组合中的天线端口，确定为用于CSI测量的天线端口。

[0217] 其中，在图9中，总线架构可以包括任意数量的互联的总线和桥，具体由处理器900代表的一个或多个处理器和存储器920代表的存储器的各种电路链接在一起。总线架构还可以将诸如外围设备、稳压器和功率管理电路等之类的各种其他电路链接在一起，这些都是本领域所公知的，因此，本文不再对其进行进一步描述。总线接口提供接口。收发机910可以是多个元件，即包括发送机和接收机，提供用于在传输介质上与各种其他装置通信的单元。针对不同的用户设备，用户接口930还可以是能够外接内接需要设备的接口，连接的设备包括但不限于小键盘、显示器、扬声器、麦克风、操纵杆等。

[0218] 处理器900负责管理总线架构和通常的处理，存储器920可以存储处理器900在执行操作时所使用的数据。

[0219] 综上所述，根据本发明实施例提供的方法，终端通过从网络设备发送导频信号的A个天线端口中选择至少一个天线端口，既降低了CSI测量导频的开销，又尽可能保证了一定的CSI测量精度，简化了系统设计。通常终端选择的天线端口的数目远远小于网络设备的大规模天线数，因此可以降低CSI测量导频开销，同时终端还可以选择多个空间波束方向以及它们的最优加权系数便可更加精确地估计CSI。

[0220] 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和光学存储器等）上实施的计算机程序产品的形式。

[0221] 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。

[0222] 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。

[0223] 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。

[0224] 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。

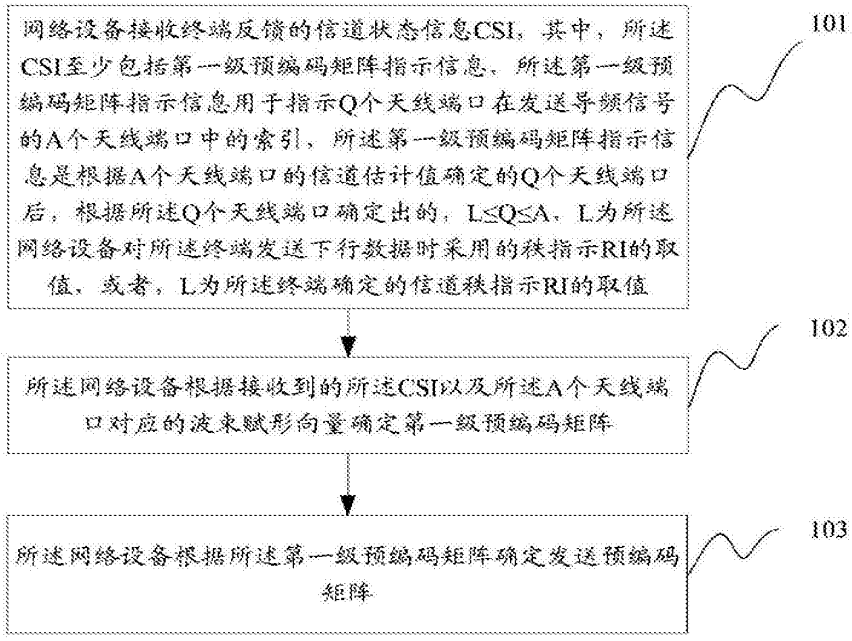

网络设备接收终端反馈的信道状态信息CSI，其中，所述CSI至少包括第一级预编码矩阵指示信息，所述第一级预编码矩阵指示信息用于指示Q个天线端口在发送导频信号的A个天线端口中的索引，所述第一级预编码矩阵指示信息是根据A个天线端口的信道估计值确定的Q个天线端口后，根据所述Q个天线端口确定出的，L≤Q≤A，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值
101
所述网络设备根据接收到的所述CSI以及所述A个天线端口对应的波束赋形向量确定第一级预编码矩阵
102
所述网络设备根据所述第一级预编码矩阵确定发送预编码矩阵
103

图 1

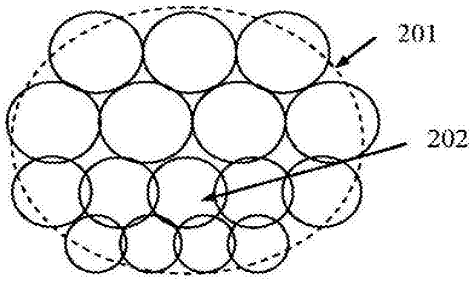

201
202

图 2

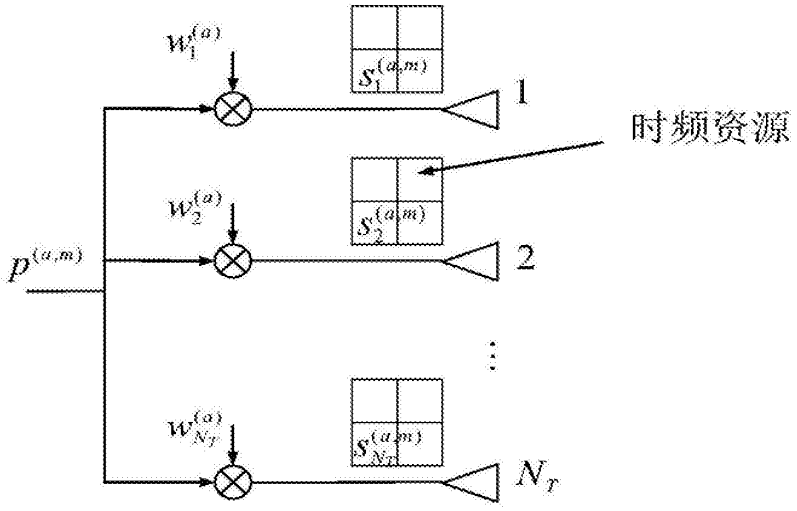

$W_1^{(a)}$
$S_1^{(a,m)}$
1
时频资源
$W_2^{(a)}$
$S_2^{(a,m)}$
$p^{(a,m)}$
2
$W_{N_T}^{(a)}$
$S_{N_T}^{(a,m)}$
N_T

图 3

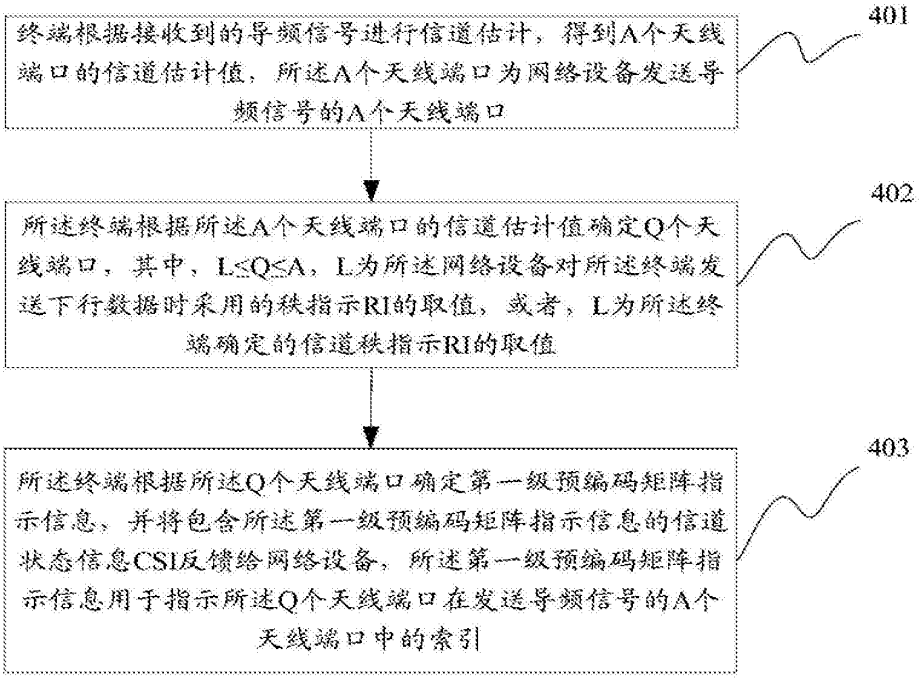

终端根据接收到的导频信号进行信道估计，得到A个天线端口的信道估计值，所述A个天线端口为网络设备发送导频信号的A个天线端口
401
所述终端根据所述A个天线端口的信道估计值确定Q个天线端口，其中，L≤Q≤A，L为所述网络设备对所述终端发送下行数据时采用的秩指示RI的取值，或者，L为所述终端确定的信道秩指示RI的取值
402
所述终端根据所述Q个天线端口确定第一级预编码矩阵指示信息，并将包含所述第一级预编码矩阵指示信息的信道状态信息CSI反馈给网络设备，所述第一级预编码矩阵指示信息用于指示所述Q个天线端口在发送导频信号的A个天线端口中的索引
403

图 4

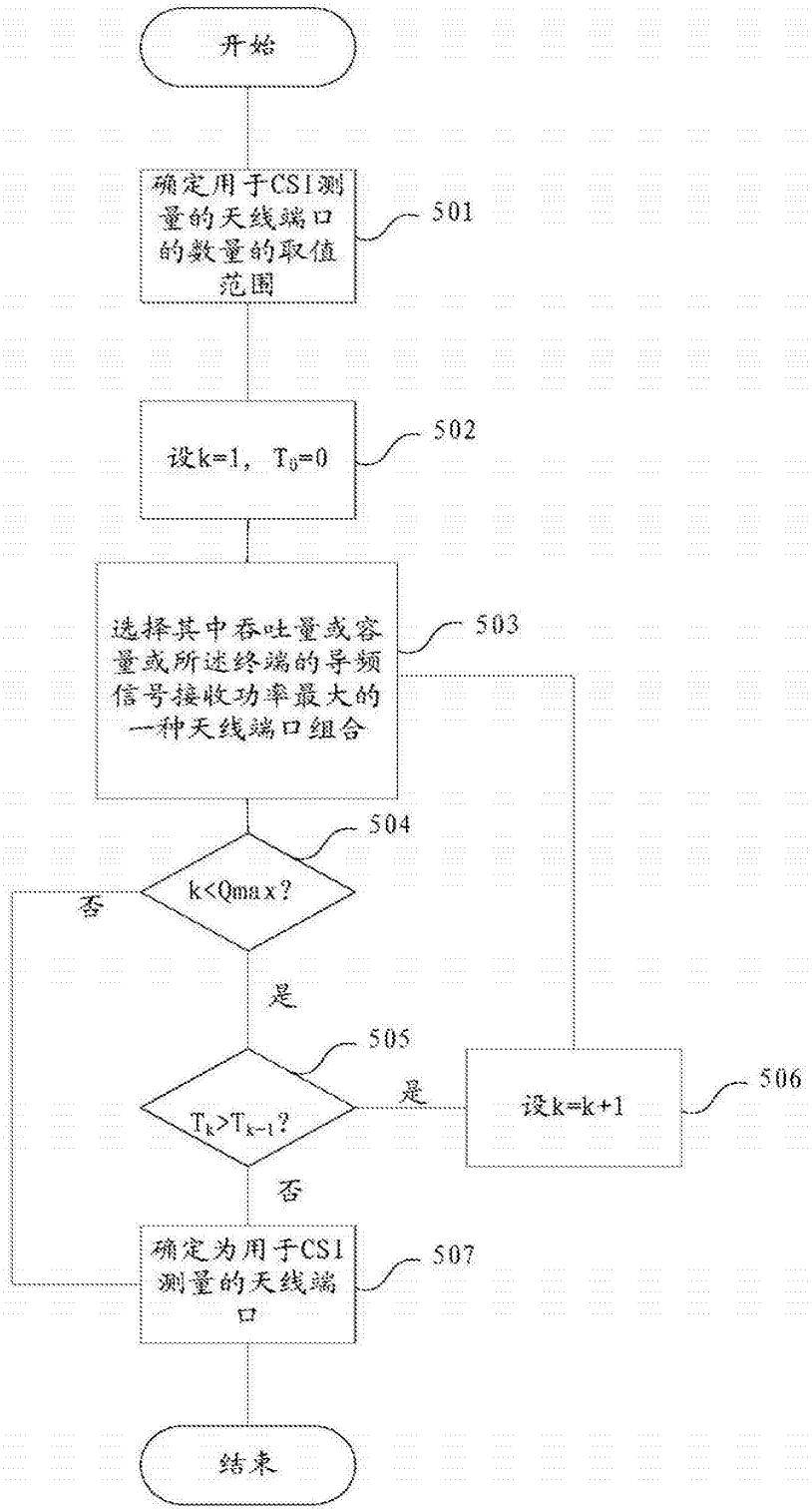

开始
确定用于CSI测量的天线端口的数量的取值范围
501
设k=1，T_0=0
502
选择其中吞吐量或容量或所述终端的导频信号接收功率最大的一种天线端口组合
503
504
k<Qmax?
否
是
505
T_k>T_{k-1}?
是
设k=k+1
506
否
确定为用于CSI测量的天线端口
507
结束

图 5

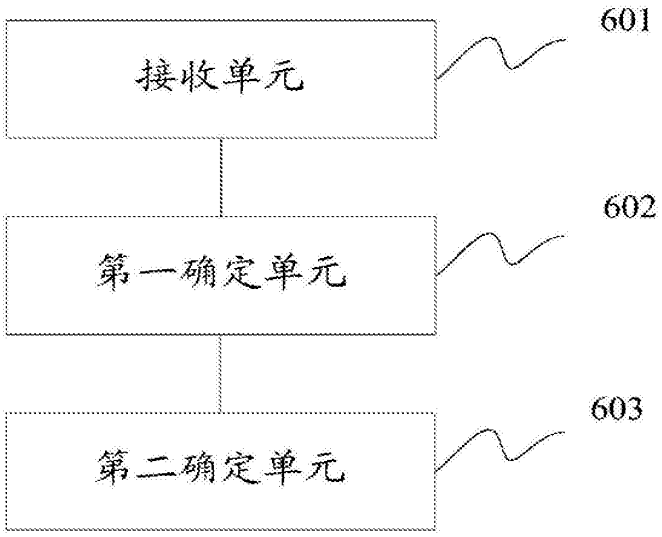


图 6

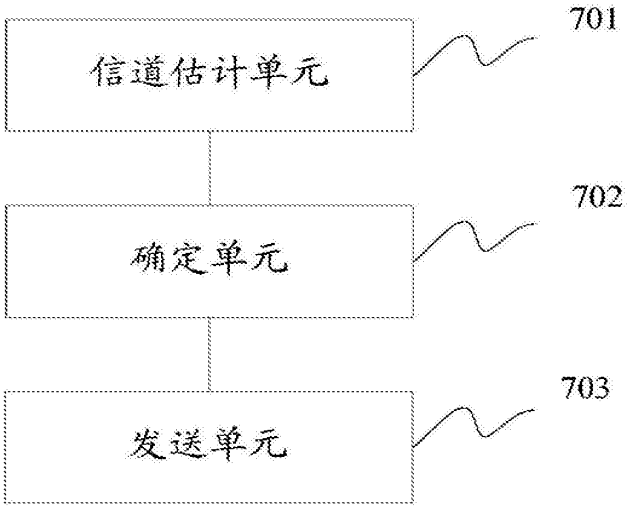


图 7

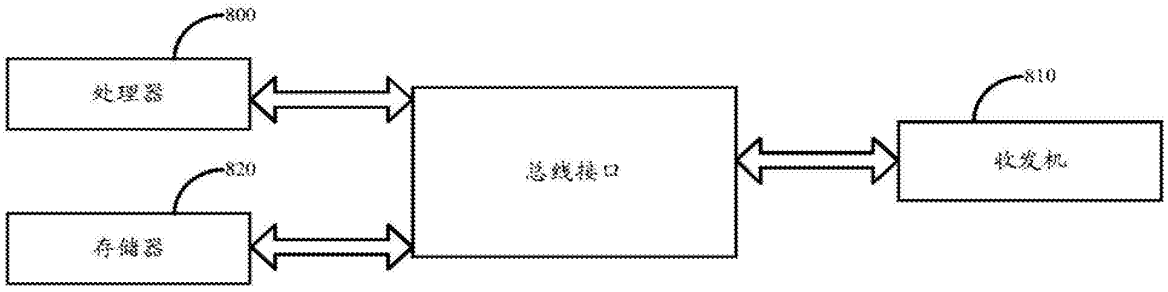

800
处理器
820
存储器
总线接口
810
收发机

图 8

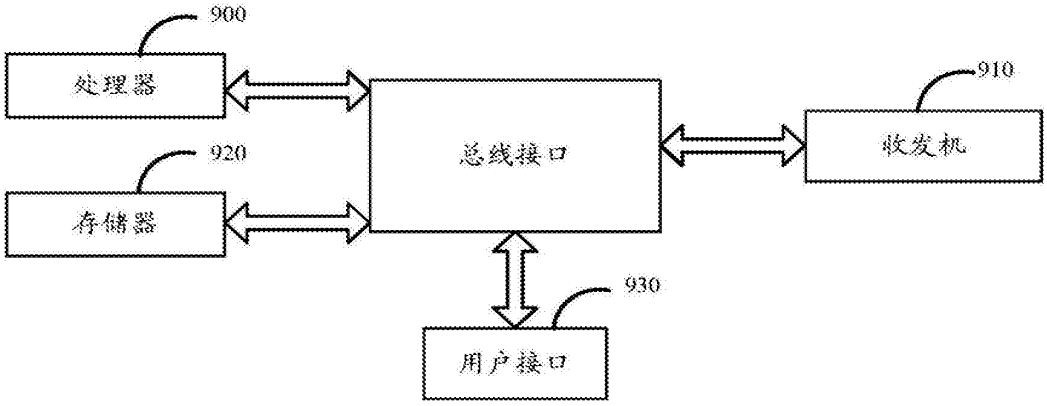

900
处理器
920
存储器
总线接口
910
收发机
930
用户接口

图 9

Espacenet

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Adaptive sectorization of a spational region for parallel multi-user transmissions

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Applicant(s): INTEL CORP ± (INTEL CORPORATION)

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Abstract of CN105474556 (A)

Technology to adaptively sectorize a spatial region for parallel multi-user transmissions is disclosed. In an example, a node (e.g., evolved Node B (eNB)) can include computer circuitry configured to: generate a set of precoding matrices for a set of beam cones in the spatial region; and generate a beam cone for multi-user beamforming transmissions using system information for the beam cone. A precoding matrix in the set of precoding matrices can be used for each beam cone, and each beam cone can cover a beam cone spatial region that differs from another beam cone spatial region of another beam cone in the spatial region. Each beam cone can include system information that differs from the system information of the other beam cones in the spatial region.

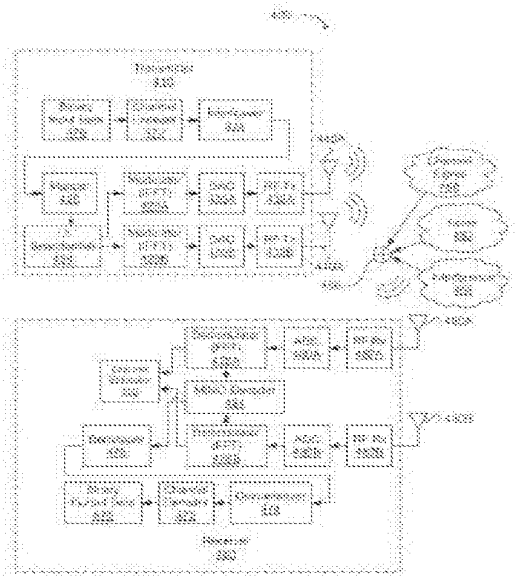


FIG. 1

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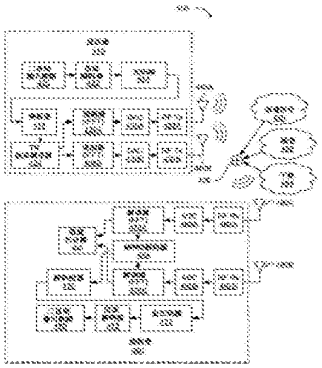
权利要求书5页 说明书14页 附图13页

(54)发明名称

用于并行多用户传输的空间区域的适应性扇区化

(57)摘要

公开了适应性地对空间区域扇区化以用于并行多用户传输的技术。在示例中，节点（例如，演进节点B(eNB)）可包括计算机电路，其配置成：为空间区域中的一组波束锥形生成一组预编码矩阵；以及使用波束锥形的系统信息生成用于多用户波束赋形传输的波束锥形。一组预编码矩阵中的预编码矩阵可用于每个波束锥形，并且每个波束锥形可覆盖波束锥形空间区域，该波束锥形空间区域不同于空间区域中的另一个波束锥形的另一个波束锥形空间区域。每个波束锥形可包括系统信息，其不同于空间区域中的其他波束锥形的系统信息。



CN 105474556 A

1.一种可操作以适应性地将空间区域扇区化以用于并行多用户传输的节点，所述节点具有计算机电路，所述计算机电路配置成：

为所述空间区域中的一组波束锥形生成一组预编码矩阵，其中所述一组预编码矩阵中的预编码矩阵被用于每个波束锥形，每个波束锥形覆盖一个波束锥形空间区域，所述一个波束锥形空间区域不同于所述空间区域中的另一个波束锥形的另一个波束锥形空间区域；以及每个波束锥形包括系统信息，所述系统信息不同于所述空间区域中的其他波束锥形的系统信息；以及

使用所述波束锥形的所述系统信息生成用于多用户波束赋形传输的波束锥形。

2.根据权利要求1所述的计算机电路，其中每个波束锥形的所述系统信息包括唯一小区标识符(CID)、天线端口、主同步信号(PSS)、辅同步信号(SSS)、系统信息块(SIB)、参考信号(RS)、控制信道或物理下行链路控制信道(PDCCH)。

3.根据权利要求1所述的计算机电路，其中所述计算机电路还配置成：

从由所述波束锥形形成的虚拟小区k中的用户设备(UE)j接收有效信道H_jF_k的信道质量指示符(CQI)，其中所述UE j测量信道$H_jF_kS_k$，其中H_j为所述UE j的信道脉冲响应，F_k为所述虚拟小区k的预编码矩阵，S_k为所述虚拟小区k的参考信号，以及j和k为整数。

4.根据权利要求3所述的计算机电路，其中F_k具有维度M*L，其中M为发射天线的数目，L为相应天线端口的数目，其中$L\in\{1,2,4,8\}$，以及M和L为整数。

5.根据权利要求1所述的计算机电路，其中所述计算机电路还配置成：

基于一组信道质量指示符(CQI)报告来选择虚拟小区k的用户设备(UE)u_k；以及

将数据信号X传输到所述UE u_k，其中由$X=\sum_k F_k B_{u_k} X_{u_k}$表示X，其中$F_k$为所述虚拟小区k的所述预编码矩阵，$B_{u_k}$为所述UE u_k的UE专用预编码矩阵，以及X_{u_k}为所述UE u_k的调制。

6.根据权利要求1所述的计算机电路，其中所述计算机电路还配置成：

确定两个波束锥形信号何时由于多径、信号散射或信号反射在用户设备(UE)处冲突；以及

修改波束锥形以避免信号冲突，其中所述修改包括：

通过将用于所述冲突信号中的两个预编码矩阵分配到形成单个虚拟小区的共同小区标识符(CID)来合并两个波束锥形；

当所述一个波束锥形内没有UE正在与所述节点主动通信时，关闭所述波束锥形中的一个；

通过将所述波束锥形中的一个的CID调整到另一个预编码矩阵来移动该所述波束锥形中的一个以远离另一个波束锥形；或者

使用所述波束锥形中的一个之上的频分双工(FDD)或时分双工(TDD)，以避免所述信号冲突。

7.根据权利要求1所述的计算机电路，其中所述计算机电路还配置成：

为所述一组波束锥形生成至少两组不同的预编码矩阵，其中每个波束锥形包括小区标识符(CID)，并且每组预编码矩阵覆盖彼此不同的空间区域；以及

在所述至少两组不同的预编码矩阵之间轮流，以用于小区扫描和所述空间区域的更好覆盖。

8.根据权利要求1所述的计算机电路，其中所述计算机电路还配置成：

生成宽广范围预编码矩阵以使用宽广的波束锥形来覆盖宽广范围；

生成一组狭窄区域预编码矩阵以使用一组狭窄波束锥形来覆盖狭窄区域；以及

使用频分多路复用(FDM)、时分多路复用(TDM)或增强型小区间干扰协调(eICIC)，以用于使用所述宽广波束锥形或所述一组狭窄波束锥形的传输。

9.根据权利要求1所述的计算机电路，其中所述计算机电路还配置成：

通过调整所述波束锥形来跟踪用户设备(UE)，其中所述计算机电路实施主动UE跟踪或被动UE跟踪，其中：

对于主动UE跟踪，所述计算机电路还配置成：

当信道质量由于UE移动而改变时，从所述UE接收跟踪触发信号；

通过到所述UE的请求来改变接收信道质量指示符(CQI)的周期性；以及

当另一个预编码矩阵提供比所述预编码矩阵的所述波束锥形更好的信道质量时，将表示服务所述UE的虚拟小区的波束锥形的所述预编码矩阵调整到另一个预编码矩阵，所述另一个预编码矩阵形成覆盖不同于所述预编码矩阵的所述波束锥形的空间范围的已调整的波束锥形，其中所述虚拟小区由小区标识符(CID)来索引；以及

对于被动UE跟踪，所述计算机电路还配置成：

监测由于UE移动而导致的信道质量改变；以及

通过将服务所述UE的所述CID的预编码矩阵调整到另一个预编码矩阵来调整波束锥形方向，所述另一个预编码矩阵形成覆盖不同于所述预编码矩阵的所述波束锥形的空间范围的已调整的波束锥形，其中所述已调整的波束锥形方向基于上行链路信号，并且上行链路信号包括上行链路参考信号(RS)或同步信号(SS)。

10.根据权利要求1所述的计算机电路，其中所述计算机电路还配置成：

从用户设备(UE)接收干扰测量反馈消息，所述干扰测量反馈消息包括邻近小区的系统信息，其中所述邻近小区的所述系统信息包括虚拟小区标识符(CID)和时间戳；以及

与所述邻近小区协调一组锥形形成波束的调度，以避免小区间干扰。

11.根据权利要求10所述的计算机电路，其中计算机电路配置成协调一组锥形形成波束的调度还配置成：

经由无线信道、有线连接、光纤连接或X2接口，通过回程链路信令与邻近节点协调一组锥形形成波束的调度。

12.根据权利要求1所述的计算机电路，其中计算电路配置成生成所述波束锥形还配置成：经由具有至少两行天线辐射元件和至少两列天线辐射元件的天线阵列动态地和适应性地生成波束锥形，其中每个天线辐射元件表示发射天线。

13.根据权利要求1所述的计算机电路，其中：所述节点包括M个发射天线，其中M>8，并且所述节点包括基站(BS)、节点B(NB)、演进节点B(eNB)、基带单元(BBU)、远程射频头(RRH)、远程无线电设备(RRE)、远程无线电单元(RRU)或中央处理模块(CPM)。

14.一种用于在演进节点B(eNB)处将小区划分为虚拟扇区以用于所述小区中的并行多用户传输的方法，包括：

为所述小区中的一组虚拟扇区生成一组预编码矩阵，其中所述一组预编码矩阵中的预编码矩阵用于每个虚拟扇区，并且其中每个虚拟扇区包括系统信息，所述系统信息不同于

所述小区中的另一个虚拟扇区的系统信息;以及

使用所述预编码矩阵以及与所述预编码矩阵关联的系统信息生成虚拟扇区的多用户波束赋形传输。

15.根据权利要求14所述的方法,还包括:

使用大天线阵列将所述多用户波束赋形传输适应性地传输到所述虚拟扇区内的用户设备(UE),其中所述大天线阵列包括至少两行天线辐射元件和至少两列天线辐射元件,并且所述大天线阵列具有超过八个的天线辐射元件。

16.根据权利要求14所述的方法,其中每个虚拟扇区的所述系统信息包括唯一小区标识符(CID)、天线端口、主同步信号(PSS)、辅同步信号(SSS)、系统信息块(SIB)、参考信号(RS)、控制信道或物理下行链路控制信道(PDCCH)。

17.根据权利要求14所述的方法,还包括:

从虚拟小区k中的用户设备(UE)j接收有效信道H_jF_k的信道质量指示符(CQI),其中所述UE j测量信道$H_jF_kS_k$,其中H_j为所述UE j的信道脉冲响应,F_k为所述虚拟小区k的预编码矩阵,S_k为所述虚拟小区k的参考信号,以及j和k为整数。

18.根据权利要求14所述的方法,还包括:

基于一组信道质量指示符(CQI)报告选择虚拟小区k的用户设备(UE)u_k;以及

将数据信号X传输到所述UE u_k,其中由$X=\sum_k F_k B_{u_k} X_{u_k}$表示X,其中$F_k$为所述虚拟小区k的所述预编码矩阵,$B_{u_k}$为所述UE u_k的UE专用预编码矩阵,以及X_{u_k}为所述UE u_k的调制。

19.根据权利要求14所述的方法,还包括:

确定来自不同虚拟扇区的两个信号何时由于多路径、信号散射或信号反射在用户设备(UE)处彼此干扰;以及

修改一个虚拟扇区的传输以避免信号干扰,其中所述修改包括:

通过将用于所述一个虚拟扇区的所述干扰信号的预编码矩阵分配到与生成所述干扰的其他虚拟扇区相同的小区标识符(CID)以形成单个虚拟扇区的共同CID,来合并两个虚拟扇区;

当所述一个虚拟扇区内没有UE正在与所述eNB主动通信时,关闭所述一个虚拟扇区;或者

通过将所述一个虚拟扇区的预编码矩阵调整到不同的预编码矩阵,同时使用相同CID来移动所述一个虚拟扇区以远离另一个虚拟扇区。

20.根据权利要求14所述的方法,还包括:

为所述一组虚拟扇区生成至少两组不同的预编码矩阵,其中每个虚拟扇区包括小区标识符(CID),并且每组预编码矩阵覆盖不同于彼此的空间区域;以及

在所述至少两组不同的预编码矩阵之间转换,以用于小区扫描和所述小区的更好覆盖。

21.根据权利要求14所述的方法,还包括:

为用于宽广小区空间范围内的宽广小区的宽广虚拟扇区生成宽广预编码矩阵;

为用于所述宽广小区空间区域内的狭窄小区的一组狭窄的虚拟扇区生成一组狭窄的预编码矩阵;以及

使用频分多路复用(FDM)、时分多路复用(TDM)或增强型小区间干扰协调(eICIC)调度所述宽广虚拟扇区和所述一组狭窄虚拟扇区之间的传输。

22.根据权利要求14所述的方法,还包括:

从用户设备(UE)接收包括邻近小区系统信息的干扰反馈消息,其中所述邻近小区系统信息包括虚拟小区标识符(CID)或资源标识符;以及

与邻近小区协调一组虚拟扇区传输的调度,以避免小区间干扰,其中由所述eNB服务所述小区和所述邻近小区,或者由所述eNB服务所述小区且由邻近eNB服务所述邻近小区,并且所述eNB和所述邻近eNB经由无线信道、有线连接、光纤连接或X2接口,通过回程链路信令通信。

23.至少一种非暂时性机器可读存储介质,其包括适于被执行以实施权利要求14所述的方法的多个指令。

24.一种用户设备(UE),配置成跟踪相对于所述UE的移动的波束赋形锥形,所述用户设备包括:

收发器,用于:

在持续时间内,从波束赋形锥形的虚拟小区中的演进节点B(eNB)接收下行链路信号;以及

处理器,用于:

在所述持续时间内,测量用于所述虚拟小区的所述下行链路信号的信道的信道质量;以及

确定由于UE的移动所述信道质量中的变化何时越过信道质量阈值;以及

其中所述收发器还配置成:

发送触发信号到所述eNB,以初始化对所述虚拟小区的所述波束赋形锥形的跟踪。

25.根据权利要求24所述的UE,其中:

初始化对波束赋形锥形的跟踪:改变与所述虚拟小区关联的预编码矩阵。

26.根据权利要求24所述的UE,还包括:

运动传感器,用于:

确定所述UE何时处于运动中。

27.根据权利要求24所述的UE,其中:

所述收发器还配置成:

传输由$H_jF_kS_k$表示的所述信道的每个信道质量测量的信道质量指示符(CQI),其中H_j为UE j的信道脉冲响应,F_k为所述虚拟小区k的预编码矩阵,S_k为所述虚拟小区k的参考信号,以及j和k为整数;以及

接收虚拟小区k中的数据信号Y,其中Y由$Y_{u_i}=(H_{u_i}F_i)B_{u_i}X_{u_i}+$干扰+噪音来表示,其中$H_{u_i}$为所述UE u_i的信道脉冲响应,F_i为所述虚拟小区i的预编码矩阵,B_{u_i}为所述UE u_i的UE专用预编码矩阵,X_{u_i}为所述UE u_i的调制,并且由$\sum_{k\neq i}(H_{u_i}F_k)B_{u_k}X_{u_k}$表示干扰,其中$F_k$为所述虚拟小区k的预编码矩阵,$B_{u_k}$为所述UE u_k的UE专用预编码矩阵,以及X_{u_k}为所述UE u_k的调制。

28.根据权利要求24所述的UE,其中:

所述处理器还配置成：

测量来自邻近小区的包括邻近小区系统信息的干扰，其中所述邻近小区系统信息包括虚拟小区标识符(CID)；以及

为所述干扰生成时间戳；以及

所述收发器配置成：

经由演进节点B(eNB)将包括所述邻近小区系统信息和所述时间戳的干扰测量反馈消息发送到服务小区，以配置所述服务小区从而降低与所述邻近小区的小区间干扰。

29.根据权利要求24所述的UE，其中所述UE包括天线、触敏显示屏幕、扬声器、麦克风、图形处理器、应用程序处理器、内存储器或非易失性存储器端口。

用于并行多用户传输的空间区域的适应性扇区化

背景技术

[0001] 无线移动通信技术使用各种标准和协议以在节点(例如,传输站或收发器节点)和无线设备(例如,移动设备)之间传输数据。一些无线设备在下行链路(DL)传输中使用正交频分多址接入(OFDMA)以及在上行链路(UL)传输中使用单载波频分多址接入(SC-FDMA)进行通信。使用正交频分双工(OFDM)以用于信号传输的标准和协议包括第三代合作伙伴项目(3GPP)长期演进(LTE)、电气和电子工程师协会(IEEE)802.16标准(例如,802.16e、802.16m),其通常被行业团体已知为WIMAX(全球微波接入互操作性),以及IEEE802.11标准,其通常被行业团体已知为WiFi。

[0002] 在3GPP无线电接入网络(RAN)LTE系统中,节点可以是与无线设备通信的演进型通用陆地无线电接入网络(E-UTRAN)节点B(通常也被指示为演进节点B、增强型节点B、eNodeB或eNB)和无线电网络控制器(RNC)的组合,所述无线设备被已知为用户设备(UE)。下行链路(DL)传输(也被已知为广播信道(BC))可以是从节点(例如,eNodeB)到无线电设备(例如,UE)的通信,并且上行链路(UE)传输(也被已知为多路接入信道(MAC))可以是从无线设备到节点的通信。

[0003] 下行链路和上行链路信道或传输可使用时分双工(TDD)或频分双工(FDD)。时分双工(TDD)是时分多路复用(TDM)到分离的下行链路和上行链路信号的应用。在TDD中,可在其中下行链路信号使用不同于上行链路信号的时间间隔的相同载波频率(即,共享载波频率)上传送下行链路信号和上行链路信号,使得下行链路信号和上行链路信号不生成对彼此的干扰。TDM为数字多路复用类型,其中诸如下行链路或上行链路的两个或更多比特流或信号作为一个通信信道中的子信道明显地同时传递,但在不同的资源上物理地传输。在频分双工(FDD)中,上行链路传输和下行链路传输可使用不同的频率载波(即,每个传输方向的分离的载波频率)操作。在FDD中,由于下行链路信号使用不同于上行链路信号的频率载波,因此可避免干扰。

[0004] eNB可具有用于到UE的传输的多个天线,从而允许eNB使用多输入和多输出(MIMO)。MIMO是智能天线技术,其是指发送器和接收器两者下的多个天线的使用,以改善通信性能,其中输入和输出是指传送信号的无线电信道,而不必需指具有天线的设备。在MIMO中,可使用至多八个发射或接收天线,或者至多八个信道可用于资源的传输。

附图说明

[0005] 本公开的特征和优点将从以下结合随附附图的详细描述中显而易见,随附附图通过示例的方式一起示出本公开的特征;以及,其中:

[0006] 图1根据示例示出正交频分复用(OFDM)无线网络中发送器和接收器的物理层的方框图;

[0007] 图2根据示例示出物理信道处理器的物理信道处理的方框图;

[0008] 图3根据示例示出用于下行链路(DL)传输的包括传统物理下行链路控制信道(PDCCH)的无线电帧资源(例如,资源网格)的示图;

[0009] 图4A根据示例示出单输入单输出(SISO)的方框图；

[0010] 图4B根据示例示出单输入多输出(SIMO)无线网络的方框图；

[0011] 图4C根据示例示出多输入单输出(MISO)无线网络的方框图；

[0012] 图4D根据示例示出多输入多输出(MIMO)无线网络的方框图；

[0013] 图5根据示例示出具有大规模多输入多输出(MIMO)的小区的示图；

[0014] 图6根据示例示出多用户波束赋形(MU-波束赋形)以形成若干波束锥形、虚拟小区或虚拟扇区的示图；

[0015] 图7A根据示例示出通过天线阵列的波束方向的示图；

[0016] 图7B根据示例示出通过天线阵列的两个波束方向的示图；

[0017] 图8根据示例示出冲突虚拟小区的示图；

[0018] 图9根据示例示出合并冲突虚拟小区的示图；

[0019] 图10根据示例示出用于小区扫描的可选的预编码矩阵组的示图；

[0020] 图11根据示例示出用于小区扫描的可选的预编码矩阵组的波束方向的示图；

[0021] 图12根据示例示出具有宽广覆盖的虚拟小区以及使用大规模多输入多输出(MIMO)由适应性扇区化生成的小且尖的虚拟小区的示图；

[0022] 图13根据示例示出使用大规模多输入多输出(MIMO)的用户设备(UE)跟踪的示图；

[0023] 图14根据示例示出大规模多输入多输出(MIMO)小区间干扰协调的示图；

[0024] 图15根据示例描绘可操作以适应性地扇区化空间区域以用于并行多用户传输的节点(例如,演进节点B(eNB))的计算机电路的功能；

[0025] 图16根据示例示出用于将小区划分为虚拟扇区以用于演进节点B(eNB)处小区中的并行多用户传输的流程图；

[0026] 图17根据示例示出节点(例如,eNB)和无线设备(例如,UE)的方框图；以及

[0027] 图18根据示例示出无线设备(例如,UE)的示图。

[0028] 现在将参考所示出的示例性实施例,并且具体语言将在本文用于描述相同目的。然而,应当理解的是,并不因此旨在对本发明的范围的限制。

具体实施方式

[0029] 在公开和描述本发明之前,应理解的是,该发明不限于本文公开的特定结构、过程步骤或材料,而是延伸到如相关领域技术人员将理解的其等效物。还应理解的是,本文采用的技术用于仅描述特定示例的目的,并且不旨在为限制性的。不同附图中的相同参考数字表示相同元素。流程图和过程中提供的数字被提供用于清楚说明步骤和操作的目的,并且不必需指示特定顺序或序列。

[0030] 示例实施例

[0031] 下面提供技术实施例的初始概述,并且然后进一步详细描述具体技术实施例。该初始总结旨在帮助读者更快速地理解所述技术,但不旨在识别所述技术的关键特征或重要特征,也不旨在限制所要求保护的主题的范围。

[0032] 无线通信系统可被细分为被称作层的各个部分。在LTE系统中,通信层可包括物理(PHY)层、媒体接入控制(MAC)层、无线电链接控制(RLC)层、分组数据汇聚协议(PDCP)层和无线电资源控制(RRC)层。物理层可包括无线通信系统400的基本硬件传输部件,如图1中所

示。为简单起见，基本多输入多输出(MIMO)系统用于说明基本硬件传输部件，但该部件还可适于复杂MIMO系统、单输入和单输出(SISO)系统或类似系统。例如在MIMO系统中，在发送器410处，二进制输入数据420可使用信道编码器422通过编码而被保护，使用交织器424对二进制输入数据交织以抵抗衰落现象，以及使用映射器426映射二进制输入数据以改善可靠性。可通过发送器(TX)波束赋形器434将映射数据分离为天线端口的层，并且可使用调制器428A-B将所述层调制为OFDM符号。调制器可使用逆快速傅里叶变换(IFFT)算法以计算逆离散傅里叶变换(IDFT)，以生成调制信号(用于每个天线端口的矢量x)。可通过数字-模拟转换器(DAC)430A-B将调制信号转换为模拟信号。可经由无线电频率(RF)发送器(Tx)432A-B传输模拟信号，所述无线电频率(RF)发送器(Tx)432A-B配置成将信号发送到可操作以传送信号的发送器天线440A-B。模拟信号将经过被称作信道的路径。传播通过该路径的模拟信号可被称作信道信号450。物理层可包括其他部件(未示出)，诸如串行-并行(S/P)转换器、并行-串行(P/S)转换器、循环前缀(CP)插入器和删除器、防护频带插入器和删除器以及其他所需的部件。

[0033] 所传输的信道信号450可经受噪音452和干扰454。干扰可包括小区内干扰和小区间干扰。小区内干扰可指示来自在发送器410的小区内传输的其他信道信号的干扰。小区间干扰可指示来自由邻近小区传输的其他信道信号的干扰。噪音和干扰被表示为信道信号的附加456，所述信道信号可在接收器460处由接收器天线490A-B以及一个或多个无线电频率(RF)接收器(Rx)482A-B接收。可通过模拟-数字转换器(ADC)480A-B将与噪音和干扰组合的信道信号转换为数字调制信号。可使用解调器478A-B对数字信号进行OFDM解调。解调器可使用快速傅里叶变换(FFT)算法以计算离散傅里叶变换(DFT)，以生成解调信号(用于每个天线端口的矢量y)。信道估计器462可使用解调信号以估计信道450以及发生在所述信道中的噪音和干扰。信道估计其可包括反馈发生器或者与反馈发生器通信，所述反馈发生器可生成物理上行链路共享信道(PUSCH)反馈报告，诸如信道质量指示符(CQI)报告、预编码矩阵指示符(PMI)报告、传输等级指示符(RI)报告或物理上行链路控制信道(PUCCH)(例如，包括RI或PMI)。CQI可用于帮助MIMO传输模式。可使用MIMO解码器484组合解调信号，使用解映射器476来解映射，使用去交织器474来去交织，以及由信道解码器472来解码，从而生成二进制输入数据470，其可由接收站的其他层使用。

[0034] 图2示出与在图1中被示出用于LTE MIMO移动通信系统的物理信道处理器的交织器424、映射器426、发送器波束赋形器434和调制器428A-B相关的附加细节。相应特征还可存在于接收器460上。图2的MIMO物理信道处理器300可包括扰频器320A-V、调制映射器330A-V、层映射器340、预编码器360、资源元素映射器370A-P和OFDM信号发生器380A-P。扰码器可将码字310中的每个扰乱为将在物理信道上传输的编码比特。调制映射器可调制扰乱的比特以生成复数调制符号。层映射器可将调制符号映射到多个传输层350上。与编码器可在每个层上预编码调制符号以用于天线端口590上的传输。与编码器可使用在发送器(例如，eNB)和接收器(例如，UE)处已知的代码本，或者可在发送器处被计算并被传递到接收器或在接收器处被学习。代码本可在发送器和接收器处限定一组矢量和矩阵，这可实现高预编码增益、较低反馈开销，并提供灵活性以支持各种天线配置和不同数目的数据流。资源元素映射器可将每个天线端口的调制符号映射到资源元素(RE)。OFDM信号发生器可生成复数时域OFDM信号，以用于每个天线端口。

[0035] 在一个示例中，资源元素(RE)可表示在使用通用3GPP长期演进(LTE)帧结构的节点(例如，eNodeB)和无线设备(例如，UE)之间的下行链路传输中，在物理(PHY)层上传输的无线帧结构的元素，如图3中所示。

[0036] 图3示出下行链路无线电帧结构类型1。在示例中，用于传输数据的信号的无线电帧100可配置成具有10毫秒(ms)的持续时间T_f。每个无线电帧可被分段或划分为十个子帧110i，其每个为1ms长。每个子帧可被进一步划分为两个时隙120a和120b，每个具有0.5ms的持续时间T_{slot}。第一时隙(#0)可包括传统物理下行链路控制信道(PDCCH)160和/或物理下行链路共享信道(PDSCH)166，并且第二时隙(#1)120b可包括使用PDSCH传输的数据。

[0037] 用于由节点和无线设备使用的分量载波(CC)的每个时隙可包括基于CC频率带宽的多个资源块(RB)130a、130b、130i、130m和130n。CC可具有载波频率，其具有带宽和中心频率。CC的每个子帧可包括在传统PDCCH中发现的下行链路控制信息(DCI)。当使用传统PDCCH时，控制区域中的传统PDCCH可在每个子帧或物理RB(PRB)中包括一行到三行的第一OFDM符号。子帧中剩余的11到13个OFDM符号(或当未使用传统PDCCH时的14个OFDM符号)可被分配到数据(对于短循环前缀或标准循环前缀)的PDSCH。

[0038] 控制区域可包括物理控制格式指示符信道(PCFICH)、物理混合自动重复请求(混合ARQ)指示符信道(PHICH)和PDCCH。控制区域具有灵活控制设计以避免不必需的开销。可通过在物理控制格式指示符信道(PCFICH)中传输的控制信道格式指示符(CFI)确定用于PDCCH的控制区域中OFDM符号的数目。PCFICH可位于每个子帧的第一OFDM符号中。PCFICH和PHICH可具有超过PDCCH的优先级，因此在PDCCH之前调度PCFICH和PHICH。

[0039] 每个RB(物理RB或PRB)130i每个时隙可包括12-15kHz子载波136(在频率轴上)以及6或7个正交频分复用(OFDM)符号132(在每个时间轴上)。如果采用了短循环前缀或标准循环前缀，则RB可使用七个OFDM符号。如果使用了扩展循环前缀，则RB可使用六个OFDM符号。可使用短循环前缀或标准循环前缀将资源块映射到84个资源元素(RE)140i，或者可使用扩展循环前缀将资源块映射到72个RE(未示出)。RE可为通过一个载波(即，15kHz)146的一个OFDM符号142的单元。

[0040] 在正交相移键控(QPSK)调制的情况下，每个RE可传输信息的两个比特150a和150b。可使用其他类型的调制，诸如16正交幅度调制(QAM)或64QAM以传输每个RE中较大的比特数目，或者双相移键控(BPSK)调制以传输每个RE中较小的比特数目(单个比特)。RB可被配置用于从eNodeB到UE的下行链路传输，或者RB可被配置用于从UE到eNodeB的上行链路传输。

[0041] 可经由资源块中的资源元素通过OFDM符号传输参考信号。参考信号(或导频信号或导频音(tone))可为用于各种原因的已知信号，诸如以估计信道和/或信道中的噪音。可通过发射台和移动通信设备接收并传输参考信号。不同类型的参考信号(RS)可用于RB。例如，在LTE系统中，下行链路参考信号可包括小区专用参考信号(CRS)、多播/广播单频率网络(MBSFN)参考信号、UE专用参考信号(UE专用RS或UE-RS)或解调参考信号(DMRS)、定位参考信号(PRS)和信道状态信息参考信号(CSI-RS)。

[0042] 图4A示出使用发射天线端口810上的单无线电信道以及接收天线端口830上的单无线电信道的无线通信系统，其可被称为单输入单输出(SISO)无线网络。图4B示出使用发射天线端口上的单无线电信道810以及许多接收天线端口840上的多个无线电信道的无线

通信系统，其可被称为单输入多输出(SIMO)无线网络。图4C示出使用许多发射天线端口820上的多个无线电信道以及接收天线端口830上的单无线电信道的无线通信系统，其可被称为多输入单输出(MISO)无线网络。图4D示出使用许多发射天线端口820上的多个无线电信道以及接收天线端口840上的多个无线电信道的无线通信系统，其可被称为多输入多输出(MIMO)无线网络。术语输入和输出通常指示传送信号的无线电信道，但不指示具有天线的设备。

[0043] MIMO无线网络可用于波束赋形。波束赋形或空间滤波为信号处理技术，其用于方向信号传输或接收的天线阵列中。可以以该种方式组合相位阵列中的元素实现波束赋形，即特定角度处的信号经历结构干扰，同时其他的经历破坏性干扰。波束赋形可用于传输端和接收端两者，以便实现空间选择性。

[0044] 蜂窝数据需求继续经历不断增大的增长率。在与可用带宽的稀缺性组合的情况下，无线和蜂窝系统可使用MIMO以传递大幅度增加的频谱效率，以满足容量需求。单用户(SU)和多用户(MU)MIMO系统为3GPP长期演进(LTE)规范的主要部分，其具有在基站(例如，eNodeB)中至多八个天线的天线维度。然而，被已知为大规模MIMO或全维MIMO的发射天线数目的数量级增加可导致显著更高的频谱效率。

[0045] 无线网络中每用户数据需要继续增大。在基站(例如，eNB)和移动设备(例如，UE)之间经由空气的无线链路可为主要瓶颈。可通过基站站点(例如，eNB 210)处的大量天线提供用于解决该瓶颈的技术，如通过图5所示。图5描绘大天线阵列202，其包括八行206天线辐射元件202和八列208天线辐射元件202。在示例中，每个天线辐射元件可被看作大规模MIMO中的天线。在另一个示例中，大天线阵列可具有超过八个的天线辐射元件(或八个天线)，诸如64个天线。

[0046] 对于许多甚至是几百个天线，可实现关于频谱效率的相对大的增益(在比特/秒/赫兹(比特/s/Hz)的单位中)。多路复用(例如，空间多路复用)可支持到多个UE的并行传输，而不显著地相互影响彼此。然而，许多实际和标准相关挑战可伴随大规模MIMO发生。

[0047] 例如，在传统MIMO的情况下，每个天线可具有分离的反馈和/或测量(例如，CSI-RS)。传统MIMO可支持至多8个天线端口。实际约束可不允许大规模MIMO的每天线信道状态信息(CSI)反馈。另外，过多的信道反馈可牺牲珍贵资源，这些资源都用于非数据传输。有效的和及时的信道反馈和/或测量可被解决用于大规模MIMO的任何有意义的实现。另一个挑战可为UE选择和配对，以用于空间多路复用(MU-MIMO)。例如，大规模MIMO的益处可为大规模MIMO以最小干扰支持MU-MIMO的潜能。在有限信道反馈和区域内的UE散射的情况下，解决UE选择和配对可有助于控制大规模MIMO。与许多技术一样，提供遗留性(legacy)的支持，其中遗留的UE可与大规模MIMO eNB适当地操作。这使得遗留的UE能够不被大规模MIMO的实现所损害。解决这些挑战可允许标准化和实际实现。

[0048] 如本文描述的技术(例如，eNB、UE、方法、计算机电路和系统)可解决与大规模MIMO关联的挑战，并且可通过利用大规模MIMO的其他唯一特性的优点提供进一步的高级技术。例如，在大规模MIMO的情况下，小区可被适应性地扇区化以支持到多个用户(MU)的并行传输。在另一个示例中，可提供用于支持小区内和小区间干扰协调的体系结构。技术可用于平稳地结合遗留支持并同时提供先进UE的先进特征。在另一种配置中，技术可提供被动或主动跟踪机制，使得虚拟小区可覆盖‘移动’UE，以用于最小反馈和/或切换。

[0049] 如图6中所示，eNB可应用多用户波束赋形(MU波束赋形)以形成若干‘波束锥形(beam cones)’212A-C，其可覆盖小区214的较大区域。波束锥形可服务小区的UE 216B-C。在示例中，多个波束锥形可覆盖整个扇区或小区。每个波束锥形可表示虚拟‘传统’eNB小区，使得每个波束锥形可包括其自己的系统信息。例如，可在每个波束锥形中传送系统信息，诸如参考信号(RS)、小区标识符(CID或小区ID)、天线端口、主同步信号(PSS)、辅同步信号(SSS)、系统信息块(SIB)、控制信道(例如，物理下行链路控制信道(PDCCH))等等。

[0050] 波束锥形之间的分离的和区别的系统信息可使得小区内的虚拟小区对遗留的UE透明。每个波束锥形还可具有新的控制信令(例如，DCI)，以用于大规模MIMO启用的UE利用大规模MIMO的优点。在另一个示例中，eNB可适应性地调整波束锥形以用于更好的小区覆盖和/或波束赋形。在另一种配置中，eNB可通过主动地或被动地调整波束来跟踪UE。eNB或UE还可执行小区间锥形协调以用于干扰协调。

[0051] 以下内容提供示例的附加细节。例如，可在eNB处假设数目M个发射天线。如本文所使用，术语‘波束锥形’、‘锥形’、‘虚拟小区’和‘虚拟扇区’可以可互换地使用。图7A示出由天线阵列生成的在两个维度(2D)中波束的单波束方向(例如，$\Phi=90^{\circ}$)。在波束赋形中，可生成波束或主波瓣220。作为波束赋形的部分，还可生成旁波瓣224。旁波瓣可为不是主波瓣(即，来自波束赋形的主波束)的远场辐射模式的波瓣(例如，局部极大值)。还可在三个维度(3D)中生成波束或波束锥形。每个波束220和222可具有不同方向以覆盖不同的空间区域或范围，如图7B中所示。

[0052] 在示例中，技术可用于设计多锥形(multi-cones)。eNB可设计或生成一组‘基层’预编码矩阵。预编码矩阵可用于形成多个锥形，其可将空间划分为若干小区(例如，虚拟小区)。预编码矩阵可提供函数(例如，g(Φ))以生成波束锥形的尺寸、形状和/或角度。波束锥形的尺寸(例如，狭窄的或宽广的)、形状(例如，矩形或圆形)和/或角度(例如，Φ)可取决于eNB实现和/或具体天线阵列设置。

[0053] 例如，eNB可使用或生成一组K个预编码矩阵F:＝{F1,F2,……,Fk}，其中Fk具有维度M*L，以用于扇区或‘锥形’中的特定区域，并且K是空间的波束锥形的数目。M是发射天线的数目，以及L可以是对应于天线端口的数目(例如，1、2、4、8、16、32或64)。不同的Fk可覆盖3D空间的不同空间区域，这可取决于天线形状。在示例中，所述组{F1,F2,……,Fk}可尝试覆盖整个空间或小区。预编码矩阵F可为动态的且对UE透明。

[0054] 从UE或协议方角度看，每个锥形(例如，虚拟小区)可为真实扇区(例如，真实小区)。如先前所陈述，每个锥形可具有不同的cell-id(小区识别码)、不同的天线端口、不同的PSS和/或SSS或不同的SIB。例如，eNB可传输用于由Fk限定的每个虚拟小区的物理无线信号。从eNB发射的信号可以是各种波束锥形的聚合。聚合信号可具有功率标准化。例如，系统信息上eNB的信号(例如，RS)可被表示为F1*s1+F2*s2+……+Fk*sK，其中sk为系统信息。

[0055] 在另一个示例中，每个锥形可作为虚拟扇区或虚拟小区操作。与虚拟扇区关联的UE可基于有效信道反馈回报告(例如，CQI)。例如，在小区k中的UE j的情况下，UE j可测量信道$H_jF_kS_k$，其中H_j为UE j的信道脉冲响应，F_k为虚拟小区k的预编码矩阵，S_k为虚拟小区k的参考信号(例如，小区专用参考信号(CRS))。因此，可通过H_jF_k表示UE j的有效信道。

[0056] 对于每个虚拟扇区k，可基于收集的报告选择UE uk。在示例中，eNB可基于在虚拟

扇区当中具有最佳报告的虚拟扇区k选择UE uk。可通过$X=\sum_k F_k B_{u_k} X_{u_k}$表示来自eNB的传输数据信号，其中$F_k$为虚拟小区k的预编码矩阵，$B_{u_k}$为UE u_k的UE专用预编码矩阵，以及X_{u_k}为UE u_k的调制。如果k等于1，那么对于通过F1表示的集群中的UE u1(UE uk，其中k＝1)，可通过$Y_{u_1}=(H_{u_1}F_1)B_{u_1}X_{u_1}$+干扰+噪音表示UE u1的信道，其中$H_{u_1}$为UE u_1的信道脉冲响应，F_1为所述虚拟小区1的预编码矩阵，B_{u_1}为UE u_1的UE专用预编码矩阵，X_{u_1}为UE u_1的调制。在示例中，B_u可表示‘锥形’的顶部上的与编码器。例如，可基于($H_{u1}F_1$)设计或生成预编码器B_u。可由$\sum_{k\neq 1}(H_{u_1}F_k)B_{u_k}X_{u_k}$表示干扰，其中$H_{u_1}$为UE u_1的信道脉冲响应，F_k为虚拟小区k的预编码矩阵，B_{u_k}为UE u_k的UE专用预编码矩阵，以及X_{u_k}为UE u_k的调制。在示例中，每个信道($H_{u1}F_k$)对于k可接近为0，而不等于1，由于可通过大规模天线实现不同方向的波束，因此这是可能的。

[0057] 在另一种配置中，虚拟锥形(例如，波束锥形)可被动态地适配到小区或扇区的条件。例如，由于各种原因，虚拟锥形的初始设计或确定可不适用于小区，诸如由于反射或覆盖中的间隙引起的变化UE、变化信道、多路径。

[0058] 例如，由于多路径和/或散射，锥形冲突可发生，如图8中所示。图8示出多个虚拟小区(由Fks限定)的多路径，其中第二波束锥形232反射234到第一波束锥形230的空间区域，使得信号彼此冲突，这可导致UE 216的强干扰。在多路径的情况下，UE可观察弱信号干扰噪音比(SINR)，其可被解释为类似于在两个小区之间的小区边缘上的UE的条件。也被已知为载波干扰比(C/I、CIR)的信号干扰噪音比(SINR)或信号干扰比(S/I或SIR)指示平均接收调制载波功率S或C以及平均接收同信道干扰功率I(即，来自其他发送器而非有用信号的串扰)之间的商。

[0059] 为了降低干扰以及/或者改善覆盖，各种机制和协议可用于改变波束锥形。例如，eNB可将冲突锥形212F-G合并作为一个虚拟小区或波束锥形212H，如图9中所示。图9示出将eNB 218A的4个波束锥形212D-G合并为eNB 218B的3个波束锥形212D-E和212H。每个波束锥形212D-H可服务UE 216D-I。在示例中，一个波束锥形212G可具有与合并的波束锥形212H相同的系统信息，并且另一个波束锥形212F消失。在示例中，通过合并的冲突降低可基于UE位置而被优化。

[0060] 在另一个示例中，如果锥形内部没有有效UE，则eNB可切断一个锥形而无需合并。UE可基于诸如CSI或SINR的反馈测量上报干扰锥形或小区。eNB可基于反馈关闭锥形，并观察反馈以用于进一步的优化。

[0061] 在另一种配置中，eNB可通过调整或重新限定预编码矩阵Fk将一个锥形移动远离干扰位置。在另一个示例中，eNB可使用FDD或TDD以避免虚拟小区的干扰，恰如两个传统小区在协作运转。在两个锥形(例如，232和230，或212F和212G)之间的干扰的情况下，eNB可使用频分多路复用(FDM)以用于配对。在示例中，eNB可通过使用回程链路信令控制小区中的所有锥形。

[0062] 在另一个示例中，多个波束锥形可具有非完美小区覆盖。即使天线的数目足够大，任何有限数目的配置可仍导致不完美的小区覆盖和波束赋形。例如，锥形限定波束可不是‘尖的’(例如，不是用于更宽广空间区的聚焦方向)，或者锥形限定波束可不是完美正交的。

折衷可存在于锐度和小区覆盖之间，其中由一组具体K个矩阵F限定的锥形可不有效地覆盖整个空间。在这种情况下，可实现至少两个选项，诸如小区扫描。

[0063] 在小区扫描中，可设计若干组矩阵F(例如，F(A)240和F(B)242)，并且eNB可以交替地打开每组矩阵，如图10所示。图10示出用于小区214中的小区扫描的两组波束锥形的空间范围。两组波束锥形可在时域中轮流(rotate)以避免与其他组波束锥形的干扰。在若干组矩阵F之间轮流可提供诸如小区的空间范围的更大覆盖。图11示出用于小区扫描的交替预编码矩阵组(例如，F(A)244和F(B)246)的2D波束方向。在示例中，每个UE可将SINR(或CQI)反馈回到用于交替的预编码矩阵组的eNB，以选择UE的最佳波束锥形和一组预编码矩阵。

[0064] eICIC的概念的模拟、变化或修改可包括宽广波束锥形和一组狭窄波束锥形，如图12中所示。例如，一组矩阵F可被设计用于具有相对尖或狭窄波束的小覆盖范围252A-B(例如，小的小区)，并且矩阵F可被设计用于宽广覆盖范围250(例如，'胖'小区)，作为未被一组狭窄波束覆盖的一般UE的支持。然后FDM(例如，小区间干扰协调)或TDM(例如，增强型小区间干扰协调(eICIC)或近乎空白子帧(ABS))可用于一组狭窄波束锥形和宽广波束锥形之间，使得宽广波束锥形的传输不干扰一组狭窄波束锥形的传输。在另一个示例(未示出)中，一组矩阵F可被设计用于宽广覆盖范围，并且更大的一组矩阵F可被设计用于小覆盖范围。

[0065] 遗留的小区间干扰协调(ICIC)或遗留的增强型ICIC(eICIC)可用于资源协调，以降低发射站(或节点)之间的干扰。网络可支持频域小区间干扰协调(ICIC)或时域增强型ICIC(eICIC)。在示例中，ICIC可用于通过降低可然后靠近节点接收的频域中子信道的一部分的功率来减少邻近小区或节点(例如，协调节点或协作节点)之间的干扰。子信道不干扰用于邻近小区中的相同子信道，并且因此，可在对靠近小区的子信道较少干扰的情况下将数据发送到移动设备。

[0066] 增强型ICIC(eICIC)可用于异构网络(HetNet)的时域中，其中可通过低功率节点(LPN)补充高功率宏小区，诸如微微小区(购物中心或机场处的热点)或毫微微小区(诸如家庭或商业的小范围中的热点)。低功率节点可存在于宏小区覆盖范围内部。宏小区可传输长范围高功率信号，并且低功率节点可在短距离上传输低功率信号。在为了减轻宏小区以及位于宏小区覆盖范围内的若干低功率节点之间的干扰，eICIC可协调宏小区中时域中的子帧的空白。可选地，为降低eICIC中的干扰，当LPN正在传输时，可将一些宏下行链路(DL)子帧转换为低干扰子帧(或近乎空白子帧[ABS])，使得宏节点的子帧可被分类为规则子帧或ABS子帧。可将eICIC的概念应用到宽广波束锥形和一组狭窄波束锥形，如先前所描述。

[0067] 在另一个示例中，节点(例如，eNB)可提供主动或被动UE跟踪，如图13所示。当UE 216四处移动260，或者小区214内仅少量UE有效时，维持虚拟小区结构是昂贵的。由于eNB在天线阵列202中可具有大量天线，因此eNB可利用观察(例如，到达角(AoA)测量)，以通过调整262锥形限定波束212J(例如，矩阵F)来跟踪UE。当使用了UE跟踪时，UE可在相同虚拟小区下，这可避免开销和广泛反馈。eNB可修改虚拟锥形(例如，调整F)，使得虚拟锥形覆盖'移动'UE。从UE的角度看，服务小区和/或CQI可不改变，即使UE实际上正在移动。

[0068] 例如，在有效UE跟踪中，当UE确定可由于移动而引起的信道质量改变(例如，信道质量大幅度下降或波动)时，UE可向eNB主动发送出触发信号，以用于eNB初始化跟踪。可通过基于下行链路参考信号(RS)和/或同步信号(SS)的计算确定信道质量改变。可选地，UE可通过运动传感器或使用全球定位系统(GPS)确定移动。根据信道改变的比率，eNB可请求更

频繁的或更少的CQI报告(或其他类似信道质量报告)。反馈报告可使用标准信道反馈或差分信道反馈。

[0069] 在另一个示例中,可实现被动UE跟踪,其中UE跟踪对UE透明。例如,eNB可确定哪些UE正在移动并确定主动地监测那些UE中的'信道改变'。例如,可通过基于上行链路RS/SS的计算确定监测'信道改变'。eNB可使用各种机制以确定如何调整锥形方向。

[0070] 在示例中,某些信道跟踪参数可在TDD和FDD两者情况下互为倒数。大量天线可提供对这些参数的准确估计。

[0071] 在示例中,可将由一组矩阵F生成的每个虚拟小区看作分离的小区。这允许节点(例如,eNB)使用小区间干扰协调(ICIC),如图14中所示。如先前所讨论,每个eNB(具有天线阵列202K-L)可为小区214K-L限定一组或多组锥形形成波束212K-L。锥形形成波束可服务UE 216K-L。对于每个eNB,eNB可以可选地打开一组波束,以用于适应性小区覆盖或小区扫描。这些波束可导致对邻近小区(例如,物理小区或虚拟小区)的干扰,恰如在实际小区中。ICIC可用于长期适应。

[0072] 在示例中,高级UE可向其服务eNB反馈干扰测量(例如,虚拟小区ID和时间戳)。高级UE可帮助邻近小区协调'锥形扫掠(cone sweeping)'序列,以避免干扰。UE可监测邻近小区以生成干扰测量。高级UE可将具有若干锥形ID的干扰测量反馈到eNB。可经由特殊链路(例如,回程链路或X2接口)在邻近eNB当中共享该干扰测量信息。在示例中,矩阵F的开-关模式可为固定的,使得邻近小区可协调该模式以避免若干干扰。在另一个示例中,基于干扰测量信息,邻近小区可生成更好的扫掠模式(sweeping pattern),以避免某些严重的干扰锥形。

[0073] 在另一个示例中,邻近eNB可共同重新设计锥形限定波束F,以用于更好的干扰协调。在另一个示例中,单个eNB可在由单个eNB服务的多个小区的锥形限定波束F之间协调。

[0074] 所描述的技术提供各种益处。例如,可创建多个虚拟的小的小区,使得支持MU传输。独立的小区ID和/或RS可允许简单的管理和/或标准。虚拟小区可实际上四处'移动'(例如,通过仅调整限定与编码器组),这允许虚拟小区与固定的物理小的小区相比更加灵活。虚拟小区的使用可独立于天线拓扑结构(例如,正方形或圆锥形)。例如,操作者可使用各种锥形形状设计扇区化(例如,锥形F),所述锥形形状使用不同的天线拓扑结构。

[0075] 另一个示例提供节点(例如,演进节点B(eNB))上的处理器和/或收发器的计算机电路的功能500,所述节点可操作以适应性地扇区化空间区域以用于并行多用户传输,如图15中的流程图中所示。可作为方法实现功能或者可作为机器上的指令执行功能,其中指令被包括在至少一个计算机可读介质上或一个非暂时性机器可读存储介质上。计算机电路可配置成为空间区域中的一组波束锥形生成一组预编码矩阵,其中一组预编码矩阵中的预编码矩阵用于每个波束锥形,每个波束锥形覆盖波束锥形空间区域,其不同于空间区域中的另一个波束锥形的另一个波束锥形空间区域;以及每个波束锥形包括系统信息,其不同于空间区域中的其他波束锥形的系统信息,如在方框510中。计算机电路可还配置成使用波束锥形的系统信息生成多用户波束赋形传输的波束锥形,如在方框520中。

[0076] 在示例中,每个波束锥形的系统信息可包括唯一小区标识符(CID)、天线端口、主同步信号(PSS)、辅同步信号(SSS)、系统信息块(SIB)、参考信号(RS)、控制信道或物理下行链路控制信道(PDCCH)。RS可包括小区专用参考信号(CRS)、信道状态信息参考信号(CSI-

RS)或解调参考信号(DM-RS)。在另一个示例中,计算机电路可还配置成从由波束锥形形成的虚拟小区k中的用户设备(UE)j接收有效信道H_jF_k的信道质量指示符(CQI),其中UE j测量信道$H_jF_kS_k$,其中H_j为UE j的信道脉冲响应,F_k为虚拟小区k的预编码矩阵,S_k为虚拟小区k的参考信号,以及j和k为整数。F_k可具有维度M*L,其中M为发射天线的数目,其中M>8个发射天线,L为相应天线端口的数目,其中L∈{1,2,4,8},以及M和L为整数。

[0077] 在另一种配置中,计算机电路还可配置成:基于一组信道质量指示符(CQI)报告选择虚拟小区k的用户设备(UE)u_k;以及将数据信号X传输到UE u_k,其中由$X=\sum_k F_k B_{u_k} X_{u_k}$表示X,其中$F_k$为虚拟小区k的预编码矩阵,$B_{u_k}$为UE u_k的UE专用预编码矩阵,以及X_{u_k}为UE u_k的调制。

[0078] 在另一个示例中,计算机电路还可配置成:确定两个波束锥形信号由于多路径、信号散射或信号反射在用户设备(UE)处何时冲突;以及修改波束锥形以避免信号冲突。所述修改可包括:通过将用于冲突信号中的两个预编码矩阵分配到形成单个虚拟小区的共同小区标识符(CID)来合并两个波束锥形;当一个波束锥形内没有UE正在与节点主动通信时,关闭波束锥形中的一个;通过将一个波束锥形的CID调整到另一个预编码矩阵,来移动波束锥形中的一个以远离另一个波束锥形;或者使用波束锥形中的一个上的频分双工(FDD)或时分双工(TDD),以避免信号冲突。

[0079] 在另一种配置中,计算机电路还可配置成:为一组波束锥形生成至少两组不同的预编码矩阵;以及在至少两组不同的预编码矩阵之间轮流,以用于小区扫描和空间区域的更好覆盖。每个波束锥形可包括小区标识符(CID),并且每组预编码矩阵可覆盖与彼此不同的空间区域。

[0080] 在另一个示例中,计算机电路还可配置成:生成宽广范围预编码矩阵以用于覆盖具有宽广波束锥形的宽广范围;生成一组狭窄区域预编码矩阵以用于覆盖具有一组狭窄波束锥形的狭窄区域;以及使用频分多路复用(FDM)、时分多路复用(TDM)或增强型小区间干扰协调(eICIC),以用于使用宽广波束锥形或一组狭窄波束锥形的传输。例如,eICIC可用于在正常子帧和近乎空白子帧(ABS)之间交替以用于宽广波束锥形。在示例中,可在宽广范围内使用一组狭窄波束锥形。

[0081] 在另一种配置中,计算机电路还可配置成通过调整波束锥形来跟踪用户设备(UE)。计算机电路可实现主动UE跟踪或被动UE跟踪。对于主动UE跟踪,计算机电路还可配置成:当信道质量由于UE移动改变时,从UE接收跟踪触发信号;经由到UE的请求改变接收信道质量指示符(CQI)的周期性;以及当另一个预编码矩阵提供比表示服务UE的虚拟小区的波束锥形的预编码矩阵的波束锥形更好的信道质量时,将所述表示服务UE的虚拟小区的波束锥形的预编码矩阵调整到所述另一个预编码矩阵,所述另一预编码矩阵形成覆盖不同于预编码矩阵的波束锥形的空间范围的调整的波束锥形。虚拟小区可由小区标识符(CID)索引。对于被动UE跟踪,计算机电路还可配置成:监测由于UE移动而导致的信道质量改变;以及通过将服务所述UE的CID的预编码矩阵调整到另一个预编码矩阵来调整波束锥形方向,所述另一个预编码矩阵形成已调整的波束锥形,所述已调整的波束锥形覆盖不同于所述预编码矩阵的波束锥形的空间范围。已调整的波束锥形方向可基于上行链路参考信号(RS)或同步信号(SS)。

[0082] 在另一个示例中，计算机电路还可配置成：从用户设备(UE)接收干扰测量反馈消息，其包括邻近小区的系统信息；以及与邻近小区协调一组锥形形成波束的调度，以避免小区间干扰。邻近小区的系统信息可包括虚拟小区标识符(CID)和时间戳。计算机电路配置成协调一组锥形形成波束的调度的还可配置成：经由无线信道、有线连接、光纤连接或X2接口，通过回程链路信令与邻近节点协调一组锥形形成波束的调度。

[0083] 在另一种配置中，配置成生成波束锥形的计算机电路还可配置成经由具有至少两行天线辐射元件和至少两列天线辐射元件的天线阵列动态地和适应性地生成波束锥形。每个天线辐射元件可表示发射天线。在另一个示例中，节点可包括其中M>8个发射天线(即，发射天线的数目大于八个天线)的M个发射天线。节点可包括基站(BS)、节点B(NB)、演进节点B(eNB)、基带单元(BBU)、远程无线电头(RRH)、远程无线电设备(RRE)、远程无线电单元(RRU)或中央处理模块(CPM)。

[0084] 另一个示例提供方法600，以用于将小区划分为虚拟扇区以用于演进节点B(eNB)处的小区中的并行多用户传输，如图16中的流程图中所示。方法可被作为节点(例如，eNB)的机器、计算机电路或处理器上的指令执行，其中指令被包括在至少一个计算机可读介质上或一个非暂时性机器可读存储介质上。该方法包括为小区中的一组虚拟扇区生成一组预编码矩阵的操作，其中一组预编码矩阵中的预编码矩阵用于每个虚拟扇区，并且每个虚拟扇区包括系统信息，其不同于小区中的另一个虚拟扇区的系统信息，如在方框610中。接着是使用预编码矩阵以及与预编码矩阵关联的系统信息生成虚拟扇区的多用户波束赋形传输的操作，如在方框620中。

[0085] 在示例中，方法还可包括使用大天线阵列将多用户波束赋形传输适应性地传输到虚拟扇区内的用户设备(UE)。大天线阵列可包括至少两行天线辐射元件和至少两列天线辐射元件，并且大天线阵列可具有超过八个的天线辐射元件。在另一个示例中，每个虚拟扇区的系统信息可包括唯一小区标识符(CID)、天线端口、主同步信号(PSS)、辅同步信号(SSS)、系统信息块(SIB)、参考信号(RS)、控制信道或物理下行链路控制信道(PDCCH)。

[0086] 在另一种配置中，方法还可包括从虚拟小区k中的用户设备(UE)j接收有效信道H_jF_k的信道质量指示符(CQI)，其中UE j测量信道$H_jF_kS_k$，其中H_j为UE j的信道脉冲响应，F_k为虚拟小区k的预编码矩阵，S_k为虚拟小区k的参考信号，以及j和k为整数。

[0087] 在另一个示例中，方法还可包括：基于一组信道质量指示符(CQI)报告选择虚拟小区k的用户设备(UE)u_k；以及将数据信号X传输到UE u_k，其中由$X=\sum_k F_k B_{u_k} X_{u_k}$表示X，其中$F_k$为虚拟小区k的预编码矩阵，$B_{u_k}$为UE u_k的UE专用预编码矩阵，以及X_{u_k}为UE u_k的调制。

[0088] 在另一种配置中，方法还可包括：确定来自不同虚拟扇区的两个信号何时由于多路径、信号散射或信号反射在用户设备(UE)处彼此干扰；以及修改一个虚拟扇区的传输以避免信号干扰。修改可包括：通过将用于一个虚拟扇区的干扰信号的预编码矩阵分配到与生成干扰的其他虚拟扇区相同的小区标识符(CID)以形成单个虚拟扇区的共同CID来合并两个虚拟扇区；当一个虚拟扇区内没有UE正在与eNB主动通信时，关闭该一个虚拟扇区；或者通过将一个虚拟扇区的预编码矩阵调整到不同的预编码矩阵，同时使用相同CID来移动该一个虚拟扇区以远离另一个虚拟扇区。

[0089] 在另一个示例中，方法还可包括：为一组虚拟扇区生成至少两组不同的预编码矩

阵；以及在至少两组不同的预编码矩阵之间转换，以用于小区扫描和小区的更好覆盖。每个虚拟扇区可包括小区标识符(CID)，并且每组预编码矩阵可覆盖不同于彼此的空间区域。

[0090] 在另一种配置中，方法还可包括：为用于宽广小区空间区域内的宽广小区的宽广虚拟扇区生成宽广预编码矩阵；为用于宽广小区空间区域内的狭窄小区的一组狭窄的虚拟扇区生成一组狭窄的预编码矩阵；以及使用频分多路复用(FDM)、时分多路复用(TDM)或增强型小区间干扰协调(eICIC)调度宽广虚拟扇区和一组狭窄虚拟扇区之间的传输。

[0091] 在另一个示例中，方法还可包括：从用户设备(UE)接收包括邻近小区系统信息的干扰反馈消息；以及与邻近小区协调一组虚拟扇区传输的调度，以避免小区间干扰。邻近小区系统信息可包括虚拟小区标识符(CID)和/或资源标识符(例如，时间戳)。可由eNB服务小区和邻近小区。或者，在另一个示例中，可由eNB服务小区且由邻近eNB服务邻近小区，并且eNB和邻近eNB经由无线信道、有线连接、光纤连接或X2接口，通过回程链路信令通信。

[0092] 图17示出示例节点710(例如，eNB)和示例无线设备720(例如，UE)。节点可包括节点设备712。节点设备或节点可配置成与无线设备(例如，UE)通信。节点设备可包括处理器714和收发器716。处理器714和/或收发器716可配置成适应性地扇区化空间区域以用于并行多用户传输，如图15的500中所描述。在另一个示例中，处理器714和/或收发器716可被配置用于将小区划分为虚拟扇区，以用于演进节点B(eNB)处的小区中的并行多用户传输，如图16的600中所描述。

[0093] 返回参考图17，无线设备720(例如，用户设备(UE))可被配置用于跟踪相对于UE的移动的波束赋形锥形。无线设备可包括收发器724和处理器722。收发器724可配置成从波束赋形锥形的虚拟小区中的演进节点B(eNB)接收持续时间内的下行链路信号。处理器722可配置成：为持续时间内虚拟小区的下行链路信号测量信道的信道质量；以及确定信道质量中的变化由于UE移动何时越过信道质量阈值。收发器724还可配置成：将触发信号传输到eNB以初始化虚拟小区的波束赋形锥形的跟踪。

[0094] 在另一个示例中，初始化波束赋形锥形的跟踪改变与虚拟小区关联的预编码矩阵。在另一种配置中，无线设备720包括运动传感器(未示出)，其配置成确定UE何时处于运动中。

[0095] 在另一个示例中，收发器724还可配置成传输由$H_jF_kS_k$表示的信道的每个信道质量测量的信道质量指示符(CQI)，其中H_j为UE j的信道脉冲响应，F_k为虚拟小区k的预编码矩阵，S_k为虚拟小区k的参考信号，以及j和k为整数；以及接收虚拟小区k中的数据信号Y，其中由$Y_{u_i}=(H_{u_i}F_i)B_{u_i}X_{u_i}$+干扰+噪音表示Y，其中$H_{u_i}$为UE u_i的信道脉冲响应，F_i为虚拟小区i的预编码矩阵，B_{u_i}为UE u_i的UE专用预编码矩阵，X_{u_i}为UE u_i的调制，并且由$\sum_{k\neq i}(H_{u_i}F_k)B_{u_k}X_{u_k}$表示干扰，其中$F_k$为虚拟小区k的预编码矩阵，$B_{u_k}$为UE u_k的UE专用预编码矩阵，以及X_{u_k}为UE u_k的调制。

[0096] 在另一种配置中，处理器722还可配置成：测量来自邻近小区的包括邻近小区系统信息的干扰，以及生成干扰的时间戳。邻近小区系统信息可包括虚拟小区标识符(CID)。收发器724还可配置成经由演进节点B(eNB)将包括邻近小区系统信息和时间戳的干扰测量反馈消息发送到服务小区，以配置服务小区从而降低与邻近小区的小区间干扰。

[0097] 图18提供无线设备的示例说明，诸如用户设备(UE)、移动站(MS)、移动无线设备、

移动通信设备、平板电脑、手机或其他类型的无线设备。无线设备可包括配置成与节点或发射站通信的一个或多个天线，诸如基站(BS)、演进节点B(eNB)、基站单元(BBU)、远程无线电头(RRH)、远程无线电设备(RRE)、中继站(RS)、无线电设备(RE)、远程无线电单元(RRU)、中央处理模块(CPM)或其他类型的无线广域网(WWAN)接入点。无线设备可配置成使用包括3GPP LTE、WiMAX、高速分组接入(HSPA)、蓝牙和WiFi的至少一个无线通信标准通信。无线设备可使用用于每个无线通信标准的分离天线或者用于多个无线通信标准的共享天线通信。无线设备可在无线局域网(WLAN)、无线个人局域网(WPAN)和/或WWAN中通信。

[0098] 图18还提供可用于从无线设备的音频输入和输出的麦克风以及一个或多个扬声器的说明。显示屏幕可为液晶显示器(LCD)屏幕或者其他类型的显示器屏幕，诸如有机发光二极管(OLED)显示器。显示器屏幕可被配置为触摸屏幕。触摸屏幕可使用电容式、电阻式或另一种类型的触摸屏幕技术。应用处理器和图形处理器可耦合到内存储器以提供处理和显示能力。非易失性存储器端口还可用于向用户提供数据输入/输出选项。非易失性存储器端口还可用于扩展无线设备的存储器能力。键盘可与无线设备整合或者无线连接到无线设备以提供附加用户输入。可还使用触摸屏幕提供虚拟键盘。

[0099] 各种技术或其某些方面或部分可采用在有形媒介中实施的程序代码(即，指令)的形式，诸如闪盘、光盘-只读存储器(CD-ROM)、硬盘驱动器、非暂时性计算机可读存储介质或任何其他机器可读存储介质，其中，当程序代码被加载到诸如计算机的机器中以及由机器执行时，机器变为装置以用于实践各种技术。电路可包括硬件、固件、程序代码、可执行代码、计算机指令和/或软件。非暂时性计算机可读存储介质可以是不包括信号的计算机可读存储介质。在可编程计算机上的程序代码执行的情况下，计算设备可包括处理器、处理器可读的存储介质(包括易失性存储器和非易失性存储器以及/或者存储元件)、至少一个输入设备和至少一个输出设备。易失性和非易失性存储器和/或存储元件可为随机存取存储器(RAM)、可擦除可编程只读存储器(EPROM)、闪盘驱动器、光学驱动器、磁硬盘驱动器、固态驱动器或其他介质以用于存储电子数据。节点和无线设备还可包括收发器模块(即，收发器)、计数器模块(即，计数器)、处理模块(即，处理器)和/或时钟模块(即，时钟)或定时器模块(即，定时器)。可实现或利用本文描述的各种技术的一个或多个程序可使用应用程序编程接口(API)、可重用控制等等。可在高级过程或面向对象编程语言中实现该类程序，以与计算机系统通信。然而，如果需要，可在汇编或机器语言中实现程序。在任何情况下，语言可为编译或解释语言，并与硬件实现组合。

[0100] 应理解的是，该说明书中描述的许多功能单元已经被标记为模块，以便更特别地强调它们的实现独立性。例如，模块可被实现作为硬件电路，其包括自定义超大规模集成(VLSI)电路或门阵列、现成半导体，诸如逻辑芯片、晶体管或其他离散部件。还可在诸如现成可编程门阵列、可编程阵列逻辑、可编程逻辑设备等等的可编程硬件设备中实现模块。

[0101] 还可在软件中实现模块以用于由各种类型的处理器执行。例如，可执行代码的识别模块可包括计算机指令的一个或多个物理或逻辑块，其可例如被组织为对象、过程或功能。然而，识别的模块的可执行文件不必物理上在一起，而是可包括存储在不同位置中的不同指令，当被结合在一起时，所述不同指令包括模块并实现所陈述的模块目的。

[0102] 实际上，可执行代码的模块可为单个指令或许多指令，并且可甚至分布在若干不同代码段内、不同程序之间以及若干存储器设备上。类似地，操作数据可在本文在模块内被

识别和示出，并且可以以任何合适形式实施以及在任何合适类型的数据结构内组织。操作数据可被集合作为单个数据集，或者可分布在不同位置内，包括分布在不同存储设备内，以及可至少部分仅作为系统或完了上的电子信号存在。模块可为无源的或有源的，包括可操作以执行所需功能的代理。

[0103] 贯穿该说明书对“示例”或“示例性”的参考意味着结合示例描述的特定特征、结构或特性被包括在本发明的至少一个实施例中。因此，在贯穿该说明书的各种位置中出现的短语“在示例中”或词语“示例性”不必需全部指示相同实施例。

[0104] 如本文所使用，为方便起见，可在一般列表中呈现多个项目、结构元件、组成元件和/或材料。然而，这些列表应被理解为好像所述列表的每个成员被单独地识别为分离的和唯一的成员。因此，该种列表的任何个体成员都不应仅仅基于它们在共同集合中的呈现而没有相反的指示而被理解为是相同列表的任何其他成员的实际等效物。另外，可在本文与其各种部件的替代一起参考本发明的各种实施例和示例。应理解的是，此类实施例、示例和替代不被理解为彼此的实际等效物，而是应被看作本发明的分离和自主表示。

[0105] 此外，可在一个或多个实施例中以任何合适的方式组合所描述的特征、结构或特性。在以下描述中，提供了许多具体细节，诸如布局、距离的示例、网络示例等等，以提供对本发明的实施例的彻底理解。然而，相关领域技术人员将认识到可在没有具体细节中的一个或多个的情况下，或者以其他方法、部件、布局等等实践本发明。在其他实例中，没有详细示出或描述众所周知的结构、材料或操作，以避免使本发明的方面晦涩。

[0106] 虽然前述实例在一个或多个特定应用中示出本发明的原理，但将对本领域技术人员明显的是，可在没有创造性能力运用的情况下以及不脱离本发明的原理和概念的情况下作出形式、使用和实现细节上的许多修改。因此，不旨在限制本发明，除了由下面提出的权利要求限制以外。

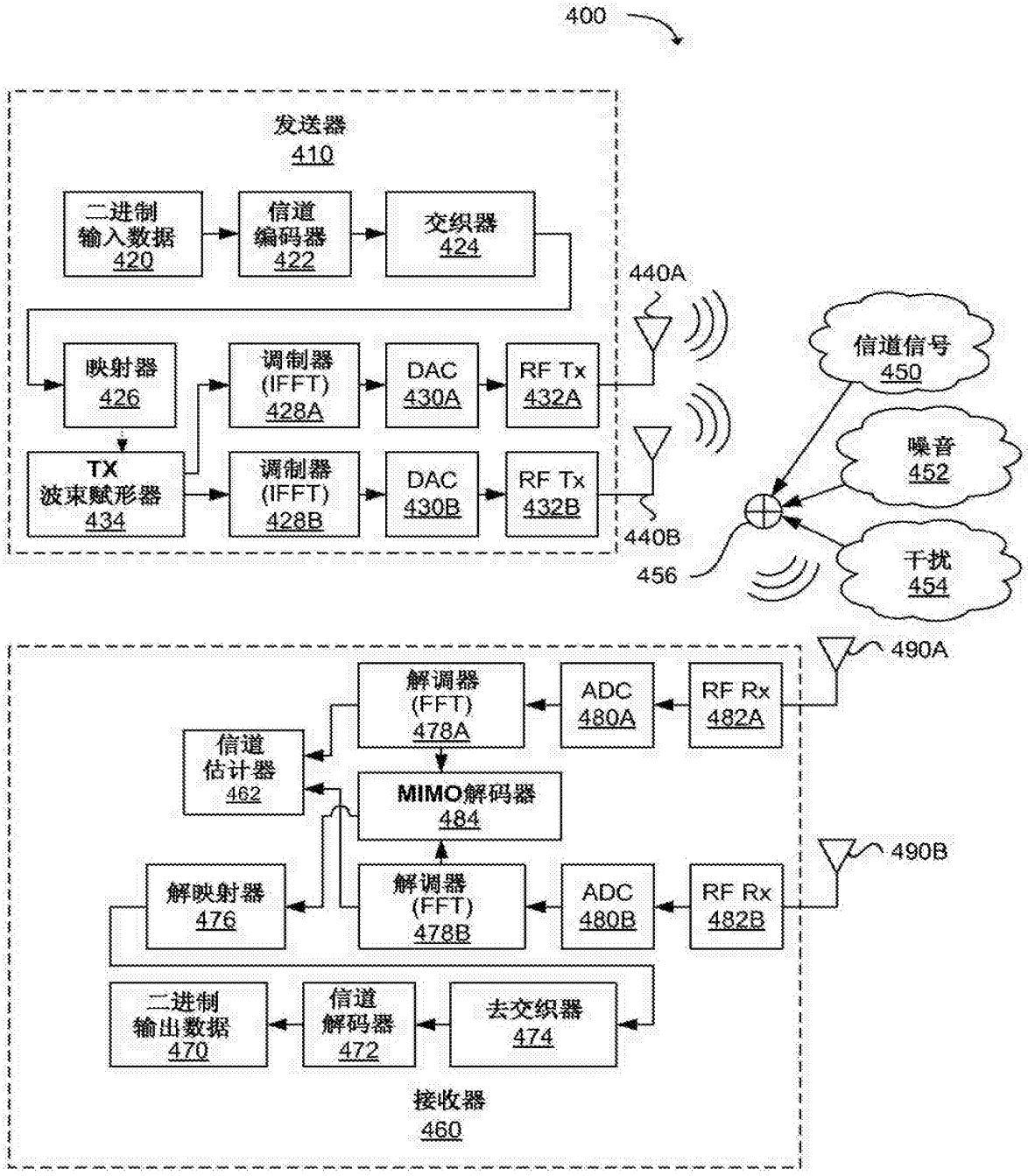

400
发送器
410
二进制
输入数据
420
信道
编码器
422
交织器
424
映射器
426
调制器
(IFFT)
428A
DAC
430A
RF Tx
432A
TX
波束赋形器
434
调制器
(IFFT)
428B
DAC
430B
RF Tx
432B
440A
440B
456
信道信号
450
噪音
452
干扰
454
490A
490B
解调器
(FFT)
478A
ADC
480A
RF Rx
482A
信道
估计器
462
MIMO解码器
484
解映射器
476
解调器
(FFT)
478B
ADC
480B
RF Rx
482B
二进制
输出数据
470
信道
解码器
472
去交织器
474
接收器
460

图1

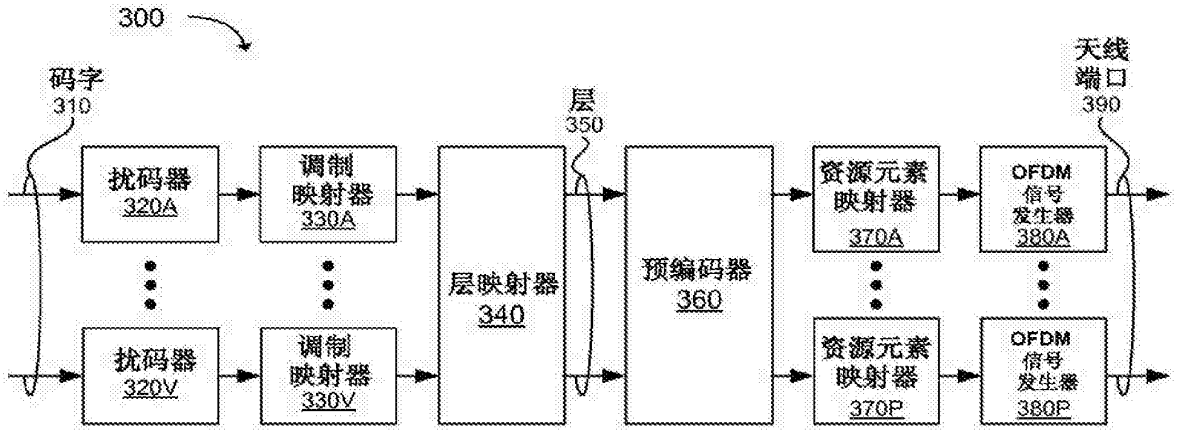

300
码字
310
扰码器
320A
扰码器
320V
调制
映射器
330A
调制
映射器
330V
层映射器
340
层
350
预编码器
360
资源元素
映射器
370A
资源元素
映射器
370P
OFDM
信号
发生器
380A
OFDM
信号
发生器
380P
天线
端口
390

图2

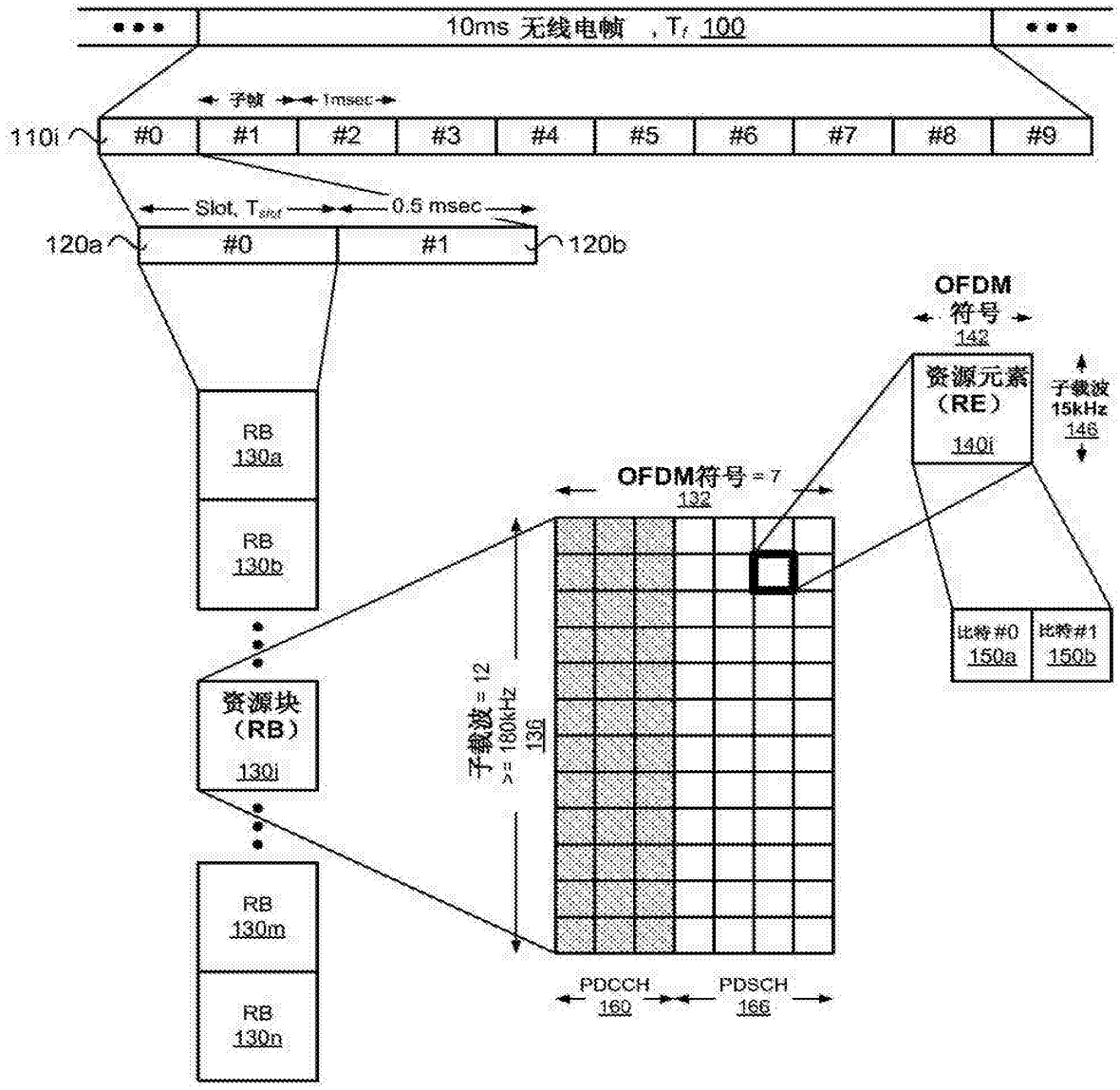

10ms 无线电帧 ，T_f 100
子帧
1msec
110i
#0
#1
#2
#3
#4
#5
#6
#7
#8
#9
Slot, T_{slot}
0.5 msec
120a
120b
RB 130a
RB 130b
资源块（RB） 130j
RB 130m
RB 130n
OFDM 符号 142
资源元素（RE） 140i
子载波 15kHz 146
OFDM符号 = 7 132
子载波 = 12 >= 180kHz 136
比特#0 150a
比特#1 150b
PDCCH 160
PDSCH 166

图3

SISO



图4A

SIMO



图4B

MISO



图4C

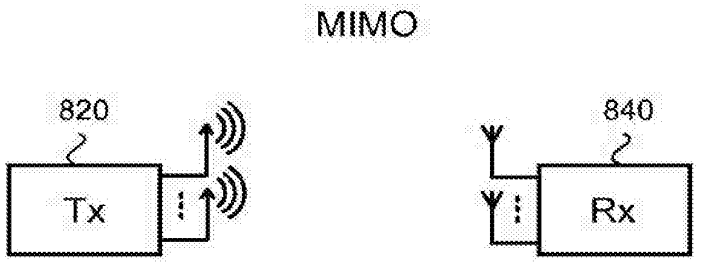

MIMO
820
Tx
840
Rx

图4D

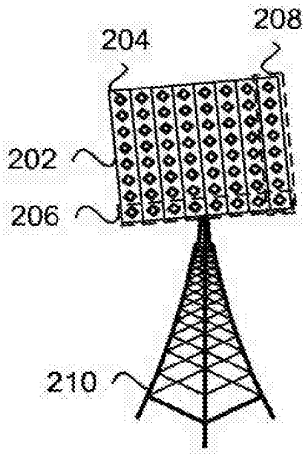

204
208
202
206
210

图5

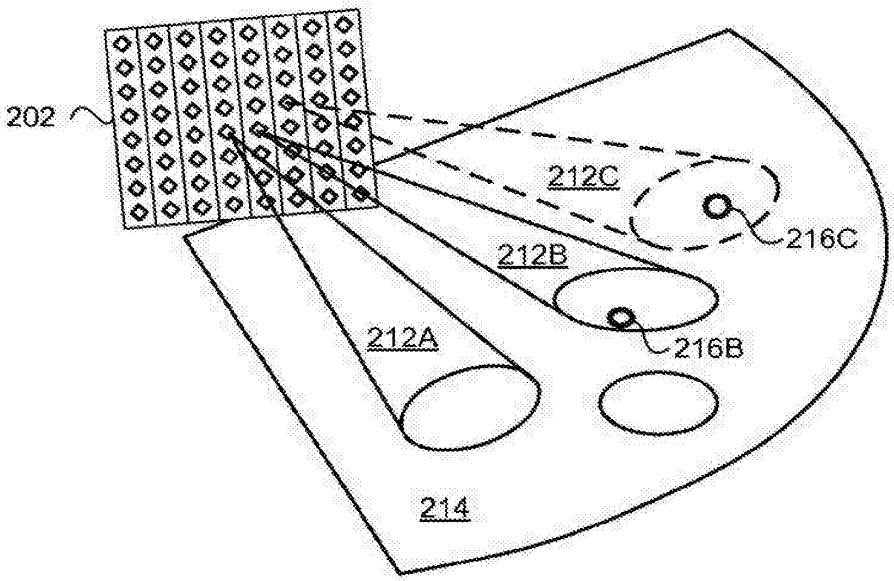

202
212C
216C
212B
216B
212A
214

图6

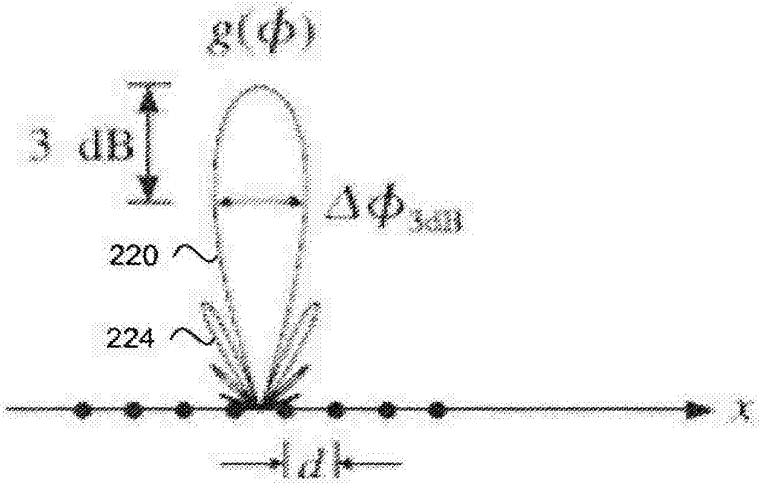


图7A

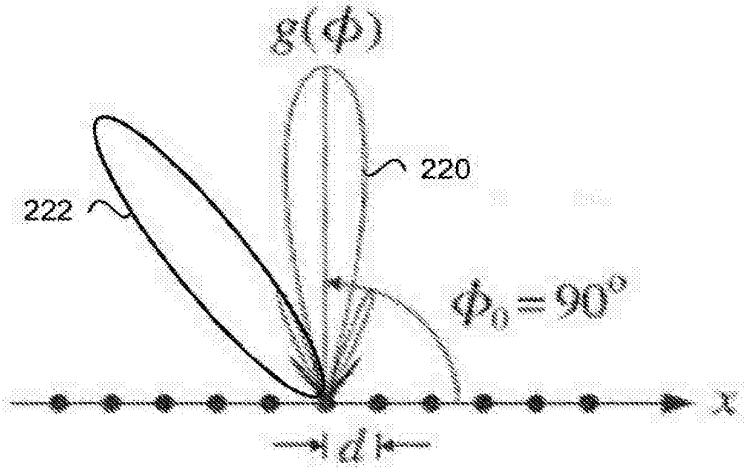


图7B

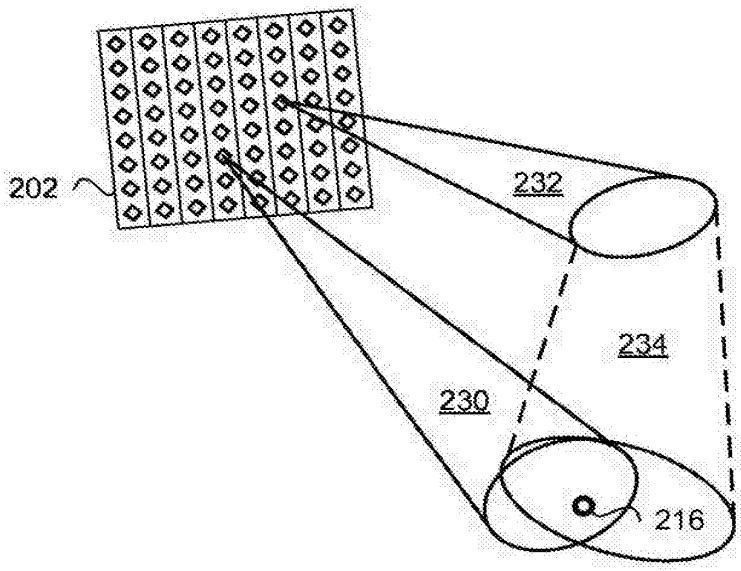

202
232
234
230
216

图8

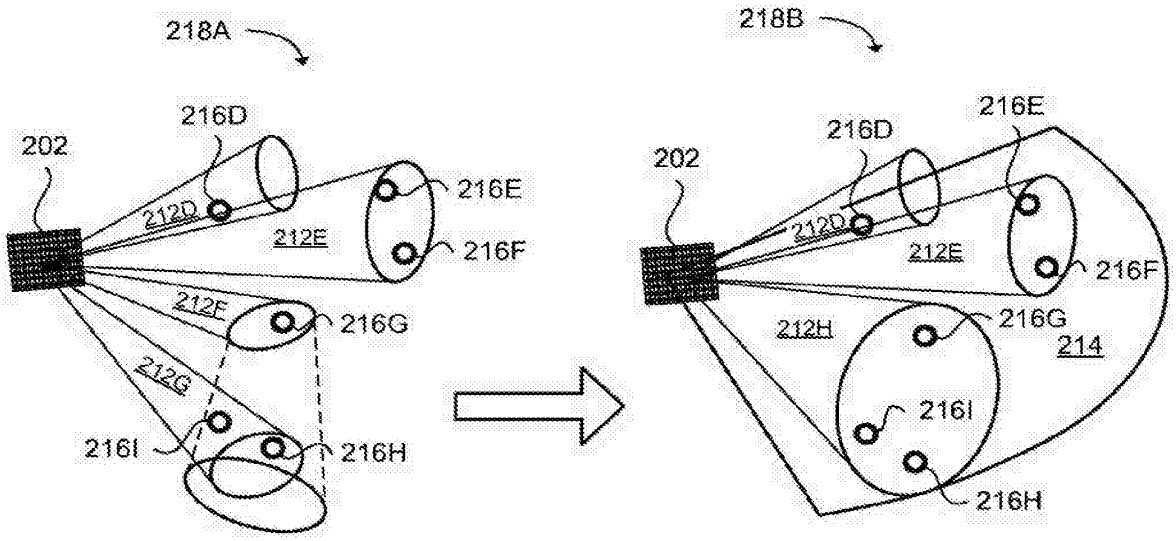

218A
216D
202
212D
216E
212E
216F
212F
216G
212G
216I
216H
218B
216D
216E
202
212D
212E
216F
212H
216G
214
216I
216H

图9

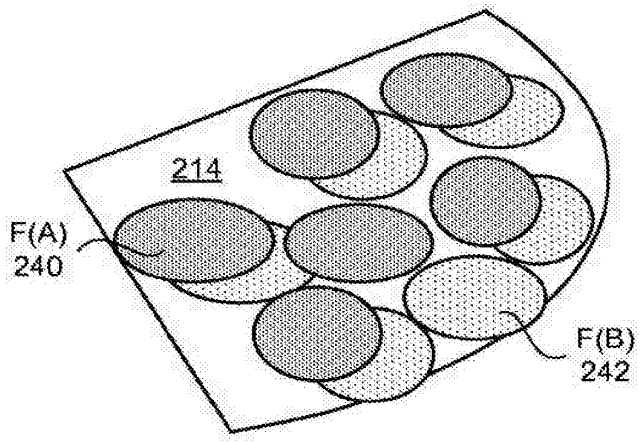


图10

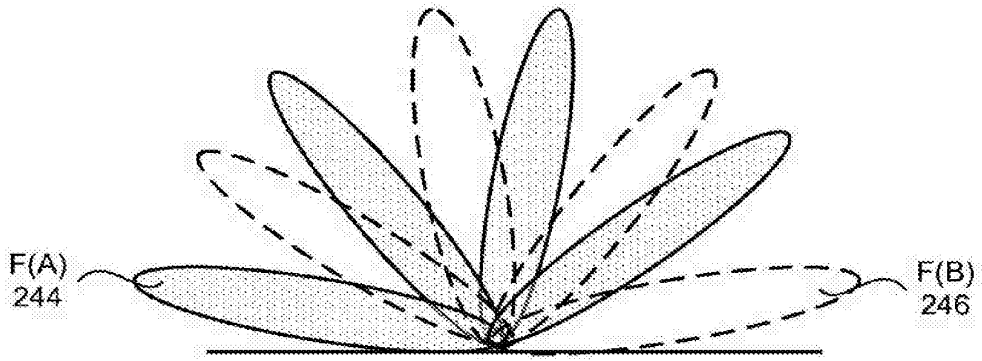


图11

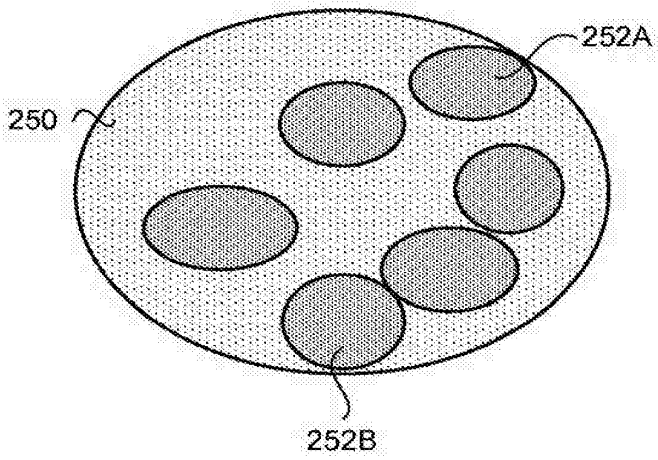


图12

28

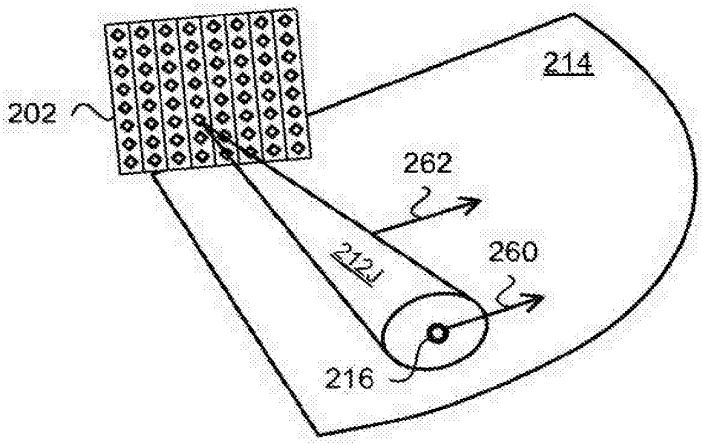

202
214
262
260
212J
216

图13

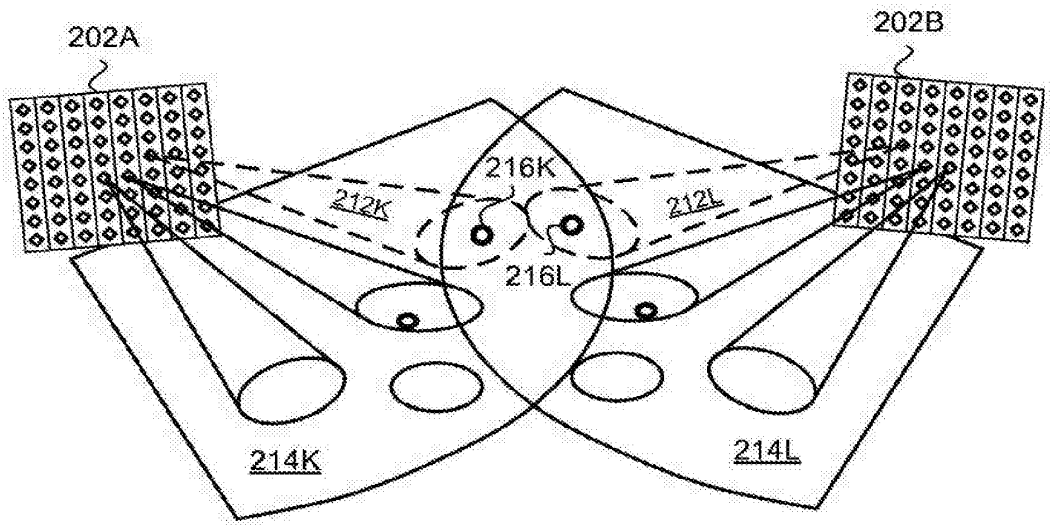

202A
202B
216K
212K
212L
216L
214K
214L

图14

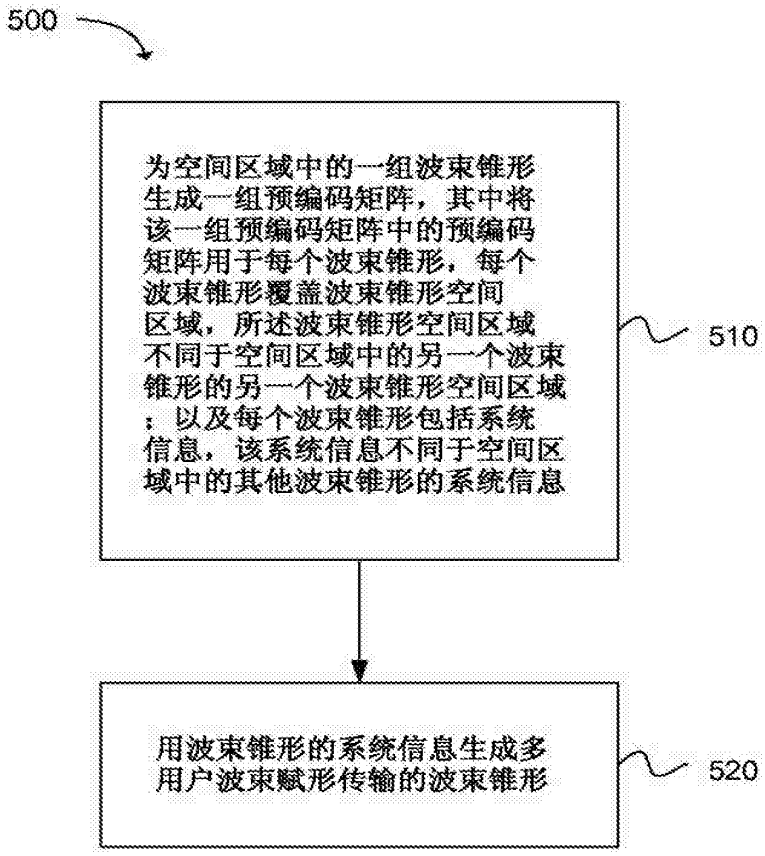

500
为空间区域中的一组波束锥形生成一组预编码矩阵，其中将该一组预编码矩阵中的预编码矩阵用于每个波束锥形，每个波束锥形覆盖波束锥形空间区域，所述波束锥形空间区域不同于空间区域中的另一个波束锥形的另一个波束锥形空间区域；以及每个波束锥形包括系统信息，该系统信息不同于空间区域中的其他波束锥形的系统信息
510
用波束锥形的系统信息生成多用户波束赋形传输的波束锥形
520

图15

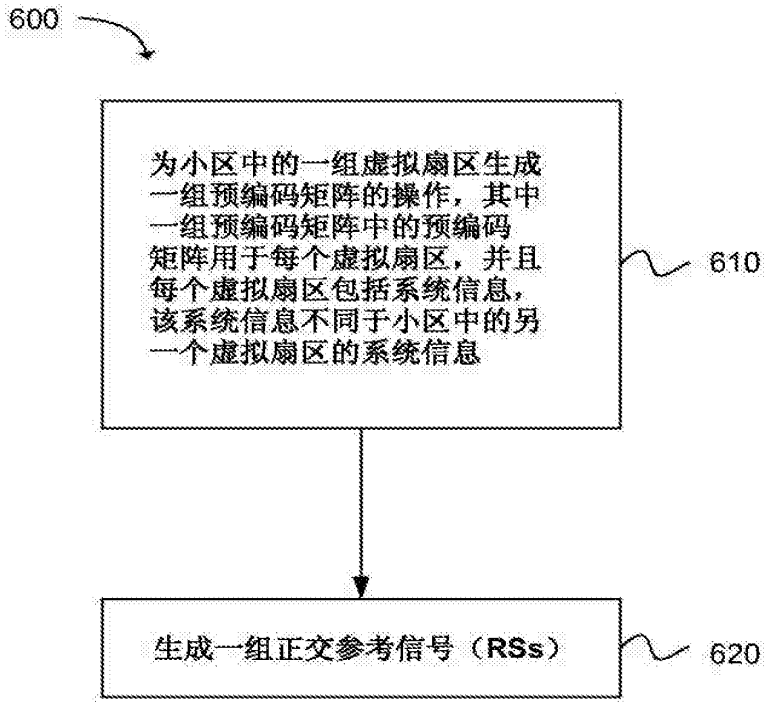

600
为小区中的一组虚拟扇区生成一组预编码矩阵的操作，其中一组预编码矩阵中的预编码矩阵用于每个虚拟扇区，并且每个虚拟扇区包括系统信息，该系统信息不同于小区中的另一个虚拟扇区的系统信息
610
生成一组正交参考信号（RSs）
620

图16

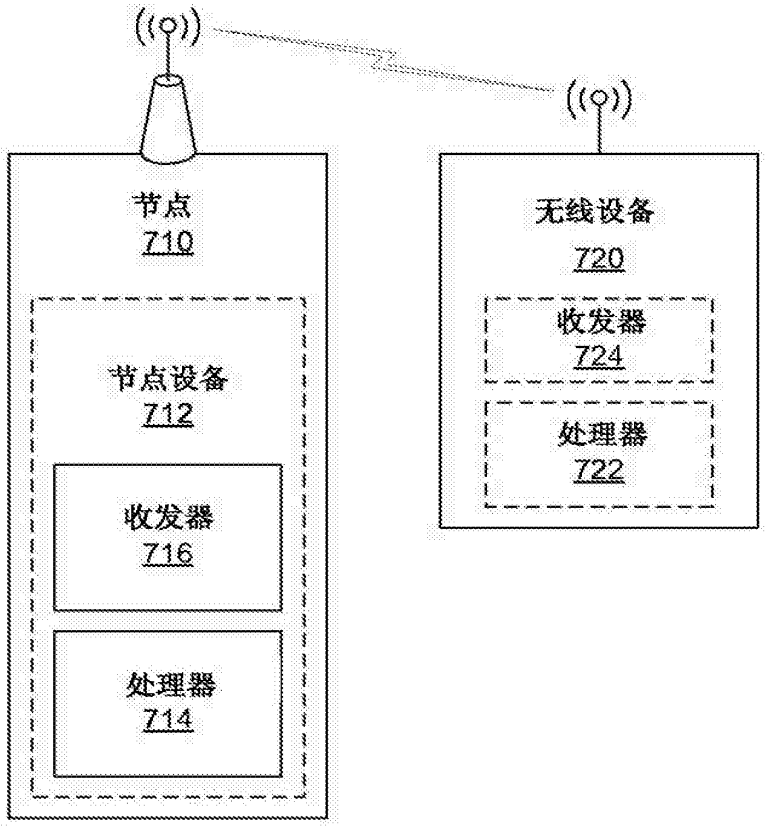


图17

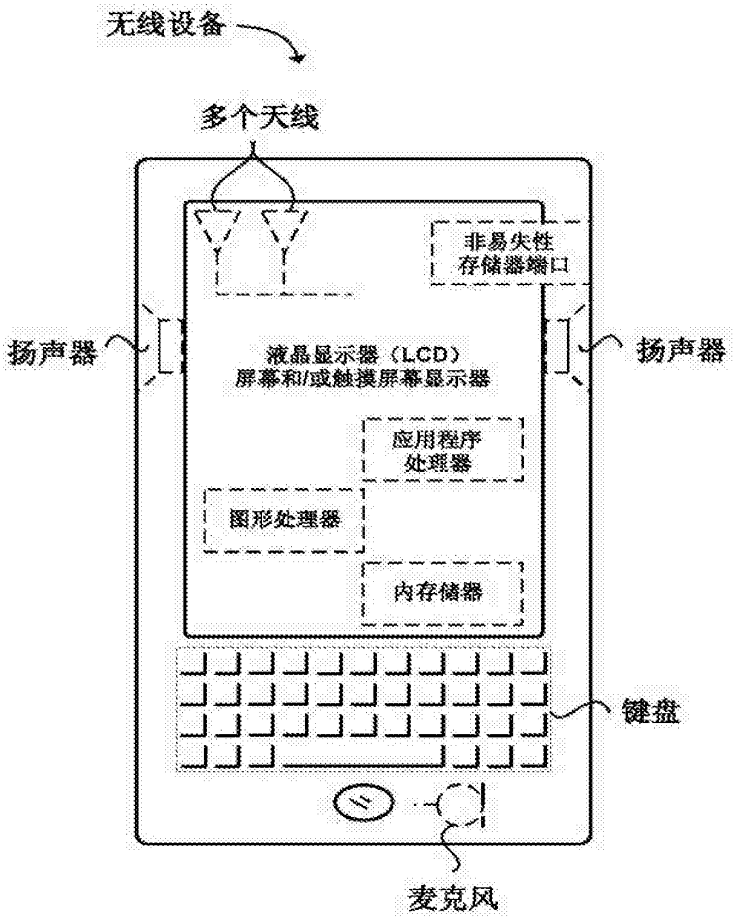

无线设备
多个天线
非易失性
存储器端口
扬声器
液晶显示器（LCD）
屏幕和/或触摸屏幕显示器
扬声器
应用程序
处理器
图形处理器
内存储器
键盘
麦克风

图18

Espacenet

Bibliographic data: CN105580468 (A) — 2016-05-11

Base station, mobile station, reference-signal transmission method, and channel-quality measurement method

Inventor(s): KAKISHIMA YUICHI; NAGATA SATOSHI; KISHIYAMA YOSHIHISA ± (KAKISHIMA YUICHI, ; NAGATA SATOSHI, ; KISHIYAMA YOSHIHISA)

Applicant(s): NTT DOCOMO INC ± (NTT DOCOMO INC)

Classification: - international: ***H04B7/04; H04J99/00; H04W16/28; H04W72/04***
- cooperative: **H04B7/0413**; **H04B7/0417**; **H04B7/0626**; **H04B7/0684**; **H04L5/0048**; **H04L5/0057**; **H04W16/28**; **H04W24/10**; **H04W72/1263**; H04L5/0023

Application number: CN20148052271 20140822 Global Dossier

Priority number(s): WO2014JP71983 20140822 ; JP20130200606 20130926

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Abstract of CN105580468 (A)

This base station, which uses a plurality of antenna ports to communicate with a mobile station, has a mapping-information sending unit, a multiplexing unit, and a transmission unit. The mapping-information sending unit generates a mapping of channel state information reference signals (CSI-RSs) to the aforementioned antenna ports by combining, within a resource block, CSI-RS mappings each defined for at most a prescribed number of antenna ports. The mapping-information sending unit then sends information representing the generated mapping to the mobile station. The multiplexing unit multiplexes CSI-RSs onto resource elements within a resource block in accordance with the generated mapping, and the transmission unit transmits said CSI-RSs.

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2016.03.23

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PCT/JP2014/071983 2014.08.22

(87)PCT国际申请的公布数据
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(51)Int.Cl.
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H04B 7/04(2006.01)
H04J 99/00(2006.01)
H04W 16/28(2006.01)

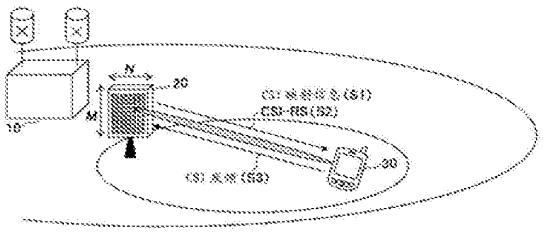
权利要求书2页 说明书11页 附图9页

(54)发明名称

基站、移动台、参考信号发送方法以及信道质量测量方法

(57)摘要

使用多个天线端口与移动台进行通信的基站具有：映射信息通知单元，通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射，从而对多个天线端口生成信道状态信息测量用的参考信号的映射，并将表示所生成的映射的信息通知给移动台；复用单元，根据所生成的映射，将信道状态信息测量用的参考信号复用到资源块内的资源元素；以及发送单元，发送信道状态信息测量用的参考信号。



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1.一种基站，使用多个天线端口与移动台进行通信，所述基站具有：

映射信息通知单元，通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射，从而对多个天线端口生成信道状态信息测量用的参考信号的映射，并将表示所生成的映射的信息通知给移动台；

复用单元，根据所生成的映射，将信道状态信息测量用的参考信号复用到资源块内的资源元素；以及

发送单元，发送信道状态信息测量用的参考信号。

2.一种基站，使用多个天线端口与移动台进行通信，所述基站具有：

映射信息通知单元，通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组，并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号，从而生成多个天线端口的信道状态信息测量用的参考信号的映射，并将表示所生成的映射的信息通知给移动台；

复用单元，根据所生成的映射，将信道状态信息测量用的参考信号复用到子帧或者资源块；以及

发送单元，发送信道状态信息测量用的参考信号。

3.一种移动台，与具有多个天线端口的基站进行通信，所述移动台具有：

映射信息接收单元，接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息，该映射通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射而生成；

参考信号提取单元，基于接收到的表示映射的信息，提取信道状态信息测量用的参考信号；

信道状态信息生成单元，使用所提取的参考信号而生成信道状态信息；以及

发送单元，发送所生成的信道状态信息。

4.一种移动台，与具有多个天线端口的基站进行通信，所述移动台具有：

映射信息接收单元，接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息，该映射通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组，并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号而生成；

参考信号提取单元，基于接收到的表示映射的信息，提取信道状态信息测量用的参考信号；

信道状态信息生成单元，使用所提取的参考信号而生成信道状态信息；以及

发送单元，发送所生成的信道状态信息。

5.一种参考信号发送方法，用于使用多个天线端口与移动台进行通信的基站，所述参考信号发送方法包括：

通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射，从而对多个天线端口生成信道状态信息测量用的参考信号的映射，并将表示所生成的映射的信息通知给移动台的步骤；

根据所生成的映射，将信道状态信息测量用的参考信号复用到资源块内的资源元素的

步骤;以及

发送信道状态信息测量用的参考信号的步骤。

6.一种参考信号发送方法,用于使用多个天线端口与移动台进行通信的基站,所述参考信号发送方法包括:

通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组,并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号,从而生成多个天线端口的信道状态信息测量用的参考信号的映射,并将表示所生成的映射的信息通知给移动台的步骤;

根据所生成的映射,将信道状态信息测量用的参考信号复用到子帧或者资源块的步骤;以及

发送信道状态信息测量用的参考信号的步骤。

7.一种信道质量测量方法,用于与具有多个天线端口的基站进行通信的移动台,所述信道质量测量方法包括:

接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息的步骤,该映射通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射而生成;

基于接收到的表示映射的信息,提取信道状态信息测量用的参考信号的步骤;以及

使用所提取的参考信号而测量信道质量的步骤。

8.一种信道质量测量方法,用于与具有多个天线端口的基站进行通信的移动台,所述信道质量测量方法包括:

接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息的步骤,该映射通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组,并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号而生成;

基于接收到的表示映射的信息,提取信道状态信息测量用的参考信号的步骤;以及

使用所提取的参考信号而测量信道质量的步骤。

基站、移动台、参考信号发送方法以及信道质量测量方法

技术领域

[0001] 本发明涉及基站、移动台、参考信号发送方法以及信道质量测量方法。

背景技术

[0002] 在3GPP(第三代合作伙伴计划(Third Generation Partnership Project))标准的Release8～11中,采用如下技术:设想将基站的天线端口(AP:Antenna Port)横向配置多个,进行水平方向的波束成形。

[0003] 在3GPP标准的Release12中,正在研究在基站中搭载沿纵向和横向等二维配置的多个天线元件,除了水平方向之外还在垂直方向上形成波束的三维MIMO(三维多输入多输出(3D-MIMO:Three Dimensional Multiple Input Multiple Output))。通过在垂直方向和水平方向上形成波束,期待系统特性的改善。

[0004] 在3GPP标准化上,将天线端口数为8以下的情况下的3D-MIMO称为垂直波束成形,将天线端口数大于8的情况(16、32、64…等)称为FD-MIMO(全维MIMO(Full Dimension-MIMO))。FD-MIMO多被称为大规模MIMO(Massive MIMO)。

[0005] 大规模MIMO通过使用非常多的基站天线元件来形成尖锐的波束,从而能够改善频率利用效率。

[0006] 此外,在3GPP标准的Release10中,规定了天线端口数为8以下的情况下的信道状态信息(CSI:Channel State Information)测量用的参考信号(CSI-RS:Reference Signal for CSI measurement)(参照3GPP TS 36.211V10.7.0(2013-02)Sec 6.10.5以及3GPP TS 36.331V10.0.0(2013-06)Sec 6.3.2)。图1示出天线端口数为8以下的情况下的CSI-RS的映射例。为了降低CSI-RS的开销,在频域中,在1个资源块(RB:Resource Block)内,每1个天线端口被分配了1个资源元素(RE:Resource Element)。此外,在时域中,以5、10、20、40或者80毫秒的发送周期来发送。CSI-RS的发送周期通过RRC(无线资源控制(Radio Resource Control))信令而被设定。

[0007] 为了将CSI-RS向资源块内的资源元素的映射通知给移动台,使用图2所示的表格(CSI-RS设置(CSI-RS configuration))(参照3GPP TS 36.211V10.7.0(2013-02)Sec 6.10.5的表格6.10.5.2-1)。图2示出在指定CSI-RS的资源结构时使用的表格的例。

[0008] 例如,在天线端口数为2的情况下,存在图1(A)所示的20种CSI-RS的映射。为了对移动台通知使用20种映射中的哪个,使用图2的表格中的0～19的其中一个索引(CSI参考信号设置(CSI reference signal configuration))。

[0009] 此外,为了对移动台通知CSI-RS的发送周期以及子帧开始位置(子帧偏移),使用图3所示的表格(CSI-RS子帧设置(CSI-RS subframe configuration))(参照3GPP TS 36.211V10.7.0(2013-02)Sec 6.10.5的表格6.10.5.3-1)。图3示出在指定CSI-RS的子帧结构时使用的表格的例。

[0010] 使用图2的表格而指定的CSI-RS以5、10、20、40或者80毫秒的周期来复用到子帧而被发送。为了指定该周期以及子帧开始位置,图3的表格中的0～154的其中一个索引(CSI-

RS-SubframeConfig)通知给移动台。

发明内容

[0011] 发明要解决的课题

[0012] 如上所述,在3GPP标准的Release10中规定的CSI-RS最多支持至8天线端口。但是,为了实现FD-MIMO中的信道质量测量,需要支持如16、32、64等的被扩展的天线端口数。

[0013] 本发明的目的在于,实现一种能够对应于被扩展的天线端口数的CSI-RS的结构。

[0014] 用于解决课题的手段

[0015] 本发明的一方式的基站为,

[0016] 一种基站,使用多个天线端口与移动台进行通信,其特征在于,所述基站具有:

[0017] 映射信息通知单元,通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射,从而对多个天线端口生成信道状态信息测量用的参考信号的映射,并将表示所生成的映射的信息通知给移动台;

[0018] 复用单元,根据所生成的映射,将信道状态信息测量用的参考信号复用到资源块内的资源元素;以及

[0019] 发送单元,发送信道状态信息测量用的参考信号。

[0020] 此外,本发明的一方式的基站为,

[0021] 一种基站,使用多个天线端口与移动台进行通信,其特征在于,所述基站具有:

[0022] 映射信息通知单元,通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组,并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号,从而生成多个天线端口的信道状态信息测量用的参考信号的映射,并将表示所生成的映射的信息通知给移动台;

[0023] 复用单元,根据所生成的映射,将信道状态信息测量用的参考信号复用到子帧或者资源块;以及

[0024] 发送单元,发送信道状态信息测量用的参考信号。

[0025] 本发明的一方式的移动台为,

[0026] 一种移动台,与具有多个天线端口的基站进行通信,其特征在于,所述移动台具有:

[0027] 映射信息接收单元,接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息,该映射通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射而生成;

[0028] 参考信号提取单元,基于接收到的表示映射的信息,提取信道状态信息测量用的参考信号;

[0029] 信道状态信息生成单元,使用所提取的参考信号而生成信道状态信息;以及

[0030] 发送单元,发送所生成的信道状态信息。

[0031] 此外,本发明的一方式的移动台为,

[0032] 一种移动台,与具有多个天线端口的基站进行通信,其特征在于,所述移动台具有:

[0033] 映射信息接收单元，接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息，该映射通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组，并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号而生成；

[0034] 参考信号提取单元，基于接收到的表示映射的信息，提取信道状态信息测量用的参考信号；

[0035] 信道状态信息生成单元，使用所提取的参考信号而生成信道状态信息；以及

[0036] 发送单元，发送所生成的信道状态信息。

[0037] 本发明的一方式的参考信号发送方法为，

[0038] 一种参考信号发送方法，用于使用多个天线端口与移动台进行通信的基站，其特征在于，所述参考信号发送方法包括：

[0039] 通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射，从而对多个天线端口生成信道状态信息测量用的参考信号的映射，并将表示所生成的映射的信息通知给移动台的步骤；

[0040] 根据所生成的映射，将信道状态信息测量用的参考信号复用到资源块内的资源元素的步骤；以及

[0041] 发送信道状态信息测量用的参考信号的步骤。

[0042] 此外，本发明的一方式的参考信号发送方法为，

[0043] 一种参考信号发送方法，用于使用多个天线端口与移动台进行通信的基站，其特征在于，所述参考信号发送方法包括：

[0044] 通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组，并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号，从而生成多个天线端口的信道状态信息测量用的参考信号的映射，并将表示所生成的映射的信息通知给移动台的步骤；

[0045] 根据所生成的映射，将信道状态信息测量用的参考信号复用到子帧或者资源块的步骤；以及

[0046] 发送信道状态信息测量用的参考信号的步骤。

[0047] 本发明的一方式的信道质量测量方法为，

[0048] 一种信道质量测量方法，用于与具有多个天线端口的基站进行通信的移动台，其特征在于，所述信道质量测量方法包括：

[0049] 接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息的步骤，该映射通过在资源块内组合对预定数以下的天线端口规定的信道状态信息测量用的参考信号的映射而生成；

[0050] 基于接收到的表示映射的信息，提取信道状态信息测量用的参考信号的步骤；以及

[0051] 使用所提取的参考信号而测量信道质量的步骤。

[0052] 此外，本发明的一方式的信道质量测量方法为，

[0053] 一种信道质量测量方法，用于与具有多个天线端口的基站进行通信的移动台，其特征在于，所述信道质量测量方法包括：

[0054] 接收表示多个天线端口的信道状态信息测量用的参考信号的映射的信息的步骤，该映射通过将多个天线端口基于成为基准的天线端口的数量来分割为预定数的组，并将对成为基准的天线端口规定的信道状态信息测量用的参考信号的映射根据子帧或者资源块而使用于不同的组的信道状态信息测量用的参考信号而生成；

[0055] 基于接收到的表示映射的信息，提取信道状态信息测量用的参考信号的步骤；以及

[0056] 使用所提取的参考信号而测量信道质量的步骤。

[0057] 发明效果

[0058] 根据本发明，能够实现能够对应于被扩展的天线端口数的CSI-RS的结构。

附图说明

[0059] 图1是8天线端口以下的情况下的CSI-RS的映射例。

[0060] 图2是在指定CSI-RS的资源结构时使用的表格的例。

[0061] 图3是在指定CSI-RS的子帧结构时使用的表格的例。

[0062] 图4是本发明的实施例的无线通信系统的概略图。

[0063] 图5是CSI-RS的映射例。

[0064] 图6是本发明的实施例的基站的框图。

[0065] 图7是本发明的实施例的移动台的框图。

[0066] 图8是在指定CSI-RS的资源结构时使用的表格的例。

[0067] 图9是CSI-RS的映射例。

具体实施方式

[0068] 在本发明的实施例中，说明具有多个天线端口的基站(演进的节点B(eNB:evolved Node B))，更具体而言，说明用于实现能够对应于被扩展的天线端口数(比8多的天线端口数)的CSI-RS的结构的基站。此外，还说明与具有多个天线端口的基站进行通信的移动台(UE:User Equipment)，更具体而言，还说明用于使用能够对应于被扩展的天线端口数的CSI-RS而实现信道质量测量的移动台。

[0069] 另外，CSI-RS是用于测量如CQI(信道质量指示符(Channel Quality Indicator))、PMI(预编码矩阵指示符(Precoding Matrix Indicator))、RI(秩指示符(Rank Indicator))这样的信道状态信息(CSI)的参考信号。此外，天线端口是发送参考信号的天线元件的汇总。既有1个天线端口对应于1个天线元件的情况，此外，也有1个天线端口对应于多个天线元件的情况。

[0070] 在设计能够对应于被扩展的天线端口数的CSI-RS时，在本发明的实施例中考虑以下的设计思想。

[0071] (A)能够对应于各种天线端口数

[0072] 期望不仅能够对应于例如16、32、64等这样的天线端口数，还能够对应于例如10、12、16、24、32、36、48、64、96、128等的天线端口数。

[0073] (B)在时间及频率上对各天线端口分配的资源元素接近

[0074] 这是为了将时间及频率方向的信道变动以及RF(射频(Radio Frequency))装置的

不完整性的影响抑制为最低限度。

[0075] (C)在时间上稀疏地复用

[0076] 这是为了将移动台用于从睡眠状态启动的时间设为最低限度，节约电池消费。

[0077] (D)开销的减少

[0078] 这是为了抑制对于吞吐量的影响，抑制对于如遵照3GPP标准的旧版本(Legacy release)(例如，8-11)的移动台那样无法进行参考信号的信令的移动台的影响。

[0079] 在本发明的实施例中，考虑到这样的点，通过以下的任一种手法来实现能够对应于被扩展的天线端口数的CSI-RS的结构。

[0080] (1)新规定被扩展的天线端口数个CSI-RS的映射的手法

[0081] 例如，在天线端口数为16的情况下，除了在3GPP标准的Release10中规定的天线端口号码0～7的CSI-RS的映射(参照图1(C))之外，还新规定天线端口号码8～15的CSI-RS的映射。基站根据新规定的映射，将CSI-RS复用到资源块内的资源元素。

[0082] (2)将在3GPP标准的Release10中规定的CSI-RS的映射进行组合的手法

[0083] 例如，在天线端口数为16的情况下，通过在资源块内组合2个在3GPP标准的Release10中规定的天线端口号码0～7的CSI-RS的映射(参照图1(C))，从而生成被扩展的天线端口数个CSI-RS的映射。为了表示天线端口号码0～7的CSI的映射和天线端口号码8～15的CSI的映射，也可以使用2个图2的表格的索引(CSI参考信号设置(CSI reference signal configuration))。基站将表示所生成的映射的信息通知给移动台。此外，基站根据所生成的映射，将CSI-RS复用到资源块内的资源元素。

[0084] (3)将在3GPP标准的Release10中规定的CSI-RS的映射以子帧单位或者资源块单位来切换的手法

[0085] 例如，在天线端口数为16的情况下，作为成为基准的映射，使用8天线端口的CSI-RS的映射(参照图1(C))。天线端口号码0～15被分割为天线端口号码0～7和天线端口号码8～15。通过将成为基准的天线端口号码0～7的CSI-RS的映射根据子帧或者资源块而使用于天线端口号码0～7的CSI-RS或者天线端口号码8～15的CSI-RS，从而生成被扩展的天线端口数个CSI-RS的映射。也可以在系统上定义天线端口的组如何被分配到子帧或者资源块。基站将表示所生成的映射的信息通知给移动台。此外，基站根据所生成的映射，将CSI-RS复用到资源块。

[0086] 参照附图，以下详细说明各个手法。

[0087] (1)新规定被扩展的天线端口数个CSI-RS的映射的手法

[0088] 图4表示本发明的实施例的无线通信系统的概略图。无线通信系统具有覆盖宽范围的宏基站10、位于宏基站10的区域内或者其周边且具有二维配置的天线元件的FD-MIMO站20、移动台30。设为FD-MIMO站20具有比8多的天线元件。该比8多的天线元件被分类为比8多的天线端口。如上所述，可以是1个天线元件对应于1个天线端口，此外，也可以是多个天线元件对应于1个天线端口。虽然在图4中，宏基站10和FD-MIMO站20被分别配置，但宏基站10也可以作为具有比8多的天线元件的FD-MIMO站来构成。此外，虽然记载为FD-MIMO站20具有二维配置的天线元件，但也可以具有一维配置或者三维配置的天线元件。

[0089] FD-MIMO站20生成被扩展的天线端口数个CSI-RS的映射，并将CSI-RS的映射信息发送给移动台30(S1)。例如，FD-MIMO站20也可以将天线端口数和表示CSI-RS的映射的索引

(CSI参考信号设置(CSI reference signal configuration))发送给移动台30。关于该映射例,参照图5以下说明。此外,FD-MIMO站20根据所生成的映射,将CSI-RS复用到资源块内的资源元素,并发送给移动台30(S2)。移动台30能够根据CSI-RS的映射信息,提取CSI-RS。移动台30使用CSI-RS而测量信道质量,生成CSI,并将CSI发送给FD-MIMO站20(S3)。

[0090] 图5(A)表示在天线端口数为16的情况下的CSI-RS的映射例。

[0091] 在天线端口数为16的情况下,也与天线端口数为8的情况同样地生成CSI-RS的映射。在天线端口数为8的情况下,如图1(C)所示,天线端口号码(0,1)的CSI-RS连续地配置在1个子载波,天线端口号码(4,5)的CSI-RS连续地配置在接下来的子载波。进一步,在与天线端口号码(0,1)的CSI-RS相同的码元位置,天线端口号码(2,3)的CSI-RS连续地配置在1个子载波,天线端口号码(6,7)的CSI-RS连续地配置在接下来的子载波。

[0092] 在天线端口数为16的情况下,例如,将上述的天线端口号码(0,1,4,5)以及号码(2,3,6,7)的CSI-RS的配置扩展到天线端口号码8～15的CSI-RS。具体而言,将天线端口号码(8,9)的CSI-RS连续地配置在天线端口号码(0,1)的CSI-RS的接下来的码元。并且,将天线端口号码(10,11)的CSI-RS连续地配置在天线端口号码(8,9)的CSI-RS的接下来的子载波。进一步,将天线端口号码(12,13)的CSI-RS连续地配置在天线端口号码(2,3)的CSI-RS的接下来的码元。并且,将天线端口号码(14,15)的CSI-RS连续地配置在天线端口号码(12,13)的CSI-RS的接下来的子载波。

[0093] 另外,在天线端口数为16的情况下的CSI-RS的映射并不限定于如图5(A)所示的映射。CSI-RS也可以考虑上述的设计思想(A)～(D),例如,如图5(B)那样配置。

[0094] 图5(C)表示在天线端口数为32的情况下的CSI-RS的映射例。

[0095] 在天线端口数为32的情况下,也同样地,将天线端口数为8的情况下的天线端口号码(0,1,4,5)以及(2,3,6,7)的CSI-RS的配置扩展到天线端口号码8～31的CSI-RS。

[0096] 具体而言,与在天线端口数为16的情况同样地,配置天线端口号码0～15的CSI-RS。并且,在与天线端口号码(0,1)的CSI-RS相同的码元位置,将天线端口号码(16,17)的CSI-RS连续地配置在1个子载波,将天线端口号码(20,21)的CSI-RS连续地配置在接下来的子载波。进一步,将天线端口号码(24,25)的CSI-RS连续地配置在天线端口号码(16,17)的CSI-RS的接下来的码元。并且,将天线端口号码(26,27)的CSI-RS连续地配置在天线端口号码(24,25)的CSI-RS的接下来的子载波。同样地,在与天线端口号码(0,1)的CSI-RS相同的码元位置,将天线端口号码(18,19)的CSI-RS连续地配置在1个子载波,将天线端口号码(22,23)的CSI-RS连续地配置在接下来的子载波。进一步,将天线端口号码(28,29)的CSI-RS连续地配置在天线端口号码(18,19)的CSI-RS的接下来的码元。并且,将天线端口号码(30,31)的CSI-RS连续地配置在天线端口号码(28,29)的CSI-RS的接下来的子载波。

[0097] 另外,在天线端口数为32的情况下的CSI-RS的映射并不限定于如图5(B)所示的映射。CSI-RS也可以考虑上述的设计思想(A)～(D)而配置在其他的资源元素。

[0098] 根据图5(A)～图5(C)的CSI-RS的配置,即使天线端口数增加,通过使用在天线端口数为8的情况下的CSI-RS的位置关系,也能够实现移动台中的信道估计的简化,且能够抑制天线端口数的差异所引起的天线估计精度的偏差。

[0099] 另一方面,在图5(A)～图5(C)所示的手法中,在PDSCH(物理下行链路共享信道(Physical Downlink Shared Channel))用的资源元素中配置CSI-RS。考虑到在这些资源

元素中复用其他的参考信号或者物理信道的可能性，也可以将CSI-RS映射为如下：即使是天线端口数变得比8还大，也使用图1所示的天线端口号码0～7的CSI-RS的资源元素。图5(D)表示在天线端口数为32的情况下的CSI-RS的映射例。

[0100] 如图1(C)所示，在天线端口数为8的情况下，存在5种映射。即，8×5＝40个资源元素能够作为CSI-RS使用。也可以在这些资源元素中如图5(D)所示那样配置天线端口号码0～31的CSI-RS。

[0101] 此外，在图5(A)～图5(C)所示的手法中，伴随着天线端口数的增加，CSI-RS的开销变大。例如，在天线端口数为64的情况下，PUCCH(物理上行链路控制信道(Physical Uplink Control Channel))、CRS(小区固有参考信号(Cell-specific Reference Signal))、DM-RS(解调参考信号(Demodulation Reference Signal))以及CSI-RS的开销成为83％。在该情况下，由于在包含CSI-RS的资源块中几乎不存在发送数据信号的区域，所以也可以以在该资源块中不发送数据信号为前提，规定CSI-RS的映射。例如，也可以在配置有DM-RS的资源元素(图1中的DMRS(Rel-9/10))、配置有天线端口号码3以及4的CRS的资源元素(图1中的CRS端口#3、4)、Release8用的DM-RS(图1中的DMRS(Rel-8)端口#5)等中，配置CSI-RS。

[0102] 另外，虽然在图5中，通过频分复用(FDM:Frequency Division Multiplexing)以及时分复用(TDM:Time Division Multiplexing)而将CSI-RS复用到资源元素，但也可以与码分复用(CDM:Code Division Multiplexing)进行组合而复用。例如，也可以是某一天线端口的CSI-RS与其他的天线端口的CSI-RS进行码分复用，并复用到确保用于CSI-RS的资源元素。

[0103] 接着，说明基站(FD-MIMO站)20以及移动台30的结构。

[0104] 图6表示本发明的实施例的基站20的框图。基站20具有CSI-RS生成单元201、CSI-RS映射信息存储单元203、CSI-RS映射信息通知单元205、复用单元207、发送单元209、接收单元211、CSI处理单元213。

[0105] CSI-RS生成单元201生成信道状态信息测量用的参考信号(CSI-RS)。

[0106] CSI-RS映射信息存储单元203存储表示CSI-RS复用到资源块内的哪个资源元素的映射信息。CSI-RS映射信息存储单元203例如存储如图5(A)～图5(D)所示的映射信息。

[0107] CSI-RS映射信息通知单元205将表示CSI-RS的映射的信息通知给移动台。例如，在系统上定义了如图5(A)那样的16天线端口时的2种映射信息的情况下，CSI-RS映射信息通知单元205也可以将表示天线端口数的信息和表示CSI-RS的映射的索引(CSI参考信号设置(CSI reference signal configuration))通知给移动台。

[0108] 复用单元207根据在CSI-RS映射信息存储单元203中存储的映射信息，将CSI-RS复用到资源块内的资源元素。此外，数据以及控制信息等也在被实施了编码、速率匹配以及调制等之后，复用到资源块内的资源元素。

[0109] 另外，根据被扩展的天线端口的CSI-RS，分配到PDSCH等的资源元素用于CSI-RS。例如，遵照3GPP标准的Release12的移动台能够根据来自基站的信令，对新规定的CSI-RS的映射进行识别。因此，复用单元207能够避开CSI-RS而复用PDSCH。在基站20的速率匹配单元(未图示)中，与CSI-RS的映射对应地，对数据以及控制信息应用速率匹配，从而能够降低数据以及控制信息的特性劣化。另一方面，遵照3GPP标准的Release8～11的移动台无法识别新规定的CSI-RS的映射。因此，复用单元207也可以应用删截(Puncturing)

[0110] 发送单元209对移动台发送信号。尤其，发送单元209将表示CSI-RS的映射的信息发送给移动台，此外，与数据以及控制信息等一同，将复用到资源块内的资源元素的CSI-RS发送给移动台。

[0111] 接收单元211从移动台接收信号。尤其，接收单元211从移动台接收CSI。

[0112] CSI处理单元213使用所接收的CSI，利用于对移动台发送数据时的调度等。

[0113] 图7表示本发明的实施例的移动台30的框图。移动台30具有接收单元301、CSI-RS提取单元303、CSI生成单元305、发送单元307。

[0114] 接收单元301接收从基站通知的映射信息。此外，接收单元301接收在资源块内的资源元素中复用的CSI-RS、数据、控制信息等。

[0115] CSI-RS提取单元303基于从基站通知的映射信息，提取CSI-RS。

[0116] CSI生成单元305使用所提取的CSI-RS来测量信道质量，生成包括表示信道质量的CQI、表示预编码矩阵的PMI和表示信号序列数的RI的CSI。

[0117] 发送单元307将所生成的CSI发送给基站。

[0118] (2)将在3GPP标准的Release10中规定的CSI-RS的映射进行组合的手法

[0119] 在该手法中，无线通信系统与图4同样地构成。但是，被扩展的天线端口数个CSI-RS的映射通过将图1所示的对预定数以下的天线端口规定的CSI-RS的映射进行组合而生成。

[0120] 例如，在天线端口数为32的情况下，通过将图1(C)所示的8天线端口的映射组合4个，能够确保32天线端口量的CSI-RS。在8天线端口的情况下，能够进行由0～4的索引(CSI参考信号设置)所示的5种CSI-RS的映射。例如，通过使用其中的0～3，能够确保32天线端口量的CSI-RS。因此，FD-MIMO站20只要将表示天线端口数的2比特和图2的表格中的0、1、2、3的索引通知给移动台30即可。另外，0、1、2、3的索引可以单独作为4个索引而通知，也可以以(0,3)这样的区间来通知。

[0121] 要通知的索引和天线端口的关系既可以显式地通知给移动台30，也可以遵照预先决定的规则。例如，也可以将图2的表格中的0的索引分配到天线端口号码0～7、1的索引分配到天线端口号码8～15、2的索引分配到天线端口号码16～23、3的索引分配到天线端口号码24～31这样的信息通知给移动台30。或者，也可以在基站20以及移动台30中预先设定按照0、1、2、3这样的索引的顺序来对天线端口号码0～7、8～15、16～23、24～31分配的规则。

[0122] 例如，在天线端口数为10的情况下，通过将图1(A)所示的2天线端口的映射和图1(C)所示的8天线端口的映射进行组合，能够确保10天线端口量的CSI-RS。在2天线端口的情况下，能够进行由0～19的索引所示的20种CSI-RS的映射，在8天线端口的情况下，能够进行由0～5的索引所示的5种CSI-RS的映射。例如，通过将其中的2天线端口用的索引0和8天线端口用的索引1进行组合，能够确保10天线端口量的CSI-RS。因此，基站20只要将表示2的天线端口数的2比特、图2的表格中的0的索引、表示8的天线端口数的2比特、图2的表格中的1的索引通知给移动台即可。

[0123] 这样，通过将图1所示的1、2、4、8天线端口用的CSI-RS的映射进行组合，能够对应于各种天线端口数。

[0124] 另外，1、2、4、8天线端口用的CSI-RS的映射的组合也可以与CSI计算时的CSI过程(CSI Process)一同通知给移动台。CSI过程是表示在3GPP标准的Release11中规定的移动

台进行的CSI反馈的细节的信息。如图8所示，CSI过程由用于CSI计算的信号功率测量用资源(CSI-RS resource)和干扰信号测量用资源(CSI-IM(CSI-interference management) resource)的组合所规定。信号功率发送用资源是表示用于测量本小区内的信号功率的资源结构的索引，干扰信号测量用资源是表示不存在本小区内的信号而用于测量其他小区内的信号功率的资源结构的索引。在Release11中，能够按每个CSI过程指定1个信号功率测量用资源和1个干扰信号测量用资源。也可以通过按每个CSI过程指定多个信号功率测量用资源(例如，#1、#2)和多个干扰信号测量用资源(例如，#1、#2)，从而被扩展的天线端口数个CSI-RS的映射通知给移动台。

[0125] 基站20以及移动台30除了以下的点之外与图6以及图7同样地构成。

[0126] CSI-RS映射信息存储单元203存储如图1(A)～(C)所示的映射信息。

[0127] CSI-RS映射信息通知单元205将表示CSI-RS的映射的信息通知给移动台。例如，在对32天线端口将由0～3的索引所示的4种CSI-RS的映射进行组合的情况下，CSI-RS映射信息通知单元205也可以通知表示32的天线端口数的信息和0～3的索引。例如，在对10天线端口将由2天线端口用的0的索引所示的CSI的映射和8天线端口用的1的索引所示的CSI的映射进行组合的情况下，CSI-RS映射信息通知单元205也可以通知表示2、8的天线端口数的信息和0、1的索引。此外，映射信息也可以与CSI过程一同通知。

[0128] (3)将在3GPP标准的Release10中规定的CSI-RS的映射以子帧单位或者资源块单位来切换的手法

[0129] 在该手法中，无线通信系统也与图4同样地构成。但是，为了确保被扩展的天线端口数个CSI-RS，将FD-MIMO站20的天线端口基于成为基准的天线端口的数量来分割为预定数的组。并且，通过将图1所示的对成为基准的天线端口规定的CSI-RS的映射根据子帧或者资源块而使用于不同的组的CSI-RS，从而生成被扩展的天线端口数个CSI-RS的映射。

[0130] 图9(A)表示在天线端口数为8的情况下的CSI-RS的映射例。如参照图3所说明，CSI-RS在每5、10、20、40或者80毫秒(子帧)发送。图9(A)表示CSI-RS在每5毫秒发送的情况。

[0131] 例如，在天线端口数为32的情况下，若将成为基准的天线端口的数量设为8，则能够分割为天线端口号码0～7、天线端口号码8～15、天线端口号码16～23、天线端口号码24～31。通过将8天线端口的CSI-RS的映射在4个组中交替地使用而在4个子帧或者4个资源块中发送，能够确保32天线端口量的CSI-RS。也可以在系统上定义天线端口的组如何分配到子帧或者资源块。例如，如图9(B)所示，32天线端口的CSI-RS也可以以对8天线端口规定的发送间隔(例如，5毫秒)，按照天线端口号码0～7、天线端口号码8～15、天线端口号码16～23、天线端口号码24～31的顺序发送。例如，如图9(C)所示，32天线端口的CSI-RS也可以以对8天线端口规定的发送间隔(例如，5毫秒)，将天线端口号码0～7、天线端口号码8～15、天线端口号码16～23、天线端口号码24～31的CSI-RS以频率单位进行复用而发送。例如，如图9(D)所示，也可以以对8天线端口规定的发送间隔(例如，5毫秒)，发送天线端口号码0～7的CSI-RS，并以相同的发送间隔，将天线端口号码8～15、天线端口号码16～23、天线端口号码24～31的CSI-RS依次发送。虽然在图9(D)中，天线端口号码0～7、天线端口号码8～15、天线端口号码16～23、天线端口号码24～31的CSI-RS分配到连续的子帧，但也可以分配到隔着预定的间隔的子帧。

[0132] 另外，虽然在图9中，通过频分复用(FDM)以及时分复用(TDM)而将CSI-RS复用到资

源块，但也可以与码分复用(CDM)进行组合而复用。例如，也可以是某一天线端口的CSI-RS与其他的天线端口的CSI-RS进行码分复用，并复用到确保用于CSI-RS的资源块。

[0133] 例如，在FD-MIMO站20的天线端口数为32的情况下，根据天线端口数(32)和成为基准的天线端口的数量(8)的关系，能够将扩展因数定义为32/8＝4。FD-MIMO站20也可以除了图2所示的表格(CSI-RS设置)的索引(CSI参考信号设置)之外还将扩展因数通知给移动台30。通过扩展因数，移动台30能够识别成为基准的天线端口的CSI-RS的映射根据子帧或者资源块而使用于不同的天线端口的组。

[0134] 此外，为了表示哪个子帧使用于CSI-RS，也可以将图3所示的子帧结构多次通知给移动台30。例如，也可以是第1次通知的子帧使用于天线端口号码0～7的CSI-RS，第2次通知的子帧使用于天线端口号码8～15的CSI-RS，第3次通知的子帧使用于天线端口号码16～23的CSI-RS，第4次通知的子帧使用于天线端口号码24～31的CSI-RS。或者，也可以关于成为基准的天线端口的CSI-RS的映射，将图3所示的子帧结构通知给移动台，并将天线端口号码8～15、天线端口号码16～23、天线端口号码24～31相对于成为基准的天线端口号码0～7的发送定时(偏移)通知给移动台。

[0135] 被复用天线端口的CRI-RS的子帧或者资源块和天线端口的关系既可以显式地通知给移动台，也可以遵照预先决定的规则。例如，也可以按照被确保的子帧或者资源块的顺序，被分配天线端口号码0～7、8～15、16～23、24～31的CRI-RS。

[0136] 基站20以及移动台30除了以下的点之外与图6以及图7同样地构成。

[0137] CSI-RS映射信息存储单元203存储如图1(A)～(C)所示的映射信息。

[0138] CSI-RS映射信息通知单元205将表示CSI-RS的映射的信息通知给移动台。例如，将在成为基准的天线端口的数量为8时的CSI-RS的映射如图9(B)～图9(D)所示那样在4个天线端口的组中交替地使用而在4个子帧或者4个资源块中发送的情况下，CSI-RS映射信息通知单元205也可以将表示成为基准的天线端口的子帧结构的索引(CSI参考信号设置)和扩展因数通知给移动台。此外，CSI-RS映射信息通知单元205也可以将图3所示的表格(CSI-RS子帧设置)的索引(CSI-RS-SubframeConfig)多次通知给移动台。或者，CSI-RS映射信息通知单元205也可以将表示成为基准的天线端口的子帧结构的索引(CSI-RS-SubframeConfig)和从成为基准的天线端口的子帧结构起的发送定时(偏移)通知给移动台。

[0139] 另外，虽然在(3)的说明中，将在3GPP标准的Release10中规定的CSI-RS的映射以子帧单位或者资源块单位来切换，但也可以将(1)或者(2)的映射以子帧单位或者资源块单位来切换。例如，在天线端口数为32的情况下，也可以根据(1)或者(2)的手法而生成16天线端口量的资源块结构，并将所生成的16天线端口的CSI-RS的映射在2个天线端口的组中交替地使用而在2个子帧或者2个资源块中发送。

[0140] 另外，虽然LTE中的接入端口号码被赋予15以后的号码，但在上述的实施例中，为了方便而赋予从0起的编号。

[0141] (4)本发明的实施例的效果

[0142] 如上所述，根据本发明的实施例，能够实现能够对应于各种天线端口数的CSI-RS的结构。此外，通过考虑8天线端口以下的情况下的CSI-RS的结构，能够降低对于现有终端的影响。

[0143] 此外，通过将8天线端口以下的情况下的CSI-RS的结构进行组合，能够降低对于移动台的信令量。

[0144] 为了便于说明，本发明的实施例的基站以及移动台使用功能性的框图进行了说明，但本发明的实施例的基站以及移动台也可以通过硬件、软件或者它们的组合而实现。此外，各功能单元也可以根据需要而组合使用。此外，本发明的实施例的方法使用表示处理的流程的流程图进行说明，但本发明的实施例的方法也可以按照与实施例所示的顺序不同的顺序来实施。

[0145] 以上，说明了用于实现能够对应于被扩展的天线端口数的CSI-RS的结构的手法，但本发明并不限定于上述的实施例，在权利要求的范围内能够进行各种变更/应用。

[0146] 本国际申请基于在2013年9月26日申请的日本专利申请2013-200606号主张优先权，将2013-200606号的全部内容援用于本国际申请中。

[0147] 标号说明

[0148] 10 宏基站

[0149] 20 基站(FD-MIMO站)

[0150] 201 CSI-RS生成单元

[0151] 203 CSI-RS映射信息存储单元

[0152] 205 CSI-RS映射信息通知单元

[0153] 207 复用单元

[0154] 209 发送单元

[0155] 211 接收单元

[0156] 213 CSI处理单元

[0157] 30 移动台

[0158] 301 接收单元

[0159] 303 CSI-RS提取单元

[0160] 305 CSI生成单元

[0161] 307 发送单元

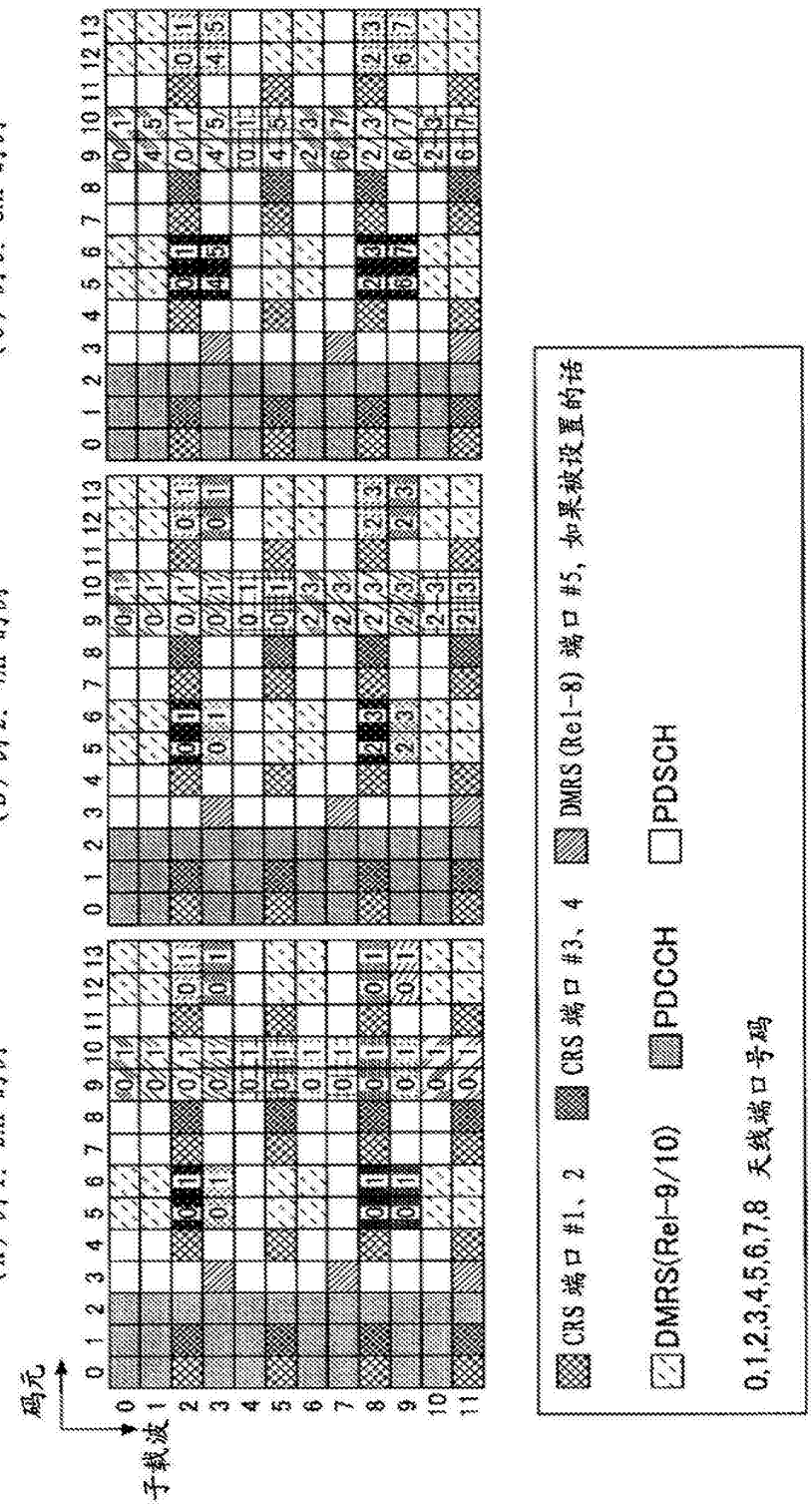
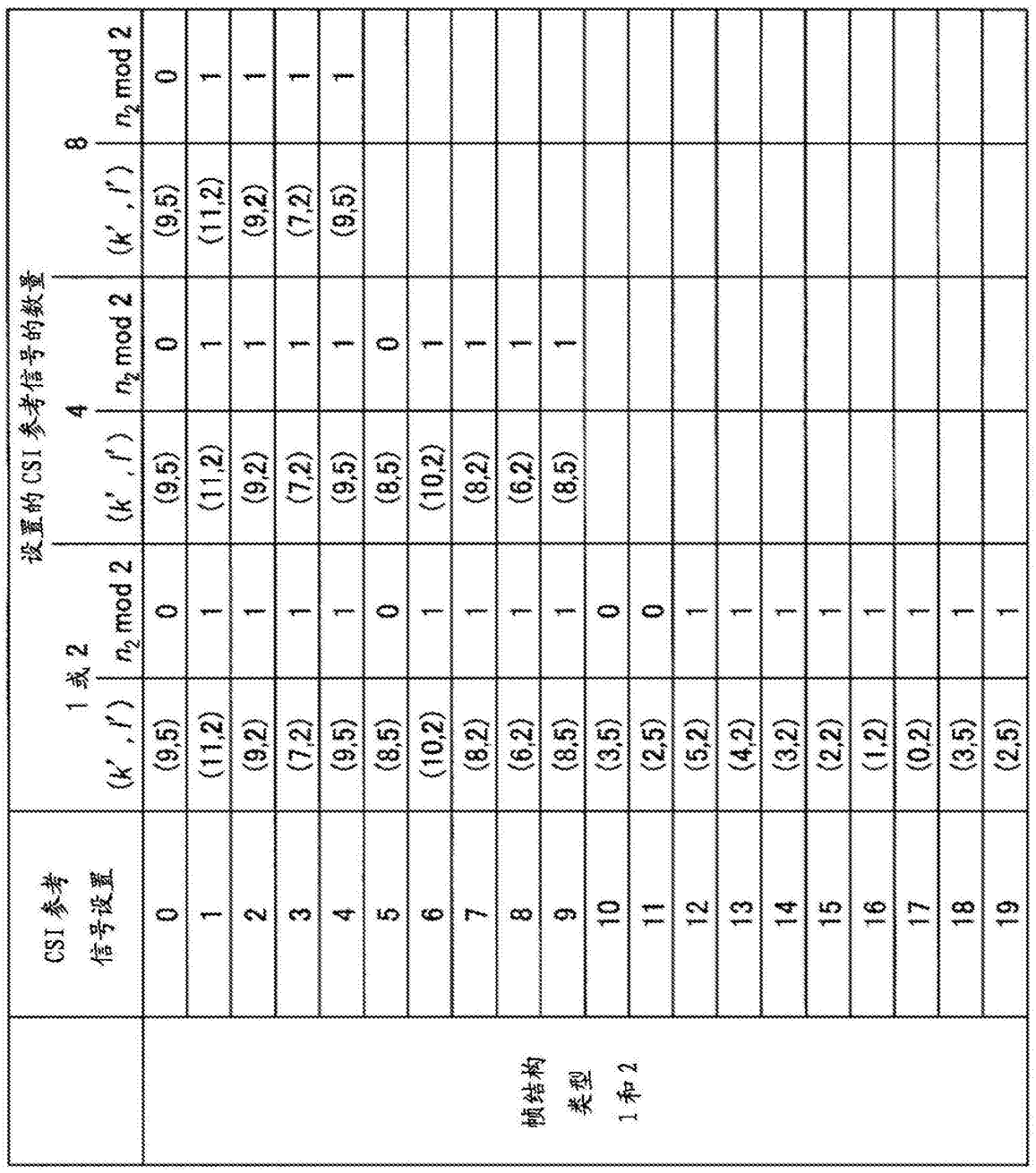

(A) 例 1: 2AP 的例
(B) 例 2: 4AP 的例
(C) 例 3: 8AP 的例
码元
子载波
CRS 端口 #1、2
CRS 端口 #3、4
DMRS(Rel-8) 端口 #5，如果被设置的话
DMRS(Rel-9/10)
PDCCH
PDSCH
0,1,2,3,4,5,6,7,8 天线端口号码

图1



	CSI 参考信号设置	设置的 CSI 参考信号的数量							
		1 或 2		4		8			
		(k', l')	$n_2 \bmod 2$	(k', l')	$n_2 \bmod 2$	(k', l')	$n_2 \bmod 2$		
帧结构类型 1 和 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						

图2

CSI-RS-SubframeConfig	CSI-RS 周期（子帧）	CSI-RS 子帧偏移（子帧）
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	$I_{CSI-RS} - 75$

图3

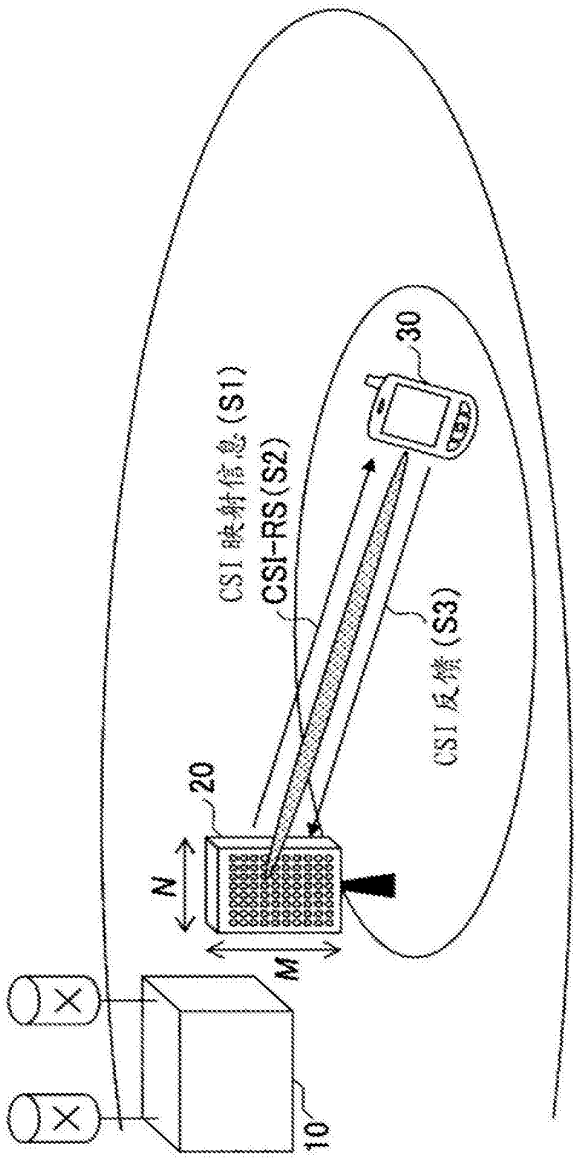


图4

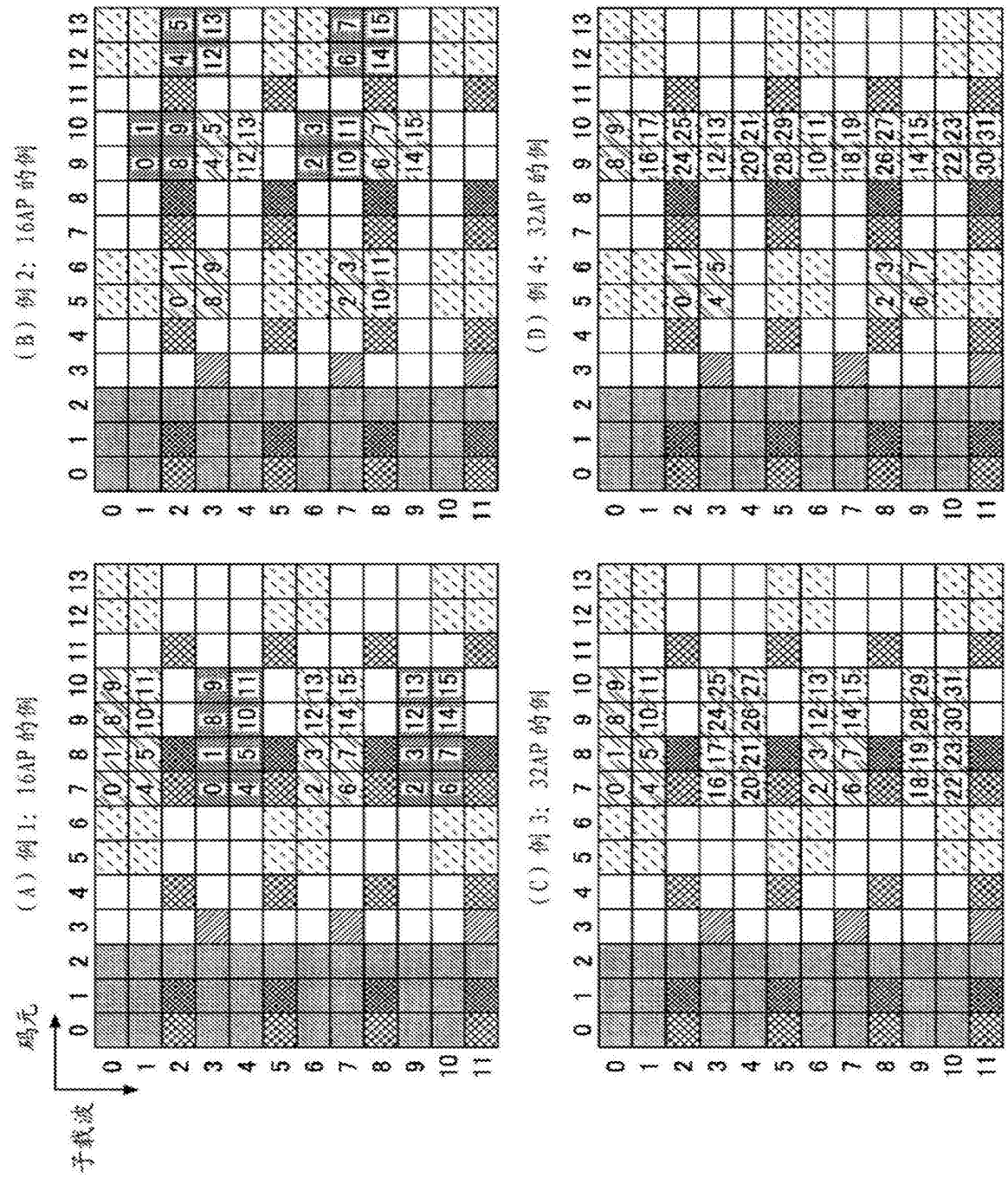


图5

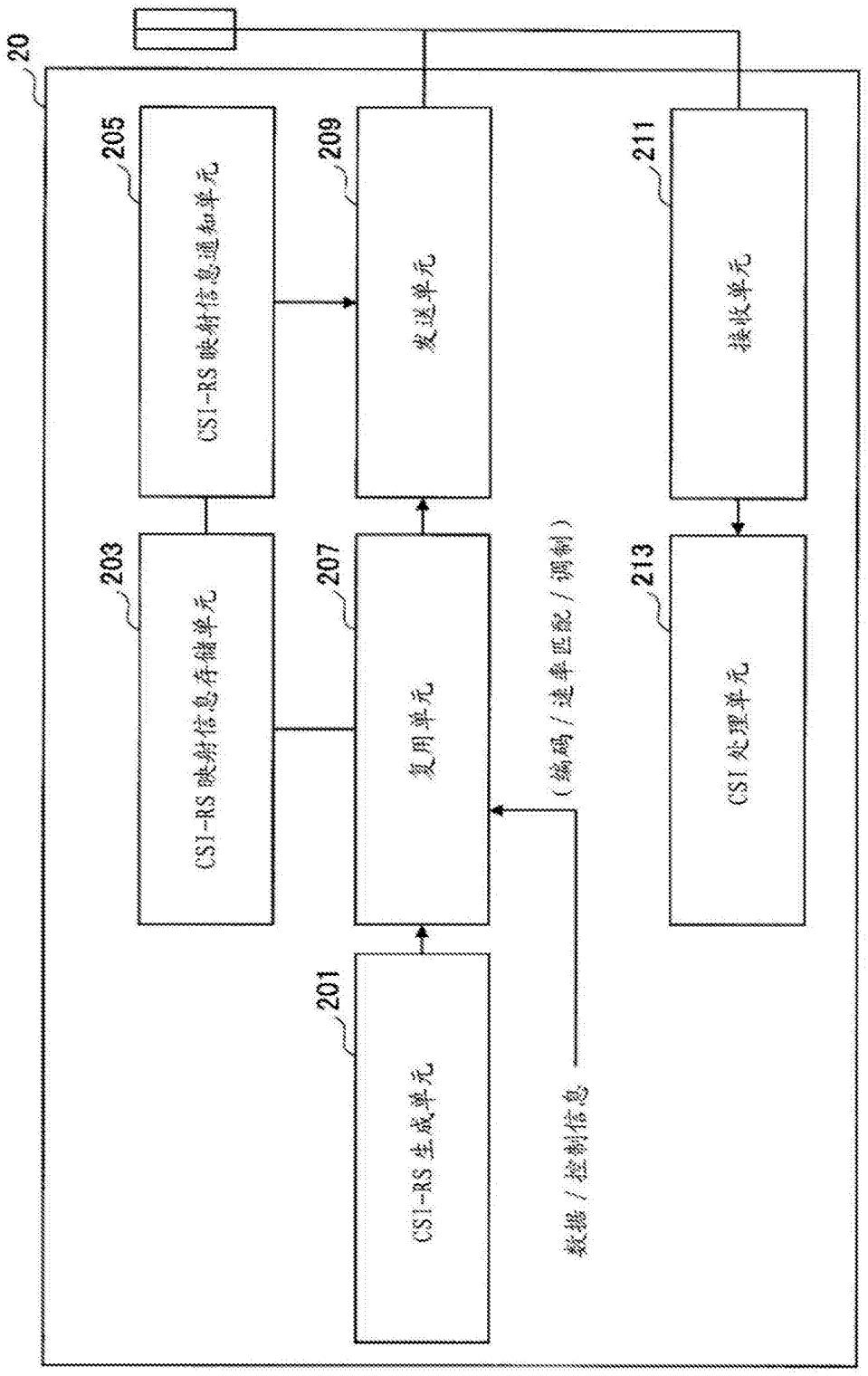

20
205
CSI-RS 映射信息通知单元
209
发送单元
211
接收单元
203
CSI-RS 映射信息存储单元
207
复用单元
213
CSI 处理单元
201
CSI-RS 生成单元
数据 / 控制信息
（编码 / 速率匹配 / 调制）

图6

20

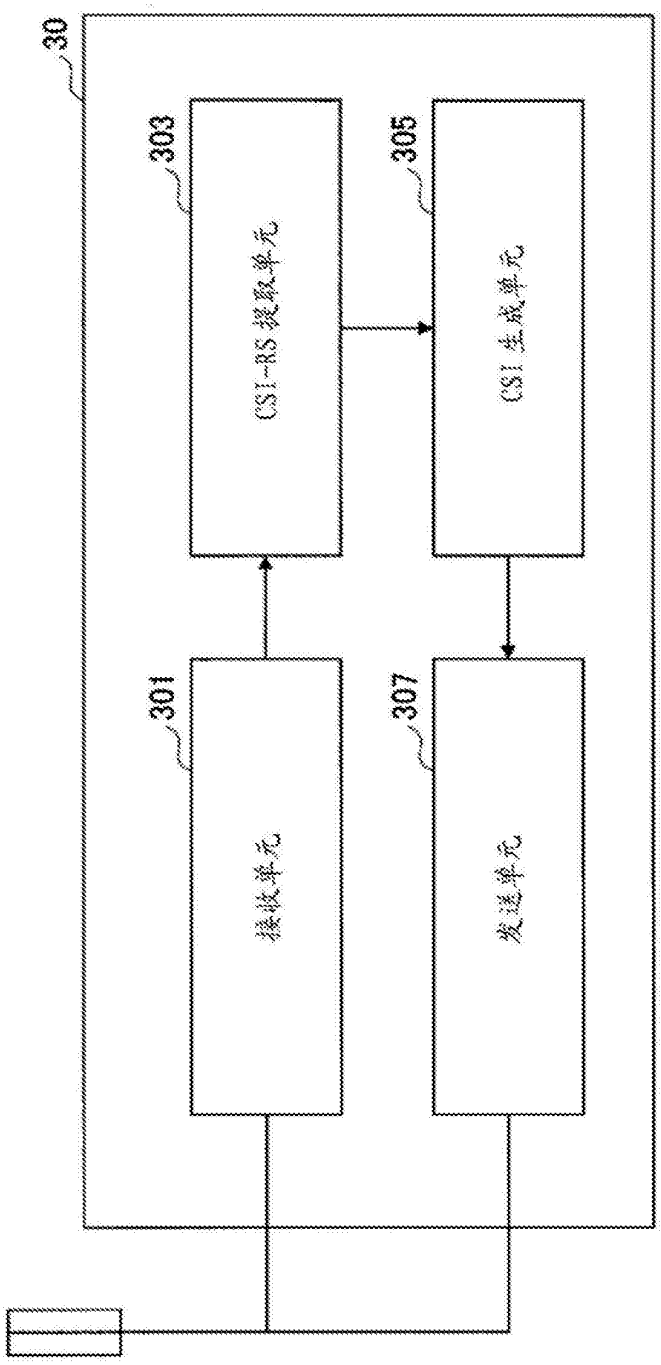


图7

CSI过程	CSI-RS 资源	CSI-IM 资源
#1	#1,#2	#1,#2
#2	#1,#2	#2
#3	#1	#2

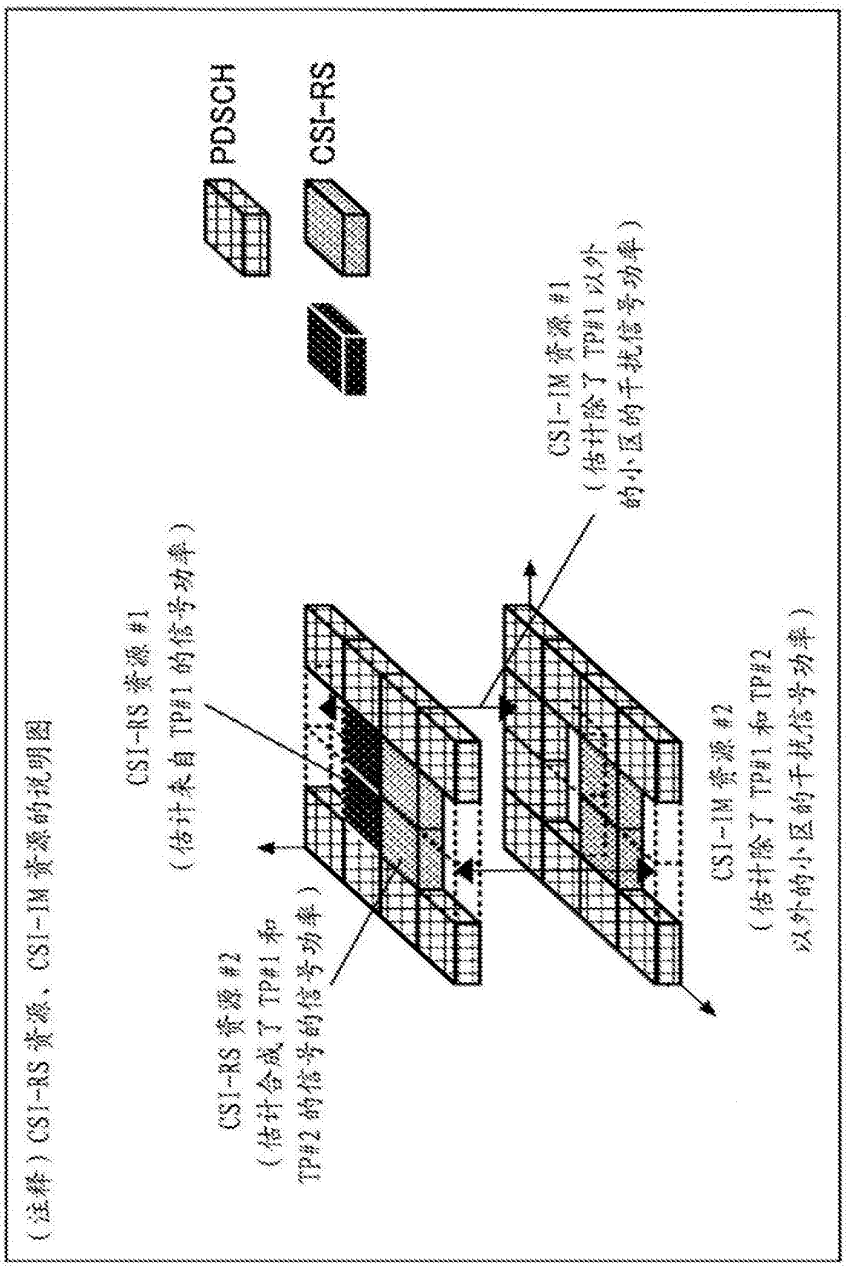


图8

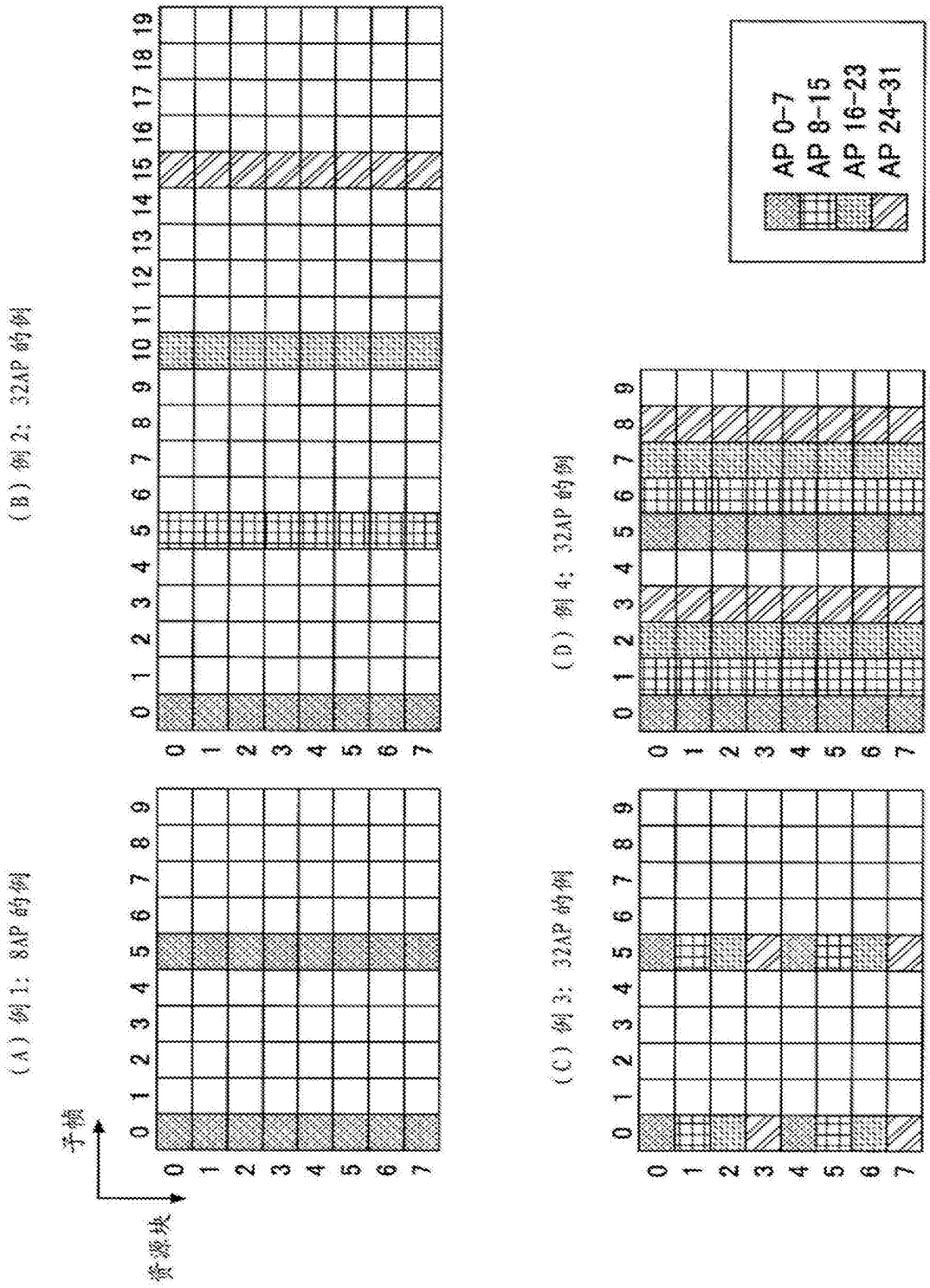

(A) 例 1：8AP 的例
(B) 例 2：32AP 的例
(C) 例 3：32AP 的例
(D) 例 4：32AP 的例
AP 0-7
AP 8-15
AP 16-23
AP 24-31
子帧
资源块

图9

Espacenet

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User scheduling method utilizing spatial position characteristics

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Abstract of CN106211338 (A)

The invention discloses a user scheduling method utilizing spatial position characteristics. The method comprises the following steps of grouping users through section level scanning, if the number of users that need scheduling is greater than the number of sections where the users are located, scheduling one user from each section based on a proportional fairness principle, determining allocated transmitting sub-arrays of a base station and corresponding optimal transmitting beams, and then training in sequence through the rest of transmitting beams and selecting the rest of users based on the proportional fairness principle; if the number of users that need scheduling is not greater than the number of sections where the users are located, scheduling one user to each section at most, adopting the proportional fairness principle when selecting the users in the sections, and allocating one transmitting sub-array of the base station and the corresponding optimal transmitting beam to the scheduled user. The scheme provided by the invention utilizes the spatial characteristics to carry out combined simulation on a beam training process, so that each sub-array of the base station allocates different transmitting beams to communicate with each user, and thus the system throughput is improved while the interference between the users is reduced, and the system performance is improved.

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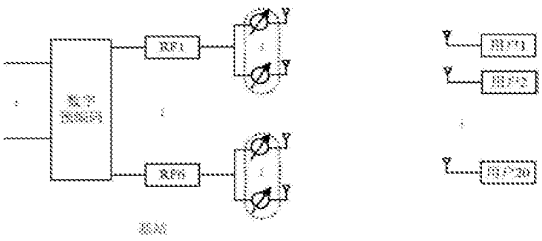
权利要求书2页 说明书4页 附图1页

(54)发明名称

一种利用空域位置特性的用户调度方法

(57)摘要

本发明公开了一种利用空域位置特性的用户调度方法，通过扇区级扫描将用户进行分组，如果所需调度用户数大于用户所在扇区数，首先基于比例公平原则从每个扇区内调度一个用户并确定分配的基站发射子阵列及其对应的最佳发射波束，然后依次用剩下的发射波束训练并基于比例公平算法选择其余用户；如果所需调度用户数不大于用户所在扇区数，那么，每个扇区最多调度一个用户，扇区内用户选择时采用比例公平算法，调度到的用户分配一个基站发射子阵列及其对应的最佳发射波束。本发明提供的方案利用空域特性，联合模拟波束训练过程，使得基站各子阵列分配不同的发射波束与各个用户通信，提高系统吞吐量的同时减小了用户间的干扰，改善了系统性能。



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1.一种利用空域位置特性的用户调度方法，其特征在于，具体包括两个阶段：

阶段一：用户分组：通过扇区级扫描将用户进行分组；

阶段二：用户调度：根据所需调度用户数和用户所在扇区数的关系确定具体调度方案，如果所需调度用户数大于用户所在扇区数，首先基于比例公平原则从每个扇区内调度一个用户并确定分配的基站发射子阵列及其对应的最佳发射波束，然后依次用剩下的发射波束训练并基于比例公平算法选择其余用户；如果所需调度用户数不大于用户所在扇区数，那么，每个扇区最多调度一个用户，扇区内用户选择时采用比例公平算法，调度到的用户分配一个基站发射子阵列及其对应的最佳发射波束。

2.根据权利要求1所述的利用空域位置特性的用户调度方法，其特征在于，所述阶段一进行用户分组的具体方法为：

基站把波束空间划分为S个扇区，通过扇区扫描确定每一个用户的扇区ID，并把在同一个扇区中的用户分为一组，待服务用户所在的扇区表示为$S_u=\{S_{u,1},S_{u,2},\cdots,S_{u,q}\}$，经分组的用户集合表示为$U=\{U_1,U_2,\cdots,U_q\}$，处于第k个扇区内的细波束集合表示为$B_k$，其中q($q\leqslant S$)表示待服务用户所在扇区的数量，$S_{u,k}$表示第k扇区，$U_k$表示第k扇区内待服务的用户集合。

3.根据权利要求2所述的利用空域位置特性的用户调度方法，其特征在于，所述阶段二在所需调度用户数M大于用户所在扇区数q时，进行用户调度的具体方法为：

步骤1：设置初始备选用户集合为$U=\{1,2,\cdots,K\}$，调度用户集合$U_s=\Phi$，已调度用户对应的最佳发射波束集合为$B_s=\Phi$，其中K($K\geqslant M$)表示待服务用户数；

步骤2：从扇区集合S_u中选择一个扇区$S_{u,k}$($S_{u,k}\in S_u$)，由基站未分配的一个发射子阵列使用该扇区内B_k集合中的各个细波束依次发射相同的信号，扇区$S_{u,k}$内的用户U_k同时接收信号，并根据接收信号质量反馈最好的性能指标和对应的基站子阵列最佳发射波束；

步骤3：根据反馈信息，选择调度优先级最高的用户i，并更新调度用户集合$U_s=U_s\cup\{i\}$，待服务的用户扇区集合$S_u=S_u-S_{u,k}$，已调度用户对应的最佳发射波束集合$B_s=B_s\cup b_i$；

步骤4：判断调度的用户数是否达到q，如果未达到，则跳转至步骤2开始调度其他用户；如果调度的用户数达到q，则跳转步骤5；

步骤5：从剩余未使用的发射子阵列中选择一个子阵列，依次使用各个扇区$S_{u,k}$(k=1,2,…,q)内细波束$B_k=B_k-\{b_{used}|b_{used}\in B_s\}$发射相同的信号，未被调度的用户同时接收信号，并根据接收信号质量反馈最好的性能指标和对应的基站最佳发射波束；

步骤6：基站根据反馈信息，选择调用优先级最高的用户i，并更新$U_s=U_s\cup\{i\}$，$B_s=B_s\cup b_i$；

步骤7：判断调度的用户数是否达到M，如果未达到，则跳转至步骤5开始调度其他用户；如果调度的用户数达到M，则停止遍历。

4.根据权利要求2所述的利用空域位置特性的用户调度方法，其特征在于，所述阶段二在所需调度用户数M不大于用户所在扇区数q时，进行用户调度的具体方法为：

步骤1：设置初始备选用户集合为$U=\{1,2,\cdots,K\}$，调度用户集合$U_s=\Phi$，已调度用户对应的最佳发射波束集合为$B_s=\Phi$，其中K($K\geqslant M$)表示待服务用户数；

步骤2：从扇区集合S_u中选择一个扇区$S_{u,k}$($S_{u,k}\in S_u$)，由基站未分配的一个发射子阵列使用该扇区内B_k集合中的各个细波束依次发射相同的信号，扇区$S_{u,k}$内的用户U_k同时接收信

号，并根据接收信号质量反馈最好的性能指标和对应的基站子阵列最佳发射波束；

步骤3：根据反馈信息，选择调度优先级最高的用户i，并更新调度用户集合$U_s=U_s\cup\{i\}$，待服务的用户扇区集合$S_u=S_u-S_{u,k}$，已调度用户对应的最佳发射波束集合$B_s=B_s\cup b_i$；

步骤4：判断调度的用户数是否达到M，如果未达到，则跳转至步骤2开始调度其他用户；如果调度的用户数达到M，则停止遍历。

5.根据权利要求3或4所述的利用空域位置特性的用户调度方法，其特征在于，确定优先级最高的用户的方法具体为：

$$\arg\max_i \frac{p_i(n)}{Q_i(n)} \qquad (1)$$

其中，$p_i(n)$表示用户i在时隙n的当前性能指标，$Q_i(n)$表示用户i在时隙n之前时间滑窗T内的平均性能指标，由下式得到：

$$Q_i(n)=\left(1-\frac{1}{T}\right)Q_i(n-1)+\frac{\mu}{T}p_i(n),\mu=\begin{cases}1, \text{在前一时隙获得调度}\\0, \text{在第一时隙未获得调度}\end{cases} \qquad (2)$$

其中，$Q_i(0)$设为1。

一种利用空域位置特性的用户调度方法

技术领域

[0001] 本发明涉及一种利用空域位置特性的用户调度方法，属于无线通信技术领域。

背景技术

[0002] 对于未来5G在传输速率和系统容量等方面的性能需求，大规模天线将是多输入多输出(Multiple-Input Multiple-Output，MIMO)技术继续演进的重要方向。毫米波由于其丰富的频谱资源成为5G无线通信系统中的一项关键技术。毫米波通信中，由于波长短便于实现大规模天线阵列，保证设备体积小且易于封装。当基站配备多个发射子阵列时可以定向并行传输多个数据流，提高系统吞吐量。

[0003] 对于多用户MIMO系统，基站将占用相同时频资源的多个数据流发送给不同的用户时，所能支持的用户数受基站发射子阵列数的限制。因此，当用户数较多时，基站同一时隙只能调度其中的一部分用户，合理的用户调度可以获得多用户分集增益(Multi-User Diversity，MUD)，实现通信资源的充分利用。

[0004] 比例公平用户调度算法综合考虑了用户的信道条件与用户之间的服务公平性，能够在系统吞吐量和服务公平性之间取得一定的折中，是目前采用较多的一种算法。在使用比例公平算法调度多个用户时，可以通过穷举算法同时选择多个用户以达到最优的性能，但是复杂度太高。而次优调度算法通常以贪婪的方式依次选择各个用户，复杂度相对减小。在现有的多用户调度算法中用户间的干扰主要通过数字预编码来解决。本发明利用空域特性联合模拟波束训练确定用户调度方案，由基站各发射子阵列采用不同的发射波束与各调度用户并行通信，从模拟域控制了用户间的干扰。

发明内容

[0005] 发明目的：考虑现有技术的不足，本发明提供一种利用空域特性的用户调度方法，联合模拟波束训练进行多用户调度，基于比例公平调度算法在一定程度上保证了用户的公平性，同时，基站各发射子阵列使用不同的发射波束与用户进行通信，减小了用户间的干扰，保证通信质量。

[0006] 技术方案：为了实现上述发明目的，本发明提出一种利用空域特性的用户调度方法，首先通过扇区级扫描将用户进行分组；然后根据所需调度用户数和用户所在扇区数的关系确定具体调度方案，如果所需调度用户数大于用户所在扇区数，首先基于比例公平原则从每个扇区内调度一个用户并确定分配的基站发射子阵列及其对应的最佳发射波束，然后依次用剩下的发射波束训练并基于比例公平算法选择其余用户；如果所需调度用户数不大于用户所在扇区数，那么，每个扇区最多调度一个用户，扇区内用户选择时采用比例公平算法，调度到的用户分配一个基站发射子阵列及其对应的最佳发射波束。

[0007] 对于MU-MIMO无线通信系统，基站配置M个发射子阵列，待服务用户数为K($K \geq M$)，调度M个用户进行通信的具体方法如下：

[0008] 阶段一：用户分组，具体方法为：

[0009] 基站把波束空间划分为S个扇区，通过扇区扫描确定每一个用户的扇区ID，并把在同一个扇区中的用户分为一组，待服务用户所在的扇区表示为$S_u=\{S_{u,1},S_{u,2},\cdots,S_{u,q}\}$，经分组的用户集合表示为$U=\{U_1,U_2,\cdots,U_q\}$，处于第k个扇区内的细波束集合表示为$B_k$，其中q($q\leq S$)表示待服务用户所在扇区的数量，$S_{u,k}$表示第k扇区，$U_k$表示第k扇区内待服务的用户集合；

[0010] 阶段二：用户调度，具体方法为：

[0011] 步骤1：设置初始备选用户集合为$U=\{1,2,\cdots,K\}$，调度用户集合$U_s=\Phi$，已调度用户对应的最佳发射波束集合为$B_s=\Phi$；

[0012] 步骤2：根据所需调度用户数M和用户所在扇区数q的关系，确定具体调度方案；

[0013] 方案1：所需调度用户数大于用户所在扇区数，即$M>q$，则执行如下步骤：

[0014] 2.1)从扇区集合S_u中选择一个扇区$S_{u,k}$($S_{u,k}\in S_u$)，由基站未分配的一个发射子阵列使用该扇区内B_k集合中的各个细波束依次发射相同的信号，扇区$S_{u,k}$内的用户U_k同时接收信号，并根据接收信号质量反馈最好的性能指标和对应的基站子阵列最佳发射波束；

[0015] 2.2)根据反馈信息，选择调度优先级最高的用户i，并更新调度用户集合$U_s=U_s\cup\{i\}$，待服务的用户扇区集合$S_u=S_u-S_{u,k}$，已调度用户对应的最佳发射波束集合$B_s=B_s\cup b_i$；

[0016] 优先级最高的用户由下式确定：

[0017] $$\arg\max_i \frac{p_i(n)}{Q_i(n)} \qquad (1)$$

[0018] 其中，$p_i(n)$表示用户i在时隙n的当前性能指标，$Q_i(n)$表示用户i在时隙n之前时间滑窗T内的平均性能指标，由下式得到：

[0019] $$Q_i(n)=\left(1-\frac{1}{T}\right)Q_i(n-1)+\frac{\mu}{T}p_i(n),\mu=\begin{cases}1, & \text{在前一时隙获得调度}\\ 0, & \text{在第一时隙未获得调度}\end{cases} \qquad (2)$$

[0020] 其中，$Q_i(0)$设为1。

[0021] 2.3)判断调度的用户数是否达到q，如果未达到，则跳转至2.1)开始调度其他用户；如果调度的用户数达到q，则跳转至2.4)；

[0022] 2.4)从剩余未使用的发射子阵列中选择一个子阵列，依次使用各个扇区$S_{u,k}$($k=1,2,\cdots,q$)内细波束$B_k=B_k-\{b_{used}|b_{used}\in B_s\}$发射相同的信号，未被调度的用户同时接收信号，并根据接收信号质量反馈最好的性能指标和对应的基站最佳发射波束；

[0023] 2.5)基站根据反馈信息，根据公式(1)选择调用优先级最高的用户i，并更新$U_s=U_s\cup\{i\}$，$B_s=B_s\cup b_i$；

[0024] 2.6)判断调度的用户数是否达到M，如果未达到，则跳转至2.4)开始调度其他用户；如果调度的用户数达到M，则停止遍历。

[0025] 方案2：所需调度户数不大于用户所在扇区数，即$M\leq q$，则循环执行方案1的2.1)至2.2)，直至调度用户数达到M。

[0026] 有益效果：与现有技术相比，本发明具有以下优点：通过扇区级扫描对用户进行分组，同一扇区内基于比例公平算法调度用户，在一定程度上保证了用户调度公平性；每个时隙调度与基站发射子阵列数相匹配的用户数，提高了系统的吞吐量；基站各发射子阵列采用不同的发射波束与各个已调度用户通信，减小了用户间的干扰，保证通信质量。

附图说明

[0027] 图1为本发明实施例中的无线通信系统示意图。

具体实施方式

[0028] 下面结合具体实施例进一步阐明本发明，应理解这些实施例仅用于说明本发明而不用于限制本发明的范围。在阅读了本发明之后，本领域技术人员对本发明的各种等价形式的修改均落于本申请所附权利要求所限定的范围。

[0029] 如图1所示的无线通信系统示意图，基站配置6个发射子阵列，待服务用户数为20，每个用户只有一根天线，同时调度6个用户进行通信。用户调度时，设置初始备选用户集合为$U=\{1,2,\cdots,20\}$，调度用户集合$U_s=\Phi$，其中Φ表示空集，备选用户所在扇区集合用S_u表示，已调度用户对应的最佳发射波束集合为$B_s=\Phi$。

[0030] 下文通过方案1和方案2具体阐述，利用空域特性的用户调度方法可分为两个阶段，用户分组和用户调度阶段。

[0031] 方案1：所需调度用户数大于用户所在扇区数的情况，具体步骤如下：

[0032] 阶段一：

[0033] 基站把波束空间划分为4个扇区。通过扇区扫描确定每一个用户的扇区ID，并把在同一个扇区中的用户分为一组。经扫描得到存在待服务用户的扇区数为4，把待服务用户所在的4个扇区表示为$S_u=\{S_{u,1},S_{u,2},S_{u,3},S_{u,4}\}$，将处于第k(k=1,2,3,4)个扇区$S_{u,k}$内的细波束集合定义为$B_k$。经分组的用户集合表示为$U=\{U_1,U_2,U_3,U_4\}$，其中$U_k$表示在第k(k=1,…,4)扇区$S_{u,k}$内待服务的用户。

[0034] 阶段二：

[0035] 步骤1：从S_u中选择一个扇区$S_{u,k}$($S_{u,k}\in S_u$)，由基站未分配的一个发射子阵列使用该扇区内B_k集合中的各个细波束依次发射相同的信号，扇区$S_{u,k}$内的用户U_k同时接收信号，每一个用户根据接收信号质量反馈最好的性能指标和对应的基站子阵列最佳发射波束。

[0036] 步骤2：根据反馈信息，选择调度优先级最高的用户i，并更新调度用户集合$U_s=U_s\cup\{i\}$，待服务的用户扇区集合$S_u=S_u-S_{u,k}$，已调度用户对应的最佳发射波束集合$B_s=B_s\cup b_i$；

[0037] 优先级最高的用户由下式确定：

[0038] $$\arg\max_i \frac{p_i(n)}{Q_i(n)} \qquad (1)$$

[0039] 其中，$p_i(n)$表示用户i在时隙n的当前性能指标，$Q_i(n)$表示用户i在时隙n之前时间滑窗T内的平均性能指标，由下式得到：

[0040] $$Q_i(n)=\left(1-\frac{1}{T}\right)Q_i(n-1)+\frac{\mu}{T}p_i(n),\ \mu=\begin{cases}1, & \text{在前一时隙获得调度}\\ 0, & \text{在第一时隙未获得调度}\end{cases} \qquad (2)$$

[0041] 其中，$Q_i(0)$设为1。

[0042] 步骤3：判断调度的用户数是否达到4，如果未达到，则跳转至步骤1开始调度其他用户；如果调度的用户数达到4，则跳转至步骤4；

[0043] 步骤4：从剩余未使用的发射子阵列中选择一个子阵列，依次使用各个扇区$S_{u,k}$(k＝1,2,3,4)内的细波束$B_k=B_k-\{b_{used}|b_{used}\in B_s\}$发射相同的信号，未被调度的用户同时接收信号，每一个用户根据接收信号质量反馈最好的性能指标和对应的基站最佳发射波束；

[0044] 步骤5：基站根据反馈信息，由公式(1)选择调用优先级最高的用户i，并更新$U_s=U_s\cup\{i\}$，$B_s=B_s\cup b_i$。

[0045] 步骤6：判断调度的用户数是否达到6，如果未达到，则继续从步骤5开始调度其他用户；如果调度的用户数达到6，则停止遍历。

[0046] 方案2：所需调度用户数不大于用户所在扇区数的情况，具体步骤如下：

[0047] 阶段一：

[0048] 基站把波束空间划分为8个扇区。通过扇区扫描确定每一个用户的扇区ID，并把在同一个扇区中的用户分为一组。经扫描得到存在待服务用户的扇区数为8，把待服务用户所在的8个扇区表示为$S_u=\{S_{u,1},S_{u,2},S_{u,3},S_{u,4},S_{u,5},S_{u,6},S_{u,7},S_{u,8}\}$，将处于第k(k＝1,2,3,4,5,6,7,8)个扇区$S_{u,k}$内的细波束集合定义为B_k。经分组的用户集合表示为$U=\{U_1,U_2,U_3,U_4,U_5,U_6,U_7,U_8\}$，其中$U_k$表示在第k(k＝1,2,3,4,5,6,7,8)扇区$S_{u,k}$内待服务的用户。

[0049] 阶段二：

[0050] 步骤1：从S_u中选择一个扇区$S_{u,k}$($S_{u,k}\in S_u$)，由基站未分配的一个发射子阵列使用该扇区内B_k集合中的各个细波束依次发射相同的信号，扇区$S_{u,k}$内的用户U_k同时接收信号，每一个用户根据接收信号质量反馈最好的性能指标和对应的基站子阵列最佳发射波束。

[0051] 步骤2：根据反馈信息，选择调度优先级最高的用户i，并更新调度用户集合$U_s=U_s\cup\{i\}$，待服务的用户扇区集合$S_u=S_u-S_{u,k}$，已调度用户对应的最佳发射波束集合$B_s=B_s\cup b_i$；

[0052] 优先级最高的用户由下式确定：

[0053] $$\arg\max_i \frac{p_i(n)}{Q_i(n)} \qquad (1)$$

[0054] 其中，$p_i(n)$表示用户i在时隙n的当前性能指标，$Q_i(n)$表示用户i在时隙n之前时间滑窗T内的平均性能指标，由下式得到：

[0055] $$Q_i(n)=\left(1-\frac{1}{T}\right)Q_i(n-1)+\frac{\mu}{T}p_i(n),\mu=\begin{cases}1,\text{在前一时隙获得调度}\\0,\text{在第一时隙未获得调度}\end{cases} \qquad (2)$$

[0056] 其中，$Q_i(0)$设为1。

[0057] 步骤3：判断调度的用户数是否达到6，如果未达到，则继续从步骤1开始调度其他用户，直到调度完6个用户。

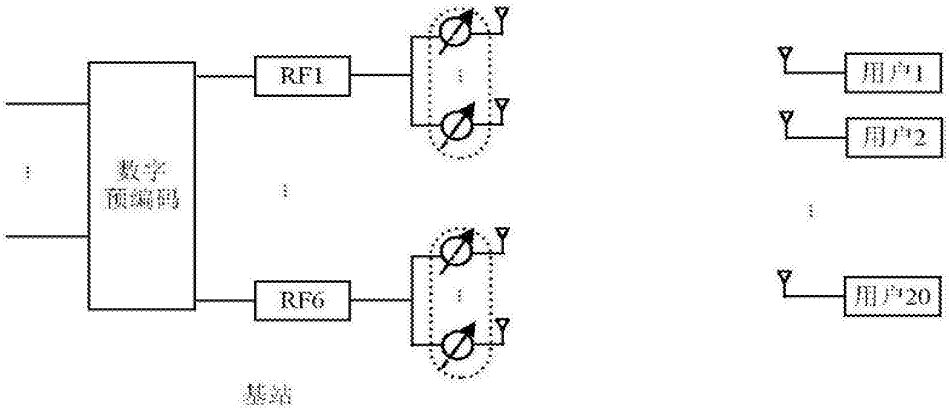


图1