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Paper 27
Date: October 1, 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.

IPR2023-00599 (Patent 10,912,081 B2)
IPR2023-00601, -00602 (Patent 10,568,113 B2)
IPR2023-00603 (Patent 10,944,527 B2)[1]

Before JOHN D. HAMANN, SEAN P. O'HANLON, 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 1002

I. INTRODUCTION

On September 11, 2024, with Board authorization, Petitioner and Patent Owner filed a joint motion to terminate the above-styled proceedings. Paper 25 ("Mot.").[2] Along with the motions, the parties filed a copy of a Confidential Settlement Agreement (Ex. 2007), as well as joint requests to treat the Confidential Settlement Agreement as business confidential information (Paper 26). *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 9. 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

[2] For convenience, this Order cites solely to the papers and exhibit in the IPR2023-00599 proceeding. Similar papers and exhibits have been filed in the other styled cases.

inter partes reviews. Paper 25, 1–3. Accordingly, in the circumstances present 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 patents. Paper 26, 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 files of the challenged patents, 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 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 is *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 is *denied*;

FURTHER ORDERED that the Confidential Settlement Agreement (Ex. 2007 in IPR2023–00599 and IPR2023-00603, and Ex. 2008 in IPR2023–00601 and IPR2023-00602) shall remain designated as "Parties and Board Only" in the Board's electronic filing system, be kept separate from the files of the involved patents, 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 IPR2023-00599, IPR2023-00601, IPR2023-00602, and IPR2023-00603 are *terminated*.

IPR2023-00599 (Patent 10,912,081 B2)
IPR2023-00601, -00602 (Patent 10,568,113 B2)
IPR2023-00603 (Patent 10,944,527 B2)

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135

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
Xiaobo ZHANG	Group Art Unit: 2477
Application No.: 15/972,167	Examiner: RANDHAWA
Patent No. 10,912,081	Confirmation No.: 3699
Filed: May 6, 2018	

For: METHOD AND DEVICE USED FOR WIRELESS COMMUNICATION IN UE AND BASE STATION

Maintenance Fee
Director of the United States
Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

ASSERTION OF REGULAR (UNDISCOUNTED) ENTITY STATUS AND PARTIAL PAYMENT

Dear Sir/Madam:

Applicant respectfully requests a change of Applicant's status to Regular Entity and a partial payment of maintenance fees for the above-identified Patent. On March 12, 2024, the 3.5 year maintenance fees were paid at the Small Entity rate of $800. Applicant submits that at the time of payment it was, and currently is, a Large Entity. Applicant is hereby paying the partial fees in the amount of the $1200.00 for the difference.

Attorney Docket No. ZL0205-0005-US

Respectfully submitted,

Dated: 8 May 2024

By: /Jialin Zhong/
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PAGE 2/5 * RCVD AT 6/24/2024 9:02:45 PM [Eastern Daylight Time] * SVR:W-PTOFAX-DTS-E1/17 * DNIS:2736500 * CSID:19083798782 * ANI:3122421052 * DURATION (mm-ss):03-05

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, Virginia 22313-1450
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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
15/972,167	05/06/2018	Xiaobo ZHANG	ZL0205-0005-US	210286

The entity status change request below filed through Patent Center on 05/05/2024 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 9
Date: October 20, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

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APEX BEAM TECHNOLOGIES LLC,
Patent Owner.

IPR2023-00599
Patent 10,912,081 B2

Before JOHN D. HAMANN, SEAN P. O'HANLON, and SCOTT RAEVSKY, *Administrative Patent Judges*.

HAMANN, 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 for *inter partes* review of claims 1–12 of U.S. Patent No. 10,912,081 B2 (Ex. 1001, "the '081 patent"). Paper 1 ("Pet."). Apex Beam Technologies LLC ("Patent Owner") filed a Preliminary Response. Paper 7 ("Prelim. Resp.").

We have authority to determine whether to institute an *inter partes* review under 35 U.S.C. § 314 (2018) and 37 C.F.R. § 42.4(a) (2022). An *inter partes* review may be instituted if "the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314(a).

Upon consideration of the papers, we determine that the information presented in the Petition demonstrates that there is a reasonable likelihood that Petitioner would prevail in establishing the unpatentability of at least one challenged claim of the '081 patent.

A. Real Parties-In-Interest

The parties identify themselves as the real parties-in-interest. Pet. 85; Paper 5, 2.

B. Related Matters

The parties identify *Apex Beam Technologies LLC v. Samsung Electronics Co.*, No. 2:22-cv-00188 (E.D. Tex.) ("the related district court litigation"); *Apex Beam Technologies LLC v. ZTE Corp.*, No. 2:22-cv-00031 (E.D. Tex.); *Apex Beam Technologies LLC v. OnePlus Technology (Shenzhen) Co.*, No. 2:22-cv-00032 (E.D. Tex.); and *Apex Beam*

Technologies LLC v. TCT Mobile Int'l Ltd., No. 2:21-cv-00438 (E.D. Tex.) as matters that may affect, or be affected by, a decision in this proceeding. Pet. 85; Paper 5, 3.

C. *The '081 Patent*

The '081 patent "relates to transmission schemes of radio signals in wireless communication systems, and in particular to . . . multi-antenna transmission." Ex. 1001, 1:17–20. As background, the '081 patent explains that in Massive Multi-Input Multi-Output (MIMO), "multiple antennas experience beamforming to form a relatively narrow beam which points to a particular direction to improve the quality of communication." *Id.* at 1:26–29. According to the '081 patent, others previously proposed "to increase the robustness of transmission [by] using a relatively wide beam transmitting Physical Downlink Control Channel (PDCCH) and to increase the Signal-to-Noise Ratio (SNR) using a relatively narrow beam transmitting Physical Downlink Shared Channel (PDSCH)." *Id.* at 1:34–39. The '081 patent adds that it was also previously proposed "to use the PDCCH to cross-slot indicate the transmission beam of the PDSCH, so as to solve the problem of delay between a User Equipment (UE) acquiring the transmission beam of the PDSCH from the PDCCH and conducting PDSCH receiving using the beam information indicated by the PDCCH." *Id.* at 1:39–45.

According to the '081 patent, however, "cross-slot beam indication would result in reduction of dynamic of beam information, increase of overhead of control signaling, reduction of dynamic of scheduling, and other problems." *Id.* at 1:49–53. For example, "[a] UE with high processing capacity can decode the PDCCH in a short time to obtain beam information

that is used for receiving the PDSCH that is in the time slot of the PDCCH, and adjust a receiving beam to receive a multicarrier symbol in which the PDSCH is located." *Id.* at 1:53–58. "However, the delay in PDSCH transmission caused by decoding PDCCH would result in underutilization of system resources," according to the '081 patent. *Id.* at 1:58–60.

In response, the '081 patent discloses embodiments that address these problems. *Id.* at 1:61–62. The '081 patent discloses for one such embodiment that "if the time-domain resource occupied by [a] given multicarrier symbol is before [a] first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal," which "is advantageous in that the delay in the receiving of the first radio signal resulted from the delay in the decoding of the second radio signal is avoided." *Id.* at 4:19–23, 4:27–31. Put differently, the '081 patent discloses that "the PDSCH receives the multicarrier symbol of the PDSCH before the first time point using the same beam used for receiving the PDCCH, thereby avoiding the problem of the delay in PDSCH transmission resulted from the delay in PDCCH decoding." *Id.* at 4:32–37.

Figure 7, shown below, illustrates an embodiment of the '081 patent.

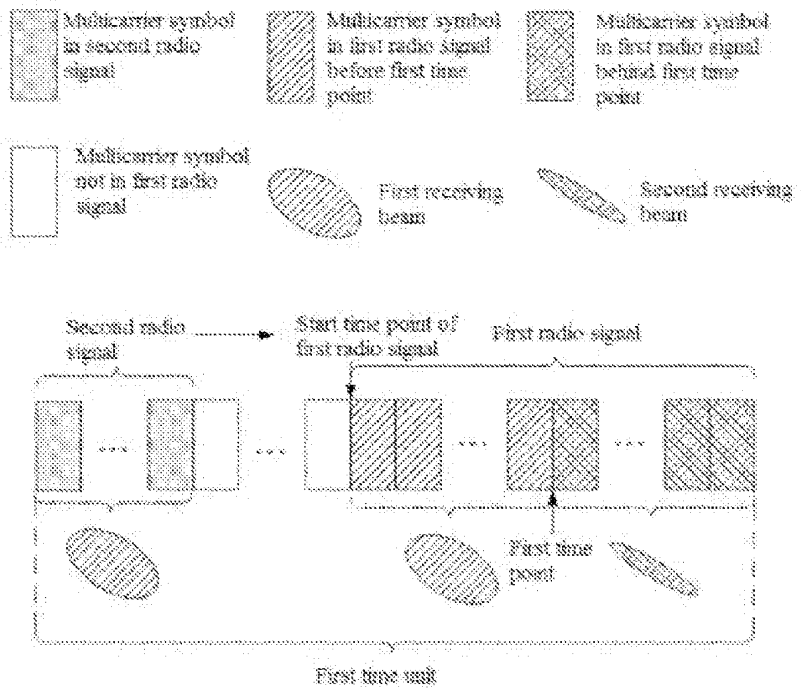


FIG. 7

Figure 7 "is a diagram illustrating a second radio signal and a first radio signal according to one embodiment of the" '081 patent. *Id.* at 9:35–37. As illustrated, "[g]rey rectangles represent multicarrier symbols in the second radio signal, rectangles filled by oblique lines represent multicarrier symbols in the first radio signal before the first time point, rectangles filled by cross lines represent multicarrier symbols in the first radio signal behind the first time point, blank rectangles represent multicarrier symbols not in the first radio signal, a wide oval filled by oblique lines represents a first receiving beam, and a narrow oval filled by cross lines represents a second receiving beam." *Id.* at 17:58–67.

As illustrated, "both the first radio signal and the second radio signal are transmitted within the first time unit, [and] the multicarrier symbols

occupied by the second radio signal are before the multicarrier symbols occupied by the first radio signal in [the] time domain." *Id.* at 18:1–5. Also as illustrated, "the first receiving beam is used for receiving the second radio signal and the multicarrier symbols of the first radio signal before the first time point, and the second receiving beam is used for receiving the multicarrier symbols of the first radio signal behind the first time point." *Id.* at 18:13–18.

The '081 patent explains that "the second radio signal indicates the start time point of the first radio signal in the first time unit, and the start time point is used for determining the time domain resource occupied by the first radio signal in the first time unit." *Id.* at 18:6–10. The '081 patent explains that "[t]he first time point is one time point within the first time unit behind the multicarrier symbols occupied by the second radio signal." *Id.* at 18:10–12.

In addition, the '081 patent discloses that for a subembodiment that "the second radio signal is a PDCCH, and the first radio signal is a PDSCH." *Id.* at 18:19–20. The '081 patent also discloses that for a subembodiment "the second radio signal is a DCI that is used for indicating downlink assignment, and the first radio signal is a PDSCH transmitted on the downlink resource indicated by the second radio signal." *Id.* at 18:21–24.

D. Illustrative Claim

Of the challenged claims, claims 1, 5, 9, and 11 are independent. Claim 1 is illustrative of the challenged claims and is reproduced below.

> 1. A method in a User Equipment (UE) for wireless communication, comprising:
>
> receiving a second radio signal;
>
> receiving a first radio signal;

> wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

Ex. 1001, 21:5–31.

E. Asserted Grounds of Unpatentability

Petitioner asserts that the challenged claims of the '081 patent are unpatentable based on the following grounds:

Claim(s) Challenged	35 U.S.C. §[1]	Reference(s)
1–12	102	Lee[2]
1–12	103	Chen,[3] Lee

[1] The Leahy-Smith America Invents Act ("AIA") included revisions to 35 U.S.C. §§ 102, 103 that became effective on March 16, 2013. Because the earliest possible effective filing date of the '081 patent is after March 16, 2013, we apply the AIA version of these bases for unpatentability.
[2] WO 2017/083489 A1, published May 18, 2017 (Ex. 1004, "Lee").
[3] WO 2018/201861 A1, published Nov. 8, 2018 (Ex. 1012, "Chen").

Pet. 13–83. Petitioner submits in support of its arguments the Declaration of Apostolos K. Kakaes, Ph.D. (Ex. 1002).

II. DISCRETIONARY DENIAL UNDER 35 U.S.C. § 314

Patent Owner argues that we should exercise discretion under § 314(a) to deny institution in light of the related district court litigation. Prelim. Resp. 40–47.

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 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 IPR2023-00599], 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. 1022, 1 (quoting *Sotera Wireless, Inc.*, Paper 12 at 13–14) (alterations in original).

We determine that the language of this stipulation sufficiently comports with the language of the stipulation discussed in the Director's Memo. *See* Director's Memo 3. We accordingly decline to discretionarily deny institution in view of the related district court litigation.

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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).

III. PETITIONER'S EXPERT DECLARATION

Relying on the Board's precedential *Xerox* decision, Patent Owner argues that we should not consider Dr. Kakaes's declaration because it "is almost entirely a recitation of the Petition." Prelim. Resp. 47–48 (citing *Xerox Corp. v. Bytemar, Inc.*, IPR2022-00624, Paper 9 (PTAB Aug. 24, 2022) (precedential); 37 C.F.R. § 42.65(a)). Patent Owner argues that "[b]ecause Dr. Kakaes barely provides any 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 repeated within the Petition. Rather, *Xerox* found a declaration was entitled to little weight where the declaration merely repeated "the *conclusory* assertion for which it is offered to support." *Xerox*, Paper 9 at 15 (emphasis added). If declaration testimony is supported sufficiently and, in turn, supports contentions in the Petition, we do not give it little to no weight simply because it is repeated in the Petition. Patent Owner does not point to any specific statements in Dr. Kakaes's declaration and explain specifically why Patent Owner believes they are conclusory, and thus, Patent Owner has not sufficiently explained the applicability of *Xerox* here. *See, e.g.*, Prelim. Resp. 13 n.1, 18 n.2, 21 n.3, 23 n.4, 25 n.5, 28 n.6, 29 n.7, 47–48.

Moreover, we can assess the weight to be given to Dr. Kakaes's declaration testimony, including based on its corresponding factual support, if any, and afford such testimony an appropriate weight. Accordingly, at this

stage, we decline Patent Owner's invitation to assign no weight to all of Dr. Kakaes's declaration testimony.

IV. LEVEL OF ORDINARY SKILL IN THE ART

To determine whether an invention would have been obvious at the time it was made, we consider the level of ordinary skill in the pertinent art at the time of the invention. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). In assessing the level of ordinary skill in the art, various factors may be considered, including the "type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field." *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (citing *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 962–63 (Fed. Cir. 1986)). "[O]ne or more factors may predominate." *Id.*

Petitioner argues that one of ordinary skill in the art at the time of the invention of the '081 patent "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." Pet. 13 (quoting Ex. 1002 ¶ 75). Petitioner adds that "[a]dditional relevant work experience can compensate for less education, and *vice versa*." *Id.*

Patent Owner at this stage of the proceeding does not provide an alternative definition for a level of skill in the art that one would have had at the time of the invention of the '081 patent or identify any shortcoming in Petitioner's formulation. *See* Prelim. Resp. 10.

For purposes of this Decision on Institution, we adopt Petitioner's definition of the level of skill for one of ordinary skill in the art, except we

decline to adopt the recitals of "at least" as that language is vague and open-ended. Pet. 13. We also decline to adopt Petitioner's assertion concerning "[a]dditional relevant work experience," as it also is vague and open-ended. As adopted, we view the definition for the level of ordinary skill is consistent with the '081 patent and the asserted prior art, and we apply it in our analysis below.

V. CLAIM CONSTRUCTION

Because the Petition was filed after November 13, 2018, we apply the same claim construction standard that would be used in a civil action under 35 U.S.C. § 282(b), following the standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). 37 C.F.R. § 42.100(b); 83 Fed. Reg. 51,340, 51,340–41, 51,343 (Oct. 11, 2018). In applying such standard, claim terms are generally given their ordinary and customary meaning, as would be understood by a person of ordinary skill in the art, at the time of the invention and in the context of the entire patent disclosure. *Phillips*, 415 F.3d at 1312–13. "In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17).

Petitioner argues that "no terms need construction to resolve the controversy in this forum." Pet. 11. Patent Owner argues that at this stage of the proceeding, "claim construction is not required to resolve any issues." Prelim. Resp. 10.

We determine that no express constructions are needed for us to render our Decision on Institution. *See, e.g.*, *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)) ("[W]e need only construe terms 'that are in controversy, and only to the extent necessary to resolve the controversy.'"). Rather, at this stage of the proceeding, we apply the plain and ordinary meaning of the claim terms.

VI. PRINCIPLES OF LAW

A claim is unpatentable under 35 U.S.C. § 102 "if each and every [claim] limitation is found either expressly or inherently in a single prior art reference." *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 851 F.3d 1270, 1273 (Fed. Cir. 2017). "A claim limitation is inherent in the prior art if it is necessarily present in the prior art, not merely probably or possibly present." *Akamai Techs., Inc. v. Cable & Wireless Internet Servs., Inc.*, 344 F.3d 1186, 1192 (Fed. Cir. 2003) (citing *Rosco, Inc. v. Mirror Lite, Co.*, 304 F.3d 1373, 1380 (Fed. Cir. 2002)).

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence

of non-obviousness, if present.[6] *See Graham*, 383 U.S. at 17–18. When evaluating a claim for obviousness, we also must "determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue." *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

VII. ALLEGED ANTICIPATION BY LEE

Petitioner argues that Lee anticipates claims 1–12. Pet. 13–83. We have reviewed the parties' arguments and the evidence of record. For the reasons that follow, we determine that Petitioner demonstrates a reasonable likelihood that it would prevail in showing that Lee anticipates at least one of these claims.

A. Summary of Lee

Lee discloses "[a] wireless transmit/receive unit (WTRU) configured to perform wireless communications in higher frequency bands (e.g., above 6 GHz) using a fallback." Ex. 1004, code (57). Lee's "WTRU includes a receiver configured to receive, in a time transmission interval (TTI), at least one control signal and a first data signal using a first beam associated with a first beam identifier (ID) and a second data signal, subsequent to the first data signal, using a second beam associated with a second beam ID different from the first beam ID, such that one of the at least one control signal indicates the second beam ID." *Id.* In addition, Lee discloses "a processor configured to switch a receive beam of the receiver from the first beam to the second beam based on the second beam ID to receive the second data signal." *Id.*

[6] Patent Owner does not present arguments or evidence of such objective evidence of non-obviousness. *See generally* Prelim. Resp.

B. Challenged Claim 1

1. Method for Wireless Communication (Preamble)

Claim 1's preamble recites "[a] method in a User Equipment (UE) for wireless communication." Ex. 1001, 21:5–6. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses claim 1's preamble. Pet. 13–15.

More specifically, we find that Lee discloses a wireless communication system 100 that includes "wireless transmit/receive units (WTRUs) 102a, 102b, 102c, 102d." Ex. 1004 ¶ 40, Fig. 1A. Lee discloses that the WTRUs "may be configured to transmit and/or receive wireless signals and may include user equipment (UE)." *Id.* ¶ 40. In addition, Lee discloses that wireless communications system 100 includes "a base station 114a and a base station 114b," which each "may be any type of device configured to wirelessly interface with at least one of the WTRUs." *Id.* ¶ 41.

After reviewing Petitioner's arguments and evidence, which are not addressed by Patent Owner at this stage of the proceeding, we are persuaded that Petitioner demonstrates, for purposes of this institution decision, that Lee discloses "[a] method in a User Equipment (UE) for wireless communication." In light of our finding, we need not, and thus do not, reach whether claim 1's preamble is limiting.

2. Receiving a Second Radio Signal

Claim 1 further recites "receiving a second radio signal." Ex. 1001, 21:7. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 15–16.

In particular, at this stage, we agree with Petitioner and find that Lee discloses that a WTRU (i.e., UE) receives control data (e.g., downlink (DL)

control information (DCI)) via a control channel. Ex. 1004 ¶¶ 167–168. We also agree with Petitioner and find that Lee interchangeability uses the terms (i) channel and signal, and (ii) control channel and PDCCH. *Id.* ¶ 86. And the '081 patent states that the second radio signal can be "a PDCCH" or "a DCI carrying downlink assignment." Ex. 1001, 3:59, 4:1–2.

In addition, at this stage, we agree with Petitioner and find that Lee's Figure 12 illustrates the received control data (i.e., the second signal). Pet. 15–16. Figure 12, as annotated by Petitioner, is shown below.

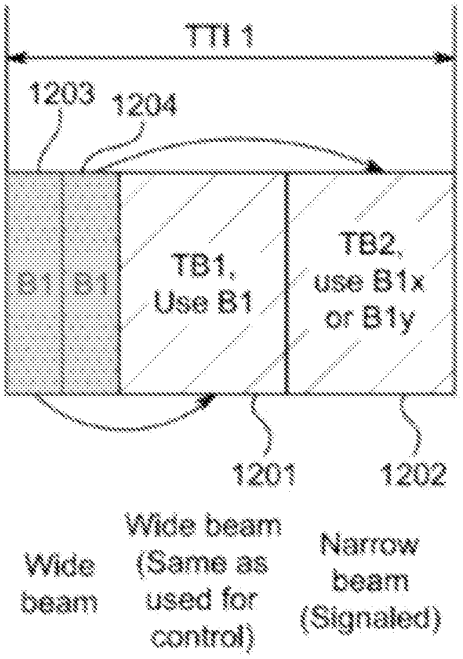


Figure 12 "shows a diagram for a dual transport block (TB) transmission scheme according to one or more [of Lee's] embodiments." Ex. 1004 ¶ 26. Petitioner annotates the figure by coloring in blue "control data B1" blocks 1203 and 1204, which together correspond to the second signal. *See* Pet. 15–16 (annotating Ex. 1004, Fig. 12); Ex. 1004 ¶¶ 168–169, Fig. 12.

At this stage, we find unavailing Patent Owner's arguments that Lee "fails to disclose 'receiving a second radio signal' because B1 1203 and B1

1204 are two separate control signals and cannot collectively be the claimed 'second radio signal.'" Prelim. Resp. 13–18. In particular, at this stage, we disagree with Patent Owner that these two control data signals together cannot disclose the claimed second radio signal. Rather, at this stage, we conclude that the '081 patent uses the term "signal" broadly, including when describing signals (e.g., comprising symbols) at the physical layer. *See, e.g.*, Ex. 1001, 12:1–4 (disclosing that "layer 1 (Ll) 301 is the lowest layer and performs signal processing functions of each PHY layer"), Fig. 3 (showing the layers for the control and user planes). And, at this stage, we conclude that the claimed second signal being a "radio" signal connotes the physical layer. In fact, the '081 patent discloses that "the second radio signal . . . is generated by the PHY 301" for some embodiments. *Id.* at 12:49–50. Thus, we find that the claimed second radio signal covers signals having multiple portions (e.g., symbols).

This conclusion is consistent with Figure 7 of the '081 patent which illustrates that the second radio signal can comprise a stream of multicarrier symbols. *See id.* at Fig. 7 (showing for the second radio signal a stream of multicarrier symbols); *see also id.* at 17:58–60 ("Grey rectangles represent multicarrier symbols in the second radio signal" in Figure 7.).

We find unavailing Patent Owner's argument that Figure 7 shows that "the second signal only has one multi-carrier symbol," in contrast to the first radio signal which "can comprise different multi-carrier symbols." Prelim. Resp. 16–17 (citing Ex. 1001, Fig. 7). On this record, we find that this argument is incorrect. *See* Ex. 1004, 17:57–67 (describing Figure 7), Fig. 7. Notably, Patent Owner does not address why a *stream* of symbols would be sent for the second radio signal, if the symbol remains the same. Prelim.

Resp. 16–17. Moreover, the fill lines for the symbol rectangles for the first radio signal change between the two illustrated patterns to denote whether the symbols are before or behind the first time point, rather than to denote that "the first radio signal . . . can comprise different multi-carrier symbols," as Patent Owner argues. *Compare* Ex. 1001, 17:57–67 *and* Fig. 7, *with* Prelim. Resp. 16–17. Notably, Patent Owner does not address how to communicate effectively with only two different symbols if that is what the two different patterns actually represented. Prelim. Resp. 16–17.

And at this stage, we view Lee's disclosure of consecutive control signals B1 1203 and B1 1204 as being consistent with a stream of symbols for a radio signal, especially when considering the control signals at that layer. *Compare* Ex. 1004, Fig. 12, *with* Ex. 1001, Fig. 7; *see generally* Ex. 1001, 11:59–12:41, Fig. 3 (describing radio and control plane layers), 14:34–38. Hence, we agree with Petitioner that "[t]he '081 patent does not preclude the 'second radio signal' from having multiple portions." Pet. 16; Ex. 1002 ¶ 83.

In sum, at this stage, we find that Lee discloses "receiving a second radio signal." To the extent that a dispute remains concerning the scope of "second radio signal," the parties during trial should fully develop the record for claim construction purposes, in accordance with our Rules.

3. Receiving a First Radio Signal

Claim 1 further recites "receiving a first radio signal." Ex. 1001, 21:8. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 16–19.

In particular, at this stage, we agree with Petitioner and find that Lee discloses that the WTRU receives two transport blocks TB1 and TB2 (i.e.,

the first signal) that carry data. Ex. 1004 ¶¶ 110, 167–168. We also agree with Petitioner and find that Lee interchangeability uses the terms data, data signal, data channel, data channel beam, and PDSCH. *Id.* ¶ 86. And the '081 patent states that the first radio signal can be "a PDSCH." *E.g.*, Ex. 1001, 8:19–20.

In addition, at this stage, we agree with Petitioner and find that Lee's Figure 12 illustrates the received transport blocks (i.e., the first signal). Pet. 17. Figure 12, as annotated by Petitioner, is shown below.

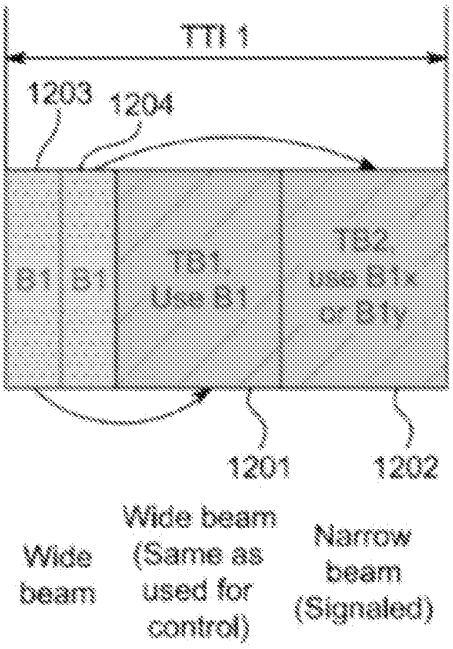


Figure 12 "shows a diagram for a dual transport block (TB) transmission scheme according to one or more [of Lee's] embodiments." Ex. 1004 ¶ 26. Petitioner annotates the figure by, *inter alia*, coloring in green transport blocks TB1 1201 and TB2 1202, which together correspond to the first signal. *See* Pet. 17 (annotating Ex. 1004, Fig. 12); Ex. 1004 ¶¶ 167–169, Fig. 12.

At this stage, we find unavailing Patent Owner's arguments that Lee's TB1 and TB2 are separate signals, and thus, Lee does not disclose that TB1 and TB2 comprise one radio signal. Prelim. Resp. 18–20. For the same reasons we discuss above concerning the second radio signal, at this stage we conclude that the '081 patent uses the term "signal" broadly, including when describing a "radio" signal, which comprises "G multicarrier symbols." *See supra* Section VII.B.2; Ex. 1001, 21:11–12, 21:31.

And at this stage, we view Lee's disclosure of consecutive transport blocks TB1 and TB2 as being consistent with a stream of symbols at the physical layer for a radio signal. *Compare* Ex. 1004, Fig. 12, *with* Ex. 1001, Fig. 7. Hence, we agree with Petitioner that the '081 patent does not preclude the first radio signal from having multiple portions. Pet. 18.

In sum, at this stage, we find that Lee discloses "receiving a first radio signal." To the extent that a dispute remains concerning the scope of "first radio signal," the parties during trial should fully develop the record for claim construction purposes, in accordance with our Rules.

4. Transmitted Within a First Time Unit

Claim 1 further recites "wherein the first radio signal is transmitted within a first time unit." Ex. 1001, 21:9–10. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 19–20.

In particular, at this stage, we agree with Petitioner and find that Lee discloses that transport blocks TB1 1201 and TB2 1202 (i.e., first radio signal) are transmitted within a single transmission time interval (TTI) (i.e., first time unit). Ex. 1004 ¶¶ 6, 167; Ex. 1002 ¶ 88. Moreover, Lee's Figure 12, as shown above, illustrates that transport blocks 1201 and 1202 are

"transmitted (multiplexed) in a TDM fashion within a single TTI (e.g., TTI1)." Ex. 1004 ¶ 167, Fig. 12 (showing that TB1 and TB2 are within TTI1).

At this stage, we find unavailing Patent Owner's arguments that Lee fails to disclose this limitation. Prelim. Resp. 20–22. These arguments are premised on Lee failing to disclose the claimed first and second radio signals. *Id.* As we find above, however, at this stage, we find that Lee discloses the claimed first and second radio signals. *See supra* Sections VII.B.2–3. Thus, Patent Owner's arguments regarding this limitation are unavailing.

In sum, at this stage, we find that Lee discloses "wherein the first radio signal is transmitted within a first time unit."

5. First Bit Block

Claim 1 further recites "a first bit block is used for generating the first radio signal." Ex. 1001, 21:10–11. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 20–21.

In particular, at this stage, we agree with Petitioner and find that Lee discloses that a Medium Access Control (MAC) Protocol Data Unit (PDU) (i.e., first bit block) is used to generate transport blocks TB1 and TB2 (i.e., first radio signal). Ex. 1004 ¶¶ 110, 224–230, Figs. 13–14; Ex. 1002 ¶¶ 90–92. To that end, Lee discloses that "[a] physical downlink data channel may carry payload information in the form of" a MAC PDU from the MAC layer. Ex. 1004 ¶ 110. And at this stage, we find persuasive Dr. Kakaes's testimony that it was well known that a MAC PDU is a bit block. Ex. 1002 ¶ 91 (citing Ex. 1008, 49); *see also* Ex. 1008, 49 ("A MAC PDU is a bit string that is byte aligned (i.e. multiple of 8 bits) in length.").

In addition, at this stage, we agree with Petitioner and find that Lee's Figure 13 illustrates that a MAC PDU is used for generating the first signal (i.e., TB1 and TB2). Pet. 20–21. Figure 13, as annotated by Petitioner, is shown below.

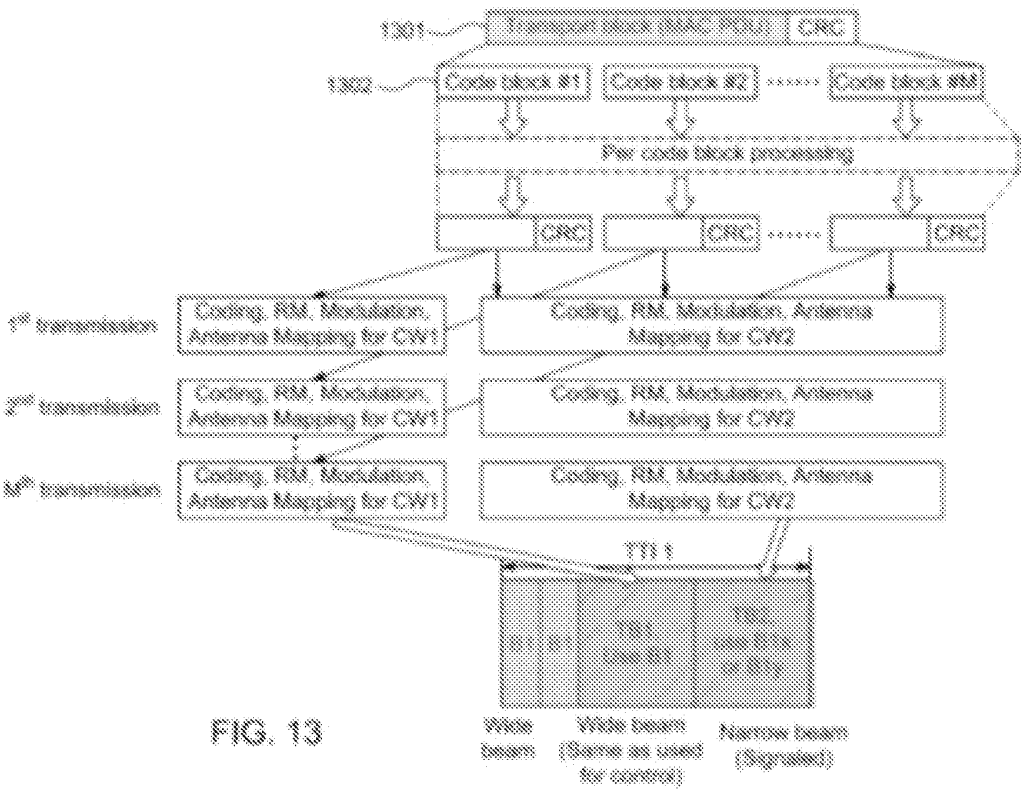


FIG. 13

Figure 13 "shows a diagram illustrating a use of a dual TB transmission scheme for data fallback according to one or more embodiments." Ex. 1004 ¶ 27. Petitioner annotates the figure by coloring (i) in orange Transport Block (MAC PDU) 1301, (ii) in blue control data B1 blocks, and (iii) in green transport blocks TB1 and TB2. *See* Pet. 21 (annotating Ex. 1004, Fig. 13). As illustrated, MAC PDU 1301 comprises M code blocks. Ex. 1004 ¶ 224, Fig. 13. Lee discloses that the code blocks may be used to transmit codewords—"a codeword represents user data before it is formatted for transmission." *Id.* ¶¶ 169, 224. Moreover, as illustrated, Lee discloses

that "a wide data Tx beam B1 may be used for transmitting TBl (i.e., first codeword) of a transmission and a narrow data Tx beam B1x or B1y may be used for transmitting TB2 (i.e., second codeword)." *Id.* ¶ 224.

At this stage, we find unavailing Patent Owner's argument that "Petitioner's annotated Fig. 13 itself shows how Lee's transport block (MAC PDU) generates two different signals (i.e., TB1 and TB2) from two different code blocks and two different code words (CW)." Prelim. Resp. 23; *see also id.* at 24 (making same argument). Again, as we discuss above, at this stage, we find that Lee's disclosure of TB1 and TB2 discloses the first radio signal. *See supra* Section VII.B.3. Moreover, at this stage, we find that a single MAC PDU is used for both TB1 and TB2. Ex. 1004 ¶¶ 169, 224, Fig. 13.

In sum, we find that Lee discloses "a first bit block is used for generating the first radio signal."

6. G Multicarrier Symbols

Claim 1 further recites that "the first radio signal comprises G multicarrier symbols," where "G is a positive integer." Ex. 1001, 21:11–12, 21:31. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses these limitations. Pet. 22–23, 33.

In particular, at this stage, we find that Lee's transport blocks TB1 and TB2 (i.e., first radio signal) comprise a number (i.e., G) of orthogonal frequency-division multiplexing (OFDM) symbols (i.e., multicarrier symbols). *See* Ex. 1004 ¶¶ 91, 95, Fig. 2; Ex. 1002 ¶¶ 93–96. At this stage, we also find that Lee's TTI includes a positive integer number of OFDM symbols, and that it was known in the art that OFDM symbols are designed such that a TTI includes an integer number of OFDM symbols. Ex. 1002 ¶ 95; Ex. 1006, 18.

In addition, Lee further discloses that a "'data region' may be part of the scheduling interval in time domain, which may be referred to in *units* of OFDM symbols, used for the transmission of all data channel beams in that scheduling interval." Ex. 1004 ¶ 79 (emphasis added). At this stage, we view "units" here as disclosing that there are a positive integer number of OFDM symbols in each TTI. *Id.*

After reviewing Petitioner's arguments and evidence, which are not addressed by Patent Owner at this stage of the proceeding, we are persuaded that Petitioner demonstrates, for purposes of this institution decision, that Lee discloses that "the first radio signal comprises G multicarrier symbols," where "G is a positive integer."

7. Second Radio Signal Within First Time Unit

Claim 1 further recites that "the second radio signal is transmitted within the first time unit." Ex. 1001, 21:12–13. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 24.

In particular, at this stage, we find that Lee discloses that its control data B1 blocks 1203 and 1204 (i.e., second radio signal) are transmitted within the same first time unit (i.e., TTI1) as transport blocks TB1 and TB2. Ex. 1004 ¶¶ 167–169, Fig. 12; Ex. 1002 ¶ 97.

At this stage, we find unavailing Patent Owner's arguments that Lee fails to disclose this limitation. Prelim. Resp. 20–22. These arguments are premised on Lee failing to disclose the claimed first and second radio signals. *Id.* As we find above, however, at this stage, we find that Lee discloses the claimed first and second radio signals. *See supra* Sections

VII.B.2–3. Thus, Patent Owner's arguments regarding this limitation are unavailing.

In sum, at this stage, we find that Lee discloses that "the second radio signal is transmitted within the first time unit."

8. Second Radio Signal Determining a Time-Domain Resource

Claim 1 further recites that "the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols." Ex. 1001, 21:13–15. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 24–26.

In particular, at this stage, we find that Lee discloses that control data B1 blocks (i.e., the second radio signal) are used for determining a time-domain resource occupied by transport blocks TB1 and TB2 (the first radio signal), which comprise G multicarrier symbols. *See supra* Sections VII.B.2, 4, 6; Ex. 1002 ¶¶ 98–100. For example, Lee discloses that "[a] physical downlink control channel may carry data related control information to identify, demodulate and decode the associated data channel properly." Ex. 1004 ¶ 109. Lee adds that "[t]he resource allocation of th[e physical downlink data] channel may be carried in the scheduling information in the physical downlink control channel." *Id.* ¶ 110. And at this stage, we find persuasive the testimony of Dr. Kakaes that one of ordinary skill in the art "would have understood that *Lee*'s scheduling information and time/frequency information included in the control channel would have included the time-domain resource allocation for the multicarrier symbols in the data channel (e.g., transport blocks TB1 and TB2)," and we find this testimony is consistent with Lee's disclosure. *See* Ex. 1002 ¶ 100; Ex. 1004 ¶¶ 109–110, Fig. 12.

At this stage, we find unavailing Patent Owner's argument that Lee's disclosure of "scheduling information in the physical downlink control channel" provides no indication of "determining a time-domain resource occupied by the G multicarrier symbols" of the first data signal. Prelim. Resp. 26 (citing Ex. 1004 ¶ 110). Lee explicitly discloses that this scheduling information relates to the resource allocation for the physical downlink data channel, which as we find above carries the first radio signal which comprises G multicarrier symbols. *See* Ex. 1004 ¶¶ 109–110; *supra* Section VII.B.6.

At this stage, we also find unavailing Patent Owner's argument that "Lee does not use a single signal to determine a time-domain resource for another single signal," as this argument relates to Patent Owner's arguments concerning Lee's disclosure of two control blocks and two transport blocks for the claimed second and first radio signals, respectively. *Id.* Thus, Patent Owner's arguments regarding this limitation are unavailing for the reasons we provide above. *See supra* Sections VII.B.2–3 (finding that Lee discloses the first and second radio signals).

In sum, at this stage, we find that Lee discloses that "the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols."

9. As for Any One Given Multicarrier Symbol

Claim 1 further recites that "as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain." Ex. 1001, 21:15–21. At this stage of the

proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 26–29.

In particular, at this stage, we find that Lee discloses that its WTRU (UE) "may employ MIMO technology." Ex. 1004 ¶ 55. For example, Lee discloses that "the WTRU 102 may include two or more transmit/receive elements 122 (e.g., multiple antennas) for transmitting and receiving wireless signals over the air interface 116." *Id.*; *see also id.* at Fig. 4, ¶ 121 (illustrating and describing an embodiment employing a multi-antenna system); Ex. 1002 ¶ 101.

In addition, Lee discloses switching beams during a data transmission period. In particular, Lee discloses switching beams at a time (i.e., a first time point), which is between transport blocks TB1 and TB2 within a time transmission interval (TTI) (i.e., a first time unit). Ex. 1004 ¶¶ 11, 171, 258–259, 261–262, Figs. 19–20; Ex. 1002 ¶ 102; *see also* Ex. 1002 ¶ 72 ("A 'beam' may be one lobe (e.g. main/side/grating) of a transmit radiation pattern and receive gain pattern of an antenna array.").

In addition, at this stage, we agree with Petitioner and find that Lee's Figure 12 illustrates this beam switching. Pet. 27–28. Figure 12, as annotated by Petitioner, is shown below.

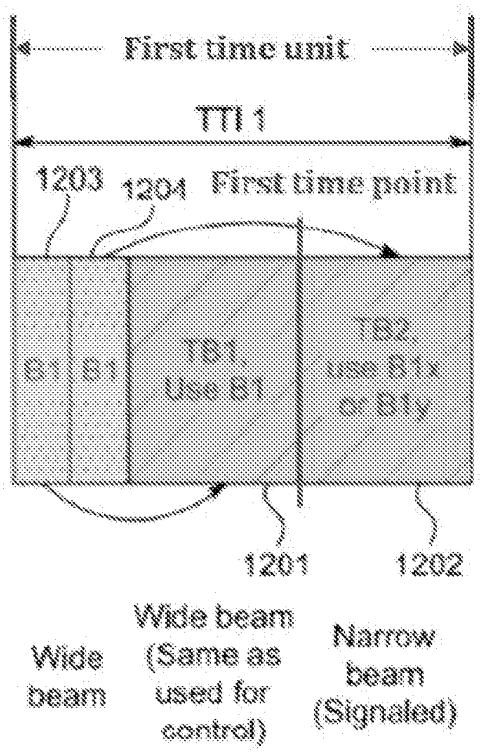


Figure 12 "shows a diagram for a dual transport block (TB) transmission scheme according to one or more [of Lee's] embodiments." Ex. 1004 ¶ 26. Petitioner annotates the figure by, *inter alia*, coloring in green transport blocks TB1 1201 and TB2 1202, labeling in red the TTI 1 interval as "First time unit," and extending and coloring purple the line between and separating blocks TB1 1201 and TB2 1202. *See* Pet. 28 (annotating Ex. 1004, Fig. 12). As illustrated, "two transport blocks 1201 and 1202 [are] transmitted (multiplexed) in a TDM fashion within a single TTI (e.g., TTI1)," and "[t]he transmission of the individual transport blocks may use the same beam as the control channel (e.g., transport block 1201 which uses a wide beam), or may use a different beam (e.g., transport block 1202 which uses a narrow beam)." Ex. 1004 ¶ 167, Fig. 12. And as also illustrated, Lee discloses switching from the wide beam to the narrow beam at the first time

point (i.e., at the start of block TB2 1202). *Id.*; *see also id.* ¶ 259 (disclosing "switching a receive beam of the WTRU from the first beam to the second beam, to receive the second transport block, based on beam information associated with the second beam received in one of the at least one control signal").

In addition, as discussed above, Lee's transport blocks TB1 and TB2 comprise G multicarrier symbols. *See supra* Section VII.B.6. Thus, Lee discloses for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving (i.e., the receiving beam) for the given multicarrier symbol is related to the relative position of a time domain resource occupied by the given multicarrier symbol with respect to the first time point in the time domain. Ex. 1004 ¶¶ 167, 259, Fig. 12; Ex. 1002 ¶ 104. In other words, when the given multicarrier symbol is before the first time point (e.g., in TB1), the wide beam is used for receiving the given multicarrier symbol, and when the given multicarrier symbol is behind the first time point (e.g., in TB2), the narrow beam is used for receiving the given multicarrier symbol. Ex. 1004 ¶¶ 167, 259, Fig. 12.

At this stage, we find unavailing Patent Owner's argument that "Petitioner and Lee are generally silent about using this time point as a metric related to the time domain resource occupied by ***any given multicarrier symbol*** out of the G multicarrier symbols because Lee discloses little more than describing that signals may be comprised of multicarrier symbols." Prelim. Resp. 28–29 (citing Pet. 45–47, 53). Likewise, we find unavailing Patent Owner's argument that "Petitioner does not and cannot make the leap required to show that Lee discloses a relational nature of any given multicarrier symbol to the relative position of the time-domain

resource occupied by the said multicarrier symbol with respect to first time point." *Id.* at 29. As we discuss above, Lee discloses that what beam is used for receiving each of the symbols is related to the relative position of a time-domain resource occupied by the given multicarrier symbol (e.g., whether a symbol occupies a slot that is before or behind) a first time point. Ex. 1004 ¶¶ 167, 259, Fig. 12; Ex. 1002 ¶ 104. Thus, at this stage, we find Patent Owner's arguments to be contrary to Lee's disclosure.

Moreover, Patent Owner's argument concerning using the first time point "as a metric" is unclear, and incorrect to the extent that it seeks to add an additional requirement to the claim language. *See In re Hiniker Co.*, 150 F.3d 1362, 1369 (Fed. Cir. 1998) (stating "the name of the game is the claim"); *In re Self*, 671 F.2d 1344, 1348 (CCPA 1982) (stating limitations not appearing in the claims cannot be relied upon for patentability).

In sum, at this stage, we find that Lee discloses that "as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain."

10. When Behind the First Time Point

Claim 1 further recites that "when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol." Ex. 1001, 21:21–25. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 29–30.

In particular, at this stage, and as we discuss above, we find that Lee discloses that when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the beam is switched to a narrow beam to receive transport block TB2. *See supra* Section VII.B.9; Ex. 1004 ¶¶ 167–168, 259, Fig. 12. Moreover, Lee discloses that the control data B1 (i.e., second radio signal) is used for determining the receiving beam for the symbols in transport block TB2. *See* Ex. 1004 ¶ 167 (disclosing that "the narrow beam ID may need to be signaled in the control region of the TTI" when transport block 1202 uses the different beam (i.e., the narrow beam)); *see also id.* ¶¶ 6–8 (disclosing that control signal(s) indicate a second beam ID associated with a second beam to be switched to for receiving additional data), 150 (disclosing that "[t]he DCI in the control channel may carry a beam ID or a beam index for the data channel"), Fig. 19.

In sum, at this stage, we find that Lee discloses this limitation.

11. When Before the First Time Point

Claim 1 further recites that "when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal." Ex. 1001, 21:25–29. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 31–32.

In particular, at this stage, and as we discuss above, we find that Lee discloses that when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the same beam (e.g., the wide beam in Figure 12) as used for the control channel is used for receiving

the symbols (e.g., transport block TB1). *See supra* Section VII.B.9; Ex. 1004 ¶¶ 167–168, 259, Figs. 12, 19.

In sum, at this stage, we find that Lee discloses this limitation.

12. First Time Point

Claim 1 further recites that "the first time point is one time point within the first time unit." Ex. 1001, 21:30–31. At this stage of the proceeding, we agree with Petitioner and find that Lee discloses this limitation. Pet. 32.

In particular, at this stage, and as we discuss above, we find that Lee discloses that the beams switch at one time point (i.e., the first time point), which is within the first time unit (i.e., TTI 1 for Figure 12). *See supra* Section VII.B.9 (discussing disclosure of first time point); Ex. 1004 ¶¶ 167–168, 259, Figs. 12, 19; Ex. 1002 ¶ 109.

In sum, at this stage, we find that Lee discloses this limitation.

13.Summary

In summary, based on the current record, and for purposes of this institution decision, we determine that Petitioner shows a reasonable likelihood that Lee anticipates claim 1.

C. Challenged Claims 2–12

At this stage in the proceeding, Patent Owner does not address separately Petitioner's arguments and evidence as to how Lee discloses the limitations of claims 2–12. *See* Prelim. Resp. 30–31. We have reviewed Petitioner's arguments and evidence regarding these claims, and, on the current record, we find them persuasive for purposes of institution.

VIII. ALLEGED OBVIOUSNESS OVER LEE AND CHEN

Petitioner argues that the combination of Lee and Chen renders claims 1–12 obvious. Pet. 50–83. Petitioner already has demonstrated a reasonable likelihood of success in proving that at least one claim of the '081 patent is anticipated. In order to provide guidance to the parties, however, we address the issues in dispute for this ground. *See* Consolidated Trial Practice Guide (November 2019)[7] 6 ("If a trial is instituted, the Board generally will provide analysis of the strengths and weaknesses of all challenges in the petition in order to provide guidance to the parties for the upcoming trial.").

A. Summary of Chen

Chen relates to the field of communications technology and in particular relates to message-decoding. Ex. 1012, 3. Chen teaches that a receiving end device (i) receives a second message associated with a first message from a transmitting end device; (ii) determines, based on the second message, a target receiver parameter for decoding the first message; and (iii) decodes the first message transmitted by the transmitting end device based on the target receiver parameter. *Id.* at code (57). Chen teaches that these steps "enable a receiving end device to determine a receiver parameter based on a second message associated with a first message and can also improve message transmission performance." *Id.* In addition, Chen teaches that the first message can comprise a data signal and that the second message can comprise a control message. *Id.* at 12.

B. Patent Owner's Arguments Concerning Chen

Patent Owner argues that Chen fails to teach multiple limitations of claim 1 because "Chen does not mention multicarrier symbols at all in its

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

specification." Prelim. Resp. 35; *see also id.* at 35–36 (arguing that Chen does not teach receiving multicarrier symbols). Petitioner, however, relies on the combined teachings of Lee and Chen, and in particular, Lee's teachings regarding multicarrier symbols for these limitations. *See* Pet. 56–57, 62. Similarly, Patent Owner argues that Chen fails to teach other limitations of claim 1, but acknowledges that Petitioner does not rely on Chen for those limitations. *See* Prelim. Resp. 31–33. Obviousness, however, cannot be overcome "by attacking references individually where the [ground] is based upon the teachings of a combination of references." *See Bradium Techs. LLC v. Iancu*, 923 F.3d 1032, 1050 (Fed. Cir. 2019) (quoting *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986)). Accordingly, we find these arguments unavailing.

In addition, Patent Owner argues that "Chen is directed to different set of problems and solutions" than the '081 patent, which seeks to "avoid[] the problem of delay" between the second and first signal due to decoding. Prelim. Resp. 37–38 (citing Ex. 1001, 4:24–37). At this stage, we find inapposite Patent Owner's argument that the prior art and the '081 patent may have different purposes. *See In re Heck*, 699 F.2d 1331, 1333 (Fed. Cir. 1983) (quoting *In re Lemelson*, 397 F.2d 1006, 1009 (CCPA 1968) ("The use of patents as references is not limited to what the patentees describe as their own inventions or to the problems with which they are concerned. They are part of the literature of the art, relevant for all they contain.")); *cf. Nat'l Steel Car, Ltd. v. Canadian Pac. Ry., Ltd.*, 357 F.3d 1319, 1339 (Fed. Cir. 2004) ("A finding that two inventions were designed to resolve different problems . . . is insufficient to demonstrate that one invention teaches away from another.").

IX. CONCLUSION

For the foregoing reasons, we determine that Petitioner shows a reasonable likelihood that it would prevail in proving the unpatentability of at least one of the challenged claims of the '081 patent. We thus institute an *inter partes* review of all of the challenged claims of the '081 patent on all grounds asserted in the Petition. *See* 37 C.F.R. § 42.108(a).

Any findings or conclusions in this Decision are made only for the purposes of institution and are not dispositive of any issue. We have not made a final determination with respect to the patentability of any challenged claim. Our final determination will be based on the record as fully developed during trial, including any evidence or argument timely presented by the parties under our Rules.

X. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of the '081 patent is instituted on all of the challenged claims and all grounds asserted 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; the trial commences on the entry date of this Decision.

FOR PETITIONER:

Joshua L. Goldberg
Kevin D. Rodkey
Nicholas A. Cerulli
Mingji Jin
Chen Zang
Yi Yu
FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, LLP
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FOR PATENT OWNER:

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plambrianakos@fabricantllp.com
eiturralde@fabricantllp.com

AO 120 (Rev. 08/10)

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

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

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

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

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

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

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

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT		
CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

AO 120 (Rev. 08/10)

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AO 120 (Rev. 08/10)

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00032	02-01-2022	for the Eastern District of Texas, Marshall Division

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

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

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

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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In the above---entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1---Upon initiation of action, mail this copy to Director Copy 3---Upon termination of action, mail this copy to Director
Copy 2---Upon filing document adding patent(s), mail this copy to Director Copy 4---Case file copy

AO 120 (Rev. 08/10)

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-00031	02/01/2022	for the Eastern District of Texas, Marshall Division

PLAINTIFF	DEFENDANT
APEX BEAM TECHNOLOGIES LLC	ZTE CORPORATION

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	
2	10,568,113	2/18/2020	
3	10,912,081	2/2/2021	
4	10,944,527	3/9/2021	
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AMENDED

AO 120 (Rev. 08/10)

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
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☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

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

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

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,462,767	10/29/2019	Apex Beam Technologies LLC
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AO 120 (Rev. 08/10)

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

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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
15/972,167	05/06/2018	Xiaobo ZHANG	ZL0205-0005-US

CONFIRMATION NO. 3699

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

POA ACCEPTANCE LETTER

OC000000129834307

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**.

/cnguyen/

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
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01

CONFIRMATION NO. 3699

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

POWER OF ATTORNEY NOTICE

OC00000012983427O

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**.

/cnguyen/

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

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	15/972,167
Filing Date	05-06-2018
First Named Inventor	Xiaobo ZHANG
Title	METHOD AND DEVICE USED FOR WIRELESS COMMUNICATION IN UE AND BASE STATION
Art Unit	2477
Examiner Name	RANDHAWA, MANDISH K
Attorney Docket Number	ZL0205-0005-US

SIGNATURE of Applicant or Patent Practitioner

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

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

☑ *Total of 1 forms are submitted.

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

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

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

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 155075

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

APEX BEAM TECHNOLOGIES LLC

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	Deepak Kumar Sharma	Date (Optional)	11/10/2021
Name	Deepak Sharma		
Title	Managing Director		

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

☑ Total of 1 forms are submitted.

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

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

Privacy Act Statement

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

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

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

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: APEX BEAM TECHNOLOGIES LLC

Application No./Patent No.: 15/972,167 Filed/Issue Date: 05-06-2018

Titled: METHOD AND DEVICE USED FOR WIRELESS COMMUNICATION 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 045728, Frame 0040, or for which a copy thereof is attached.

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

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

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

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

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Jialin Zhong/	November 11, 2021
Signature	Date
Jialin Zhong	62,937
Printed or Typed Name	Title or Registration Number

[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:	44268057
Application Number:	15972167
International Application Number:	
Confirmation Number:	3699
Title of Invention:	METHOD AND DEVICE USED FOR WIRELESS COMMUNICATION 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:	S3876.10011US01
Receipt Date:	12-NOV-2021
Filing Date:	06-MAY-2018
Time Stamp:	12:34:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ZL0205-0005-US_Marked_UP_ADS.pdf	1727541 ff63c80fc81acd669879428d22fd773b6b34a4d9	no	8

Warnings:

Information:					
This is not an USPTO supplied ADS fillable form					
2	Power of Attorney	ZL0205-0005-US_82A.pdf	278339 b37ca91f2b92376721e20ea935ab7701c70d597f	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	ZL0205-0005-US_3_73c.pdf	121272 ee73b241833684c6a5839fef76f3ca0b5de880b7	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	3227734		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/AIA/14 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	126099-8013.US00
	Application Number	15/972,167
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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 — Remove

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 E3, 8th Floor, JunYao Building
Address 2	No.789, ZhaoJiaBang Road, XuHui District

City	Shanghai	State/Province	
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	70416		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION		
Attorney Docket Number	126099-8013.US00	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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	70416		

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)

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	

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)[i] 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).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
201710318202.4	CN	2017-05-08	

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

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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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	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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 — Remove

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~~ APEX BEAM TECHNOLOGIES LLC		
Mailing Address Information For Applicant:			
Address 1	~~Room E3, 8th Floor, JunYao Building~~ 104 EAST HOUSTON STREET		
Address 2	~~No.799, ZhaodiaBang Road, Xuhui District~~ SUITE 180		
City	~~Shanghai~~ MARSHALL	**State/Province**	TX
Country	~~CN~~ US	Postal Code	~~200032~~ 75670
Phone Number		Fax Number	
Email Address			

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

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 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	

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.

Remove

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 E3, 6th Floor, JunYao Building~~ 104 EAST HOUSTON STREET		
Address 2	~~No.789, ZhaojiaBang Road, Xuhui District~~ SUITE 180		
City	~~Shanghai~~ MARSHALL	**State/Province**	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. Add

Signature:

Remove

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	~~/Aaron Wininger, Reg. No. 45,220/~~ /Jialin Zhong/			Date (YYYY-MM-DD)	~~2018-05-06~~ 221-11-12
First Name	~~Aaron~~ Jialin	Last Name	~~Wininger~~ Zhong	Registration Number	~~45220~~ 62937

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

PTO/AIA/14 (11-15)
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	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	

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Privacy Act Statement

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

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

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/972,167	02/02/2021	10912081	S3876.10011US01	3699

97149 7590 01/13/2021

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 220 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 (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15972167
Filing Date	2018-05-06
First Named Inventor	Xiaobo, ZHANG
Art Unit	2477
Examiner Name	RANDHAWA, MANDISH K
Attorney Docket Number	S3876.10011US01

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, /C.C.B./ 10/28/2020	1	20150124736	A	2015-05-07	~~LG Electronics Inc~~ Ko et al.	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	106550445	CN	A	2017-03-29	Shanghai LANGBO Communication Technology CO.,Ltd		
	2	101771437	CN	A	2010-07-07	ZTE		

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.K.R/

EFS Web 2.1.18

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

97149 7590 09/29/2020

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.
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01	3699

TITLE OF INVENTION: METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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	$500	$0.00	$0.00	$500	12/29/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
RANDHAWA, MANDISH K	2477	370-336000

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 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 /R. Burns Israelsen, Reg. No. 42685/ Date December 22, 2020

Typed or printed name R. Burns Israelsen Registration No. 42685

Electronic Patent Application Fee Transmittal

Application Number:	15972167
Filing Date:	06-May-2018
Title of Invention:	METHOD AND DEVICE USED FOR WIRELESS COMMUNICATION IN UE AND BASE STATION
First Named Inventor/Applicant Name:	Xiaobo ZHANG
Filer:	Robert Burns Israelsen/Clarissa Gundersen
Attorney Docket Number:	S3876.10011US01

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	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**500**

Electronic Acknowledgement Receipt	
EFS ID:	41443351
Application Number:	15972167
International Application Number:	
Confirmation Number:	3699
Title of Invention:	METHOD AND DEVICE USED FOR WIRELESS COMMUNICATION 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:	S3876.10011US01
Receipt Date:	22-DEC-2020
Filing Date:	06-MAY-2018
Time Stamp:	17:12:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$500
RAM confirmation Number	E2020BLH13153865
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)	S3876-10011US01_Issue_Fee_Transmittal.pdf	842299 035c6591c0ab3b18c241dfdaaae9ce8525fa2dff	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30481 6fe8f809621b62a590607550ce6066f3bfd5f764	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	872780		

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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01	3699

97149 7590 11/27/2020

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

EXAMINER
RANDHAWA, MANDISH K

ART UNIT	PAPER NUMBER
2477	

NOTIFICATION DATE	DELIVERY MODE
11/27/2020	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)	
	15/972,167	ZHANG, Xiaobo	
	Examiner	Art Unit	AIA (FITF) Status
	MANDISH RANDHAWA	2477	Yes

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

1. ☑ The amendment filed on 23 October 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.

/MANDISH K RANDHAWA/ Examiner, Art Unit 2477	

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Address: COMMISSIONER FOR PATENTS
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www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/972,167	05/06/2018	2477	1015	S3876.10011US01	18	4

CONFIRMATION NO. 3699

CORRECTED FILING RECEIPT

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

OC000000121450400

Date Mailed: 11/19/2020

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 Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

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 201710318202.4 05/08/2017 No 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: 05/29/2018
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/972,167**
Projected Publication Date: Not Applicable
Non-Publication Request: No
Early Publication Request: No
**** SMALL ENTITY ****
Title

METHOD AND DEVICE USED FOR WIRELESS COMMUNICATION 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).

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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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01	3699

97149 7590 11/19/2020

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

EXAMINER
RANDHAWA, MANDISH K

ART UNIT	PAPER NUMBER
2477	

NOTIFICATION DATE	DELIVERY MODE
11/19/2020	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)	
	15/972,167	ZHANG, Xiaobo	
	Examiner	Art Unit	AIA (FITF) Status
	MANDISH RANDHAWA	2477	Yes

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

1. ☑ The amendment filed on 09 October 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.

/MANDISH K RANDHAWA/ Examiner, Art Unit 2477	

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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01	3699

97149 7590 10/29/2020

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

EXAMINER
RANDHAWA, MANDISH K

ART UNIT	PAPER NUMBER
2477	

NOTIFICATION DATE	DELIVERY MODE
10/29/2020	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

Applicant-Initiated Interview Summary	**Application No.** 15/972,167	**Applicant(s)** ZHANG, Xiaobo	
	Examiner MANDISH RANDHAWA	**Art Unit** 2477	**AIA (FITF) Status** Yes

All participants (applicant, applicants representative, PTO personnel):

(1) Mandish Randhawa. (3) _____.

(2) Lance Jensen. (4) _____.

Date of Interview: 22 October 2020.

Type: ☑ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☑Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1,6,11 and 15.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Discussed proposed amendments. Examiner indicated the amendment does not appear to change the scope of the claims, however, further consideration would be required to enter the amendments..

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

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

☑ Attachment

/MANDISH K RANDHAWA/ Examiner, Art Unit 2477	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiners responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicants correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,-
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicants record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiners version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, Interview Record OK on the paper recording the substance of the interview along with the date and the examiners initials.

DRAFT – FOR THE PURPOSES OF DISCUSSION ONLY
NOT FOR ENTRY ON THE RECORD

INTERVIEW AGENDA

TO: Examiner RANDHAWA, MANDISH K.

FROM: Lance Jensen, Reg. No. 68,022

APPLICATION SERIAL NO.: 15/972,167

SUBJECT: Interview to Discuss the Notice of Allowance dated September 29, 2020

INTERVIEW DATE: October 22, 2020, 12:30 PM ET

The purpose of the proposed interview is to discuss the following claim amendments:

1. **(Currently Amended)** A method in a User Equipment (UE) for wireless communication, comprising:

receiving a ~~first~~ second radio signal;

receiving a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

6. **(Currently Amended)** A method in a base station device for wireless communication, comprising:

transmitting a ~~first~~ second radio signal;

transmitting a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

11. **(Currently Amended)** A UE for wireless communication, comprising:

a first transceiver module, to receive a ~~first~~ second radio signal and a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

15. **(Currently Amended)** A base station device for wireless communication, comprising:

a second transceiver module, to transmit a ~~first~~ second radio signal and a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo Zhang	
Application No.:	15/972,167	Art Unit 2477
Filed:	May 6, 2018	
Conf. No.:	3699	
For:	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	
Examiner:	Mandish K. Randhawa	
Customer No.:	97149	
Attorney Docket No.:	S3876.10011US01	

AMENDMENT UNDER 37 C.F.R. §1.312

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

Dear Commissioner:

In response to the Notice of Allowance mailed September 29, 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 7 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 in a User Equipment (UE) for wireless communication, comprising:

receiving a ~~first~~ second radio signal;

receiving a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

2. **(Canceled)**

3. **(Canceled)**

4. **(Previously Presented)** The method according to claim 1, comprising:

receiving first information, wherein the first information is used for determining the first time point;

or,

receiving third information, wherein the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

5. **(Previously Presented)** The method according to claim 1 comprising:

transmitting second information;

wherein the second information is used for determining the first time point.

6. **(Currently Amended)** A method in a base station device for wireless communication, comprising:

transmitting a ~~first~~ second radio signal;

transmitting a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

7. **(Canceled)**

8. **(Canceled)**

9. **(Previously Presented)** The method according to claim 6, comprising:

transmitting first information, wherein the first information is used for determining the first time point;

or,

transmitting third information, wherein the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

10. **(Previously Presented)** The method according to claim 6, comprising:

receiving second information;

wherein the second information is used for determining the first time point.

11. **(Currently Amended)** A UE for wireless communication, comprising:

a first transceiver module, to receive a ~~first~~ second radio signal and a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

12. **(Canceled)**

13. **(Canceled)**

14. **(Original)** The UE according to claim 11, wherein the first transceiver module receives first information, the first information being used for determining the first time point; or, the first transceiver module transmits second information, the second information being used for determining the first time point; or, the first transceiver module receives third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

15. **(Currently Amended)** A base station device for wireless communication, comprising:

a second transceiver module, to transmit a ~~first~~ second radio signal and a ~~second~~ first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

16. **(Canceled)**

17. **(Canceled)**

18. **(Original)** The base station device according to claim 15, wherein the second transceiver module transmits first information, the first information being used for determining the first time point; or, the second transceiver module receives second information, the second information being used for determining the first time point; or, the second transceiver module transmits third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

19. **(Previously Presented)** The method according to claim 4 comprising:

transmitting second information, wherein the second information is used for determining the first time point.

20. **(Previously Presented)** The method according to claim 9 comprising:

receiving second information, wherein the second information is used for determining the first time point.

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 23rd day of October, 2020.

Respectfully submitted,

/B. Lance Jensen/ Reg. # 68022

B. Lance Jensen
Registration No. 68022
Attorney for Applicant
Customer No. 97149
Telephone No. (435) 252-1360

Electronic Acknowledgement Receipt	
EFS ID:	40928727
Application Number:	15972167
International Application Number:	
Confirmation Number:	3699
Title of Invention:	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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:	S3876.10011US01
Receipt Date:	23-OCT-2020
Filing Date:	06-MAY-2018
Time Stamp:	17:54:11
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_10011US01_312_AMD_102320.pdf	42009 3290b65ccd109553f3891c2771e2d1f97a488bd9	yes	7

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment after Notice of Allowance (Rule 312)	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	7
Warnings:			
Information:			
	Total Files Size (in bytes):	42009	

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo ZHANG	
Application No.:	15/972,167	Art Unit 2477
Filed:	May 6, 2018	
Conf. No.:	3699	
For:	METHOD AND DEVICE ~~USD~~ USED FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	
Examiner:	Mandish K Randhawa	
Customer No.:	97149	
Attorney Docket No.:	S3876.10011US01	

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 September 29, 2020, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper. **Remarks** begin on page 3 of this paper.

AMENDMENTS TO THE SPECIFICATION

Please amend the title as follows:

METHOD AND DEVICE ~~USD~~ USED FOR WIRELESS COMMUNICATION IN UE AND BASE STATION

REMARKS

The amendments to the specification 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 specification 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 9th day of October, 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:	40784001
Application Number:	15972167
International Application Number:	
Confirmation Number:	3699
Title of Invention:	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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:	S3876.10011US01
Receipt Date:	09-OCT-2020
Filing Date:	06-MAY-2018
Time Stamp:	15:25:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		S3876-10011US01_312_Amendment.pdf	152189 4827c230fa186423f2baa360e65c5b82e2b727d1	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment after Notice of Allowance (Rule 312)	1	1
	Specification	2	2
	Claims	3	3
Warnings:			
Information:			
	Total Files Size (in bytes):	152189	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

97149 7590 09/29/2020

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

EXAMINER
RANDHAWA, MANDISH K

ART UNIT	PAPER NUMBER
2477	

DATE MAILED: 09/29/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01	3699

TITLE OF INVENTION: METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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	$500	$0.00	$0.00	$500	12/29/2020

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

97149 7590 09/29/2020

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.
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01	3699

TITLE OF INVENTION: METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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	$500	$0.00	$0.00	$500	12/29/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
RANDHAWA, MANDISH K	2477	370-336000

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

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

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

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

1_____

2_____

3_____

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

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

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

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

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

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

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

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

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01	3699

97149 7590 09/29/2020

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

EXAMINER	
RANDHAWA, MANDISH K	
ART UNIT	**PAPER NUMBER**
2477	

DATE MAILED: 09/29/2020

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. 15/972,167	Applicant(s) ZHANG, Xiaobo	
	Examiner MANDISH RANDHAWA	Art Unit 2477	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 communication(s) filed on June 24, 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 1,4-6,9-11,14-15 and 18-20, renumbered as 1-12 . 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 6/2/20.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☑ Interview Summary (PTO-413), Paper No./Mail Date. 9/23/20.
5. ☑ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/MANDISH K RANDHAWA/
Examiner, Art Unit 2477

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.

EXAMINER'S AMENDMENT

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with B. Lance Jensen on September 23, 2020.

3. The application has been amended as follows:

1. (Currently Amended) A method in a User Equipment (UE) for wireless communication, comprising:

receiving a first radio signal;

receiving a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect

to a first time point in time domain; [[if]] when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; and [[if]] when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

6. (Currently Amended) A method in a base station device for wireless communication, comprising:

transmitting a first radio signal;

transmitting a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; [[if]] when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and [[if]] when the time-domain resource occupied by the given multicarrier symbol is before the

first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

11. (Currently Amended) A UE for wireless communication, comprising:

a first transceiver module, to receive a first radio signal and a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; [[if]] when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and [[if]] when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

15. (Currently Amended) A base station device for wireless communication, comprising:

a second transceiver module, to transmit a first radio signal and a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; [[if]] when the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and [[if]] when the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

Allowable Subject Matter

4. Claims 1, 4-6, 9-11, 14, 15, 18-20, renumbered as 1-12, are allowed.

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MANDISH RANDHAWA whose telephone number is (571)270-5650. The examiner can normally be reached on Monday-Thursday (7 AM-4 PM).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ayaz Sheikh can be reached on (571) 272-3795. 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.

/MANDISH K RANDHAWA/
Examiner, Art Unit 2477

Examiner-Initiated Interview Summary	Application No. 15/972,167	Applicant(s) ZHANG, Xiaobo	
	Examiner MANDISH RANDHAWA	Art Unit 2477	AIA (FITF) Status Yes

All participants (applicant, applicant's representative, PTO personnel):

(1) Mandish Randhawa. (3) _____.

(2) B. Lance Jensen. (4) _____.

Date of Interview: 23 September 2020.

Type: ☑ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐ 101 ☐ 112 ☐ 102 ☑ 103 ☑ Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1,6,11 and 15.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant's representative authorized examiner's amendment to place the application in condition for allowance. For more details, see the examiner's amendment..

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

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

☐ Attachment

/MANDISH K RANDHAWA/ Examiner, Art Unit 2477	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/972,167	ZHANG, Xiaobo
	Examiner	**Art Unit**
	MANDISH RANDHAWA	2477

CPC						
Symbol					**Type**	**Version**
H04W	/	72	/	0446	F	2013-01-01
H04W	/	24	/	02	I	2013-01-01
H04W	/	72	/	042	I	2013-01-01
H04L	/	5	/	0023	I	2013-01-01
H04L	/	27	/	2602	I	2013-01-01
H04B	/	7	/	0617	I	2013-01-01
H04L	/	5	/	001	A	2013-01-01
H04B	/	7	/	0695	A	2013-01-01
H04B	/	7	/	088	A	2013-01-01

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	12	
/MANDISH K RANDHAWA/ Examiner, Art Unit 2477	15 September 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	7

U.S. Patent and Trademark Office — Part of Paper No.: 20200915

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/972,167	ZHANG, Xiaobo
	Examiner	**Art Unit**
	MANDISH RANDHAWA	2477

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04W	/	72	/	04

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	12	
/MANDISH K RANDHAWA/ Examiner, Art Unit 2477	15 September 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	7

U.S. Patent and Trademark Office — Part of Paper No.: 20200915

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/972,167	ZHANG, Xiaobo
	Examiner	**Art Unit**
	MANDISH RANDHAWA	2477

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	8	10	3	19										
-	2	9	11	7	20										
-	3	-	12												
2	4	-	13												
4	5	10	14												
5	6	11	15												
-	7	-	16												
-	8	-	17												
6	9	12	18												

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 12	
/MANDISH K RANDHAWA/ Examiner, Art Unit 2477 (Primary Examiner)	15 September 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 7

U.S. Patent and Trademark Office — Part of Paper No.: 20200915

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/972,167	ZHANG, Xiaobo
	Examiner	Art Unit
	MANDISH RANDHAWA	2477

CPC - Searched*		
Symbol	Date	Examiner
H04W24/02, H04W72/042, H04L5/0023, H04L27/2602, H04W72/0446, H04B7/0617,H04B7/0695,H04L5/001,H04B7/088	09/15/2020	MR

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
Performed Inventor/Double Patenting search	03/09/2020	MR
Performed NPL and East text search	03/09/2020	MR
Performed Inventor/Double Patenting search	09/15/2020	MR
Performed NPL and Patent search on IP.com	09/15/2020	MR
Performed East cpc/text search	09/15/2020	MR
Performed interference search	09/15/2020	MR

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/972,167	ZHANG, Xiaobo
	Examiner	Art Unit
	MANDISH RANDHAWA	2477

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
H04W	24/02, 72/042, 72/0446	09/15/2020	MR
H04L	L5/0023, 27/2602, 5/001	09/15/2020	MR
H04B	7/0617, 7/0695,7/088	09/15/2020	MR

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

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	15972167
Filing Date	2018-05-06
First Named Inventor	Xiaobo, ZHANG
Art Unit	2477
Examiner Name	RANDHAWA, MANDISH K
Attorney Docket Number	S3876.10011US01

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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
	1					

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20150124736	A	2015-05-07	LG Electronics Inc	

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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	106550445	CN	A	2017-03-29	Shanghai LANGBO Communication Technology CO.,Ltd		
	2	101771437	CN	A	2010-07-07	ZTE		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15972167
	Filing Date	2018-05-06
	First Named Inventor	Xiaobo, ZHANG
	Art Unit	2477
	Examiner Name	RANDHAWA, MANDISH K
	Attorney Docket Number	S3876.10011US01

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	CN Search Report in application No.201710318202.4 dated 13 February 2020	☒
	2	CN Office Action in Application No.201710318202.4 dated 26 February 2020	☒
	3	CN Notice of Granting Patent Right in Application No.201710318202.4 dated 28 April 2020	☒

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EXAMINER SIGNATURE

Examiner Signature	/MANDISH K RANDHAWA/	Date Considered	09/15/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.K.R/

/MANDISH K RANDHAWA/

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	3	"20180083680"	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 14:28
L3	97	(multi$1carrier or multi$1 adj carrier) near3 symbol same (beam$2 or beam$form$4 or beam adj form$4)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 14:46
L4	132	(mult$1carrier or multi$1 adj carrier or ofdm or filter bank multiple carrier or fbmc) near2 symbol same (first or wid$3) near3 beam$5 same (second or narrow$3) beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 15:01
L5	16	(symbol) with (chang$4 beam$4) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 15:02
L6	48	(symbol) with ((chang$4 or different or mode or wide$4 or narrow$4) near2 beam$8) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 15:04
L7	1,103	(time or symbol index) with (data channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 15:47
L8	114	(time or symbol index) with (data channel or $3dsch) same (chang$4 or different or wide$4 or narrow$4) near beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 15:49
L9	39	(time or symbol or slot) with (data channel or $3dsch) with (control or $3dcch) with (chang$4 or different or wide$4 or narrow$4) near beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 15:57
L10	58	(time or symbol or slot) with (data channel or $3dsch) with (control or $3dcch) with (chang$4 or different or wide$4 or narrow$4 or direction or "same") near beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 16:02
L11	44	10 not 6	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 17:03
L12	60	(cross$2 symbol) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 17:08

EAST Search History (Prior Art)

L13	3	(cross$2 symbol) same ($3dcch or dci) same (data near2 channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 17:09
L14	375	($3dcch or dci or control near2 (channel or symbol)) with (data near2 (channel or symbol) or $3dsch) same "same" near3 beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 17:35
L15	72	($3dcch or dci or control near2 (channel or symbol)) with (data near2 (channel or symbol) or $3dsch) same "same" near3 beam same symbol	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 17:38
L16	75	($3dcch or dci or control near2 (channel or symbol)) with (data near2 (channel or symbol) or $3dsch) same (current or "same") near3 beam same symbol	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:25
L17	3	16 not 15	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:31
L18	353	(Shanghai Langbo Communication Technology Company Limited or shangai lanbo comm$8).as. or (ZHANG near2 Xiaobo).in.	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:34
L19	12,088	($3dcch or dci or control near2 (channel or symbol) or second signal) with (data near2 (channel or symbol) or $3dsch or first signal) same (beam or (multi$1antenna or antenna) near2 relat$4 receiv$4)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:36
L20	4,359	(($3dcch or dci or control near2 (channel or symbol) or second signal) with (data near2 (channel or symbol) or $3dsch or first signal) same (beam or (multi$1antenna or antenna) near2 relat$4 receiv$4)).clm.	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:37
L21	4	18 and 20	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:41
L22	5,766	(($3dcch or dci or control near2 (channel or symbol) or second signal) same (data near2 (channel or symbol) or $3dsch or first signal) same (beam or (multi$1antenna or antenna) near2 relat$4 receiv$4)).clm.	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:43
L23	4	22 and 18	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:44
L24	0	23 not 21	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:44

EAST Search History (Prior Art)

L25	57	(symbol) with ((chang$4 or different or mode or wide$4 or narrow$4 or swap$4 or switch$4) near2 beam) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:45
L26	57	L25	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:45
L27	66	(symbol) with ((chang$4 or different or mode or wide$4 or narrow$4 or swap$4 or switch$4) near2 beam) same ($3dsch or data (symbol or region or channel)) same ($3dcch or control (region or symbol or channel))	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:45
L28	37	27 not 16	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/09/15 18:46
L29	122,353	(H04W24/02 or H04W72/042 or H04L5/0023 or H04L27/2602 or H04W72/0446 or H04B7/0617 or H04B7/0695 or H04L5/001 or H04B7/088). cpc.	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/09/15 18:50
L30	602	22 and 29	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/09/15 18:50
L31	196	(($3dcch or dci or control near2 (channel or symbol)) same (data near2 (channel or symbol) or $3dsch) same (beam or (multi$1antenna or antenna) near2 relat$4 receiv$4)).clm.	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:51
L32	129	31 and 29	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:52
L33	30	(($3dcch or dci or control near2 (channel or symbol)) same (data near2 (channel or symbol) or $3dsch) same ((chang$4 or switch$4 or current or "same" or different) near3 beam or (multi$1antenna or antenna) near2 relat$4 receiv$4)).clm.	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 18:53
L34	36	(($3dcch or dci or control near2 (channel or symbol)) same (data near2 (channel or symbol) or $3dsch) same ((chang$4 or switch$4 or current or "same" or different or wide$4 or narrow$4) near3 beam or (multi$1antenna or antenna) near2 relat$4 receiv$4)).clm.	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 19:09
L35	6	34 not 33	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/09/15 19:10

EAST Search History (Prior Art)

S1	1	"15972167"	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:18
S2	1,537	(multi$carrier symbols)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:20
S3	300	("g" or "n" or "m" or multiple or plurality or two or several) near2 (multi$carrier symbols)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:20
S4	20	(multi$carrier symbols) same beam$5	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:23
S5	0	(multi$carrier symbols) same P$DCCH near3 resource	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:50
S6	8	(multi$carrier symbols) same P$dsch same p$dcch	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:52
S7	1	(multi$carrier symbols) and symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:55
S8	171	symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:55
S9	38	(multi$carrier) and symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:56
S10	1	(multi$carrier) same symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:56
S11	5	(multi$carrier near4 symbol) same (antenna) near2 (direction or position)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:01
S12	57	(multi$carrier symbols) same (beam$2 or beam$form$4 or beam adj form$4)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:08

EAST Search History (Prior Art)

S13	37	S12 not S4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:08
S14	26	(wide$3 near3 beam$3) with p$dcch same narrow$4 near3 beam$3 with p$dsch	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:21
S15	102	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) symbol same (first or wid$3) near3 beam$5 same (second or narrow$3) beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 18:08
S16	1	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) symbol same (first or wid$3) near3 beam$5 same (second or narrow$3) beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 18:13
S17	133	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) near2 symbol same beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 18:47
S18	123	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) near2 symbol same (chang$4 or adjust$4) near2 beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:04
S19	2	(cross$2 symbol) same beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:35
S20	145	(symbol) with beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:35
S21	10	(symbol) with (chang$4 beam) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:36
S22	21	(symbol) with ((chang$4 or different or mode or wide$4 or narrow$4) beam) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:36
S23	34	(symbol) with ((chang$4 or different or mode or wide$4 or narrow$4 or swap$4 or switch$4) near2 beam) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 16:10
S24	13	S23 not S22	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 16:11

EAST Search History (Prior Art)

S25	906	(time or symbol index) with (data channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:19
S26	6	(symbol index) with (data channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:19
S27	215	(index) with (data channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:22
S28	111	(index) with (data channel or $3dsch) same beam same (control channel or $3dcch)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:23
S29	11	(index) with (data channel or $3dsch) same beam same (control channel or $3dcch) same symbol	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:24
S30	3	"20040110469"	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:40
S31	56	(cross$2 symbol) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:43
S32	12	"10383093"	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/03/20 12:02
S33	8	(("10383093") or ("10334568") or ("10045338")).PN.	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2020/03/20 12:02
S34	0	("15540517").PN.	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2020/03/20 12:03
S35	2	"15540517"	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/03/20 12:03
S36	1	"15344193"	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/03/20 12:27

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/972,167	Filing Date 05/06/2018	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (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	06/24/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 12	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".	/TRACEY M YOUNG/
*** 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.**

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Xiaobo Zhang	
Application No.:	15/972,167	Art Unit 2477
Filed:	May 6, 2018	
Conf. No.:	3699	
For:	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	
Examiner:	Mandish K. Randhawa	
Customer No.:	97149	
Attorney Docket No.:	S3876.10011US01	

AMENDMENT AND RESPONSE TO NON-FINAL OFFICE ACTION DATED MARCH 24, 2020

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

Dear Sir:

In response to the Non-Final Office Action dated March 24, 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 7 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 in a User Equipment (UE) for wireless communication, comprising:

receiving a first radio signal;

receiving a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; and if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

2. **(Canceled)**

3. **(Canceled)**

4. **(Currently Amended)** The method according to claim[[s]] 1, comprising:

receiving first information, wherein the first information is used for determining the first time point;

or,

receiving third information, wherein the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

5. **(Currently Amended)** The method according to claim[[s]] 1 comprising:

transmitting second information;

wherein the second information is used for determining the first time point.

6. **(Currently Amended)** A method in a base station device for wireless communication, comprising:

transmitting a first radio signal;

transmitting a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

7. **(Canceled)**

8. **(Canceled)**

9. **(Currently Amended)** The method according to claim[[s]] 6, comprising:

transmitting first information, wherein the first information is used for determining the first time point;

or,

transmitting third information, wherein the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

10. **(Currently Amended)** The method according to claim[[s]] 6, comprising:

receiving second information;

wherein the second information is used for determining the first time point.

11. **(Currently Amended)** A UE for wireless communication, comprising:

a first transceiver module, to receive a first radio signal and a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

12. **(Canceled)**

13. **(Canceled)**

14. **(Original)** The UE according to claim 11, wherein the first transceiver module receives first information, the first information being used for determining the first time point; or, the first transceiver module transmits second information, the second information being used for determining the first time point; or, the first transceiver module receives third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

15. **(Currently Amended)** A base station device for wireless communication, comprising:

a second transceiver module, to transmit a first radio signal and a second radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used to determine the multi-antenna related receiving for the given multicarrier symbol; and if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal; the first time point is one time point within the first time unit; and G is a positive integer.

16. **(Canceled)**

17. **(Canceled)**

18. **(Original)** The base station device according to claim 15, wherein the second transceiver module transmits first information, the first information being used for determining the first time point; or, the second transceiver module receives second information, the second

information being used for determining the first time point; or, the second transceiver module transmits third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

19. **(New)** The method according to claim 4 comprising:

transmitting second information, wherein the second information is used for determining the first time point.

20. **(New)** The method according to claim 9 comprising:

receiving second information, wherein the second information is used for determining the first time point.

REMARKS

This paper in response to the Office Action cancels claims 2, 3, 7, 8, 12, 13, 16, and 17; amends claims 1, 4-6, 9-11, and 15; and adds new claims 19 and 20. Claims 1, 4-6, 9-11, 14, 15, and 18-20 are now pending in view of the amendments presented herein. Applicants respectfully request reconsideration of the application in view of the above amendments to the claims and the following remarks.

In connection with the prosecution of this case and any related cases, Applicants have, and/or may, discuss various aspects of the disclosure of the cited references as those references are then understood by Applicants. Because such discussion could reflect an incomplete or incorrect understanding of one or more of the references, the position of Applicants with respect to a reference is not necessarily fixed or irrevocable. Applicants thus hereby reserve the right, both during and after prosecution of this case, to modify the views expressed with regard to any reference.

Please note that Applicants do not intend the following remarks to be an exhaustive enumeration of the distinctions between any cited references and the claims. Rather, Applicants present the distinctions below solely by way of example to illustrate some of the differences between the claims and the cited references. Finally, Applicants request that Examiner carefully review any references discussed below to ensure that Applicants' understanding and discussion of any reference is consistent with Examiner's understanding.

Unless otherwise explicitly stated, the term "Applicants" is used herein generically and may refer to a single inventor, a set of inventors, an appropriate assignee, or any other entity or person with authority to prosecute this application.

Rejections Under 35 U.S.C. § 102

The Office Action rejects claims 1-18 under 35 U.S.C. § 102 over *Guo et al.* (U.S. Publication No. 2018/0083680).

Applicants do not necessarily agree with Examiner's statements regarding at least (1) whether *Guo* discloses each and every element recited in the claims, (2) whether *Guo* teaches the

combination presented in the claims, and (3) whether *Guo* discloses or inherently includes the features that the Office Action asserts that *Guo* includes. Nevertheless, in the interest of expediting prosecution, Applicants have herein amended independent claims 1, 6, 11, and 15 to recite, for example, "receiving a second radio signal", wherein "the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols", and "if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; **and** if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal". Support for these amendments can be found at least in paragraphs [0242]-[0243] of the specification and Figure 5 of the drawings.

The Office Action contends that paragraphs [0272]-[0273] of *Guo* disclose "a time-domain resource" that may indicate "the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol" or "the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal" depending whether "the time-domain resource occupied by the given multicarrier symbol" is "behind" or "before the first time point", elements which originally appeared in dependent claim 3 but now are required as part of amended claim 1. (Office Action, p. 4). However, as amended, independent claim 1 requires both elements to be present, as denoted by the presence of and, not or.

Guo appears to disclose a configuration of Rx beams across N number of symbols. (*See, e.g., Guo* para. [0272], and Office Action, p. 4). Additionally, the Rx beams cycle across symbols in subsequent slots/subframes, until another set of Rx beam indications is received. *Id.* Amended claim 1 requires that a determination is made as to when a time-domain resource occupied by the given multicarrier symbol occurs relative to the first time point. Claim 1 also recites that a determination is made for the use of the second radio signal, depending on whether the "time-domain resource occupied by the given multicarrier symbol" was "behind" or "before" the first time point. Specifically, *Guo* appears to not disclose both aforementioned determinations for the second radio signal as required by amended claim 1.

Independent claims 6, 11, and 15 have substantially the same amendments, directed to a base station, a UE for wireless communication, and a base station for wireless communication, respectively, and Applicants submit independent claims 6, 11, and 15 appear to be allowable for the same reasons cited above in relation to independent claim 1.

The amendments presented herein, taken as a whole, render the rejections moot. Applicants note that portions of the claims, other than those specifically amended and/or mentioned above, may contribute to patentability. In light of the references as now understood by Applicants and the amendments made herein, claims 1, 6, 11, and 15 appear to be allowable. Applicants therefore respectfully request that Examiner withdraw the rejections under 35 U.S.C. § 102 of claims 1, 6, 11, and 15 and of claims 4, 5, 9, 10, 14, and 18-20 which depend therefrom.

New Claims

Support for new claims 19 and 20 can be found at least in paragraphs [0085], [0087]-[0088], [0121]-[0122], [0142], etc. of the specification and Figure 8 of the drawings.

Inasmuch as new claims 19 and 20 depend from amended dependent claims 4 and 9, which depend from amended independent claims 1 and 6, that appear to be allowable, Applicants respectfully request that new claims 19 and 20 also be allowed.

Charge Authorization

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

CONCLUSION

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

Dated this 24th day of June, 2020.

Respectfully submitted,

/B. Lance Jensen/

B. Lance Jensen
Registration No. 68,022
Attorney for Applicant
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Electronic Acknowledgement Receipt	
EFS ID:	39811901
Application Number:	15972167
International Application Number:	
Confirmation Number:	3699
Title of Invention:	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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:	S3876.10011US01
Receipt Date:	24-JUN-2020
Filing Date:	06-MAY-2018
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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_10011US01_Response_062420.pdf	59833 bdeaa2a65f042a6b221feea6c9277aa980fc32b1	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	10
Warnings:			
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(Not for submission under 37 CFR 1.99)

Application Number	15972167
Filing Date	2018-05-06
First Named Inventor	Xiaobo, ZHANG
Art Unit	2477
Examiner Name	RANDHAWA, MANDISH K
Attorney Docket Number	S3876.10011US01

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	1	106550445	CN	A	2017-03-29	Shanghai LANGBO Communication Technology CO.,Ltd		
	2	101771437	CN	A	2010-07-07	ZTE		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15972167
	Filing Date	2018-05-06
	First Named Inventor	Xiaobo, ZHANG
	Art Unit	2477
	Examiner Name	RANDHAWA, MANDISH K
	Attorney Docket Number	S3876.10011US01

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	1	CN Search Report in application No.201710318202.4 dated 13 February 2020	☒
	2	CN Office Action in Application No.201710318202.4 dated 26 February 2020	☒
	3	CN Notice of Granting Patent Right in Application No.201710318202.4 dated 28 April 2020	☒

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Examiner Signature		Date Considered	

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[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	15972167
	Filing Date	2018-05-06
	First Named Inventor	Xiaobo, ZHANG
	Art Unit	2477
	Examiner Name	RANDHAWA, MANDISH K
	Attorney Docket Number	S3876.10011US01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	Xiaobo ZHANG	Date (YYYY-MM-DD)	2020-06-02
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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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.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public 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.

(19)中华人民共和国国家知识产权局

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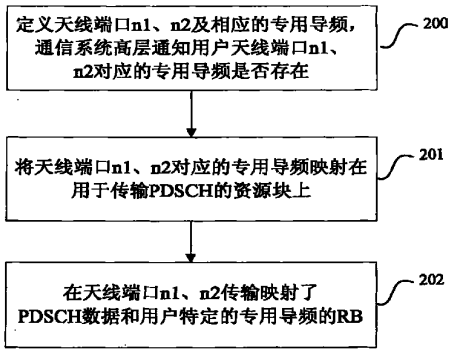
权利要求书 3 页 说明书 9 页 附图 3 页

(54)发明名称

一种专用导频的传输方法

(57)摘要

一种专用导频的传输方法，该方法包括：接入节点在天线端口 n1 和天线端口 n2 分别发送用于实现多点协作传输的专用导频；所述天线端口 n1 和天线端口 n2 对应的专用导频仅存在于用于传输物理下行共享信道 PDSCH 的资源块上；所述天线端口 n1 对应的专用导频与天线端口 n2 对应的专用导频映射到相同的正交频分复用 OFDM 符号上且在频域上相互正交。采用本发明的方法，使 CoMP 技术能够支持空间复用，并能够获得更合理的导频开销。



CN 101771437 A

1. 一种专用导频的传输方法，其特征在于，该方法包括：

接入节点在天线端口 n1 和天线端口 n2 分别发送用于实现多点协作传输的专用导频；

所述天线端口 n1 和天线端口 n2 对应的专用导频仅存在于用于传输物理下行共享信道 PDSCH 的资源块上；

所述天线端口 n1 对应的专用导频与天线端口 n2 对应的专用导频映射到相同的正交频分复用 OFDM 符号上且在频域上相互正交。

2. 如权利要求 1 所述的方法，其特征在于，

所述天线端口 n1 和天线端口 n2 对应的专用导频的时域导频密度为每一子帧占用 2 个 OFDM 符号。

3. 如权利要求 1 所述的方法，其特征在于，

在正常循环前缀 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频映射到第 2i 个时隙的第 6 个正交频分复用 OFDM 符号上和第 2i+1 个时隙的第 7 个或者第 4 个 OFDM 符号上；

i 为大于等于 0 的整数。

4. 如权利要求 1 所述的方法，其特征在于，

在扩展 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频映射到第 2i 个时隙的第 6 个 OFDM 符号和第 2i+1 个时隙的第 6 个或者第 3 个 OFDM 符号；

i 为大于等于 0 的整数。

5. 如权利要求 1 所述的方法，其特征在于，

在正常 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置可以是以下任意一种：

(a) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号；或

(b) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号；或

(c) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号；或

(d) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号；

i 为大于等于 0 的整数。

6. 如权利要求 1 所述的方法，其特征在于，

在扩展 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 5 个 OFDM 符号；

i 为大于等于 0 的整数。

7. 如权利要求 3 至 6 中任一权利要求所述的方法，其特征在于，

所述天线端口 n1 和天线端口 n2 对应的专用导频在频域的映射位置按照以下公式中的一个或全部确定，且天线端口 n1 和天线端口 n2 对应的专用导频在频域上不重叠：

$(u*\mathrm{m}'+(2+v_{\mathrm{shift}})\bmod\ u)\bmod N_{\mathrm{sc}}^{\mathrm{RB}}+N_{\mathrm{sc}}^{\mathrm{RB}}\cdot n_{\mathrm{PRB}}$，和

$(u*m'+v_{\text{shift}})\bmod N_{\text{sc}}^{\text{RB}}+N_{\text{sc}}^{\text{RB}}\cdot n_{\text{PRB}}$；

其中，u 为大于 1 的正整数；$m'=0,1,\ldots,\frac{12}{u}N_{\text{RB}}^{\text{PDSCH}}-1$；$v_{\text{shift}}$ 为频率偏移；$N_{\text{sc}}^{\text{RB}}$为以子载波个数表示的资源块的频域大小；$n_{\text{PRB}}$ 表示资源块的频域索引，$N_{\text{RB}}^{\text{PDSCH}}$表示 PDSCH 传输时，以资源块个数表示的带宽。

8. 如权利要求 7 所述的方法，其特征在于，

所述天线端口 n1 对应的专用导频在相邻的时隙中的频域映射位置不同；

所述天线端口 n2 对应的专用导频在相邻的时隙中的频域映射位置不同。

9. 如权利要求 7 所述的方法，其特征在于，

v_{shift} 可以采用如下方式之一取值：

(A) 令$v_{\text{shift}}=N_{\text{ID}}^{\text{cell}}\bmod u$；或

(B) 令 v_{shift} 为小于 u 的固定常数值；或

(C) 令 v_{shift} ＝协作域 ID mod w；

其中，N_{ID}^{cell}为接入节点标识符 ID，，w 为大于 1 的正整数，不同协作域的协作域 ID 不同。

10. 一种专用导频传输方法，其特征在于，该方法包括：

接入节点在天线端口 n1 和天线端口 n2 分别发送用于实现多点协作传输的专用导频；

所述天线端口 n1 和天线端口 n2 对应的专用导频仅存在于用于传输 PDSCH 的资源块上；

所述天线端口 n1 和天线端口 n2 对应的专用导频分别映射到不同的 OFDM 符号上。

11. 如权利要求 10 所述的方法，其特征在于，

所述天线端口 n1 和天线端口 n2 对应的专用导频的时域导频密度为每一子帧占用 1 或 2 个 OFDM 符号。

12. 如权利要求 10 所述的方法，其特征在于，

在正常 CP 情况下，所述天线端口 n1 对应的专用导频映射到第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号；所述天线端口 n2 对应的专用导频映射到第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号；

i 为大于等于 0 的整数。

13. 如权利要求 10 所述的方法，其特征在于，

在扩展 CP 情况下，所述天线端口 n1 对应的专用导频映射到第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 5 个 OFDM 符号，所述天线端口 n2 对应的专用导频映射到第 2i+1 个时隙的第 2 个 OFDM 符号；

i 为大于等于 0 的整数。

14. 如权利要求 12 或 13 所述的方法，其特征在于，

所述天线端口 n1 和天线端口 n2 对应的专用导频在频域的映射位置按照以下公式中的一个或全部确定：

$(u*\text{m}'+(2+v_{\text{shift}})\bmod u)\bmod N_{\text{sc}}^{\text{RB}}+N_{\text{sc}}^{\text{RB}}\cdot n_{\text{PRB}}$，和

$(u*m'+v_{\text{shift}})\bmod N_{\text{sc}}^{\text{RB}}+N_{\text{sc}}^{\text{RB}}\cdot n_{\text{PRB}}$；

其中，u 为大于 1 的正整数；$m' = 0,1,\ldots,\frac{12}{u}N_{RB}^{PDSCH} - 1$；$v_{shift}$ 为频率偏移；N_{sc}^{RB}为以子载波个数表示的资源块的频域大小；n_{PRB} 表示资源块的频域索引；N_{RB}^{PDSCH}表示 PDSCH 传输时，以资源块个数表示的带宽。

15. 如权利要求 14 所述的方法，其特征在于，

所述天线端口 n1 对应的专用导频在相邻的时隙中的频域映射位置不同；

所述天线端口 n2 对应的专用导频在相邻的时隙中的频域映射位置不同。

16. 如权利要求 14 所述的方法，其特征在于，

v_{shift} 可以采用如下方式之一取值：

(A) 令$v_{shift} = N_{ID}^{cell} \bmod u$；或

(B) 令 v_{shift} 为小于 u 的固定常数值；或

(C) 令 v_{shift} ＝协作域 ID mod w；

其中，N_{ID}^{cell}为接入节点标识符 ID，，w 为大于 1 的正整数，不同协作域的协作域 ID 不同。

一种专用导频的传输方法

技术领域

[0001] 本发明涉及无线通信领域，尤其涉及一种专用导频的传输方法。

背景技术

[0002] 为了在提供高的吞吐率的同时解决小区间的干扰问题，新一代无线通信系统（如 LTE-Advance(Long-Term Evolution advance，高级长期演进，简称 LTE-A)，IMT-Advance(International Mobile Telecommunication advance，高级国际移动通信）等）考虑引入网络级间的协作 MIMO(Multiple Input andMultiple Output，多输入多输出）技术。而 LTE-Advance 中，已经正式将多点协作传输 (CoMP) 技术作为一种备选技术进行研究。

[0003] 由于小区边缘用户距离多个相邻小区的天线距离相差不大，因此利用多个小区的发射天线协作来实现小区边缘处无线链路的较高容量和可靠传输可以完全消除小区边缘处的用户的干扰问题。多点协作传输技术的特点在于：

[0004] 1) 通过多个 BS(Base Station，基站）在相同的无线资源上的协作（分集、复用等），共同为一个 UE(User Equipment，用户终端）服务。

[0005] 2) 每个 BS 在相同的无线资源上可以同时为一个或多个 UE 服务。

[0006] 目前各家公司在 CoMP 方面分别以 LTE 为基础提出了各自的观点。其中基于天线端口 5(antenna port 5) 的 CoMP 协作传输方法，由于可以兼容 LTER8(long term evolution Release 8，长期演进版本 8) 用户，因此被多数公司所青睐。

[0007] 在 LTE R8 中，对应于天线端口 5 定义了一路用户特定的专用导频 (LTE 中也称为 user-specific reference signal（用户特定的参考信号）或者 dedicatedreference signal（专用参考信号）)，用于协助传输 PDSCH(physical downlinkshare channel) 的数据，导频只有在用天线端口 5 给用户终端发送数据的情况下，才会存在，用户可以根据高层控制信令获得是否存在专用导频的信息，且导频位置根据小区 ID 的不同进行频率的跳变（跳频）。

[0008] 如图 1a 和图 1b 所示，LTE R8 中定义的专用导频的正常 CP(normal cyclicprefix，正常循环前缀）和扩展 CP(extend cyclic prefix，扩展循环前缀）情况下导频序列的映射方式如下所示：

[0009] a) 正常 CP 情况：

[0010] $$a_{k,l}^{(p)} = r(3 \cdot l' \cdot N_{\mathrm{RB}}^{\mathrm{PDSCH}} + m');$$

[0011] $$k = (k') \bmod N_{\mathrm{sc}}^{\mathrm{RB}} + N_{\mathrm{sc}}^{\mathrm{RB}} \cdot n_{\mathrm{PRB}}$$

[0012] $$k' = \begin{cases} 4m' + v_{\mathrm{shift}} & \text{if } l \in \{2,3\} \\ 4\mathrm{m}' + (2 + v_{\mathrm{shift}}) \bmod 4 & \text{if } l \in \{5,6\} \end{cases}$$

[0013] $$l=\begin{cases}3 & l'=0\\6 & l'=1\\2 & l'=2\\5 & l'=3\end{cases}$$

[0014] $$l'=\begin{cases}0,1 & \text{if } n_s \bmod 2=0\\2,3 & \text{if } n_s \bmod 2=1\end{cases}$$

[0015] $$m'=0,1,\ldots,3N_{RB}^{PDSCH}-1$$

[0016] b) 扩展 CP 情况：

[0017] $$a_{k,l}^{(p)}=r(4\cdot l'\cdot N_{RB}^{PDSCH}+m');$$

[0018] $$k=(k')\bmod N_{sc}^{RB}+N_{sc}^{RB}\cdot n_{PRB}$$

[0019] $$k'=\begin{cases}3m'+v_{shift} & \text{if } l=4\\3m'+(2+v_{shift})\bmod 3 & \text{if } l=1\end{cases}$$

[0020] $$l=\begin{cases}4 & l'\in\{0,2\}\\1 & l'=1\end{cases}$$

[0021] $$l'=\begin{cases}0 & \text{if } n_s \bmod 2=0\\1,2 & \text{if } n_s \bmod 2=1\end{cases}$$

[0022] $$m'=0,1,\ldots,4N_{RB}^{PDSCH}-1$$

[0023] 其中，r(·)表示导频序列；$a_{k,l}^{(p)}$为天线端口 5(p = 5) 对应的当前子帧的复数调制符号；N_{RB}^{PDSCH}表示 PDSCH 传输时，以 RB(Resource Block，资源块）个数表示的带宽；N_{sc}^{RB}为以子载波个数表示的资源块的频域大小；n_{PRB} 表示 RB 的频域索引，在导频序列的映射过程中，首先按照频域索引递增的方式映射；m' 是每个 OFDM(Orthogonal Frequency Division Multiplexing，正交频分复用）符号中UE特定导频信号资源单元计数器；v_{shift} 为小区特定的频率偏移，$v_{shift}=N_{ID}^{cell} \bmod 3$，$N_{ID}^{cell}$为小区 ID（标识符），$n_s$ 为时隙索引。

[0024] 由于现有技术中仅使用天线端口 5 进行 CoMP，因此只能实现空口合并分集增益，无法实现空间复用。为了使 CoMP 技术能够支持空间复用，需要对天线端口进行扩展。

发明内容

[0025] 本发明所要解决的技术问题是，克服现有技术的不足，提供一种专用导频的传输方法，使 CoMP 技术能够支持空间复用。

[0026] 为了解决上述问题，本发明提供一种专用导频的传输方法，该方法包括：

[0027] 接入节点在天线端口 n1 和天线端口 n2 分别发送用于实现多点协作传输的专用导频；

[0028] 所述天线端口 n1 和天线端口 n2 对应的专用导频仅存在于用于传输物理下行共享信道 PDSCH 的资源块上；

[0029] 所述天线端口 n1 对应的专用导频与天线端口 n2 对应的专用导频映射到相同的正交频分复用 OFDM 符号上且在频域上相互正交。

[0030] 此外，所述天线端口 n1 和天线端口 n2 对应的专用导频的时域导频密度为每一子帧占用 2 个 OFDM 符号。

[0031] 此外，在正常循环前缀 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频映射到第 2i 个时隙的第 6 个正交频分复用 OFDM 符号上和第 2i+1 个时隙的第 7 个或者第 4 个 OFDM 符号上；

[0032] i 为大于等于 0 的整数。

[0033] 此外，在扩展 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频映射到第 2i 个时隙的第 6 个 OFDM 符号和第 2i+1 个时隙的第 6 个或者第 3 个 OFDM 符号；

[0034] i 为大于等于 0 的整数。

[0035] 此外，在正常 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置可以是以下任意一种：

[0036] (a) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号；或

[0037] (b) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号；或

[0038] (c) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号；或

[0039] (d) 所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号；

[0040] i 为大于等于 0 的整数。

[0041] 此外，在扩展 CP 情况下，所述天线端口 n1 和天线端口 n2 对应的专用导频均映射到第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 5 个 OFDM 符号；

[0042] i 为大于等于 0 的整数。

[0043] 此外，所述天线端口 n1 和天线端口 n2 对应的专用导频在频域的映射位置按照以下公式中的一个或全部确定，且天线端口 n1 和天线端口 n2 对应的专用导频在频域上不重叠：

[0044] $(u*\mathrm{m}'+(2+v_{\mathrm{shift}})\bmod u)\bmod N_{\mathrm{sc}}^{\mathrm{RB}}+N_{\mathrm{sc}}^{\mathrm{RB}}\cdot n_{\mathrm{PRB}}$，和

[0045] $(u*m'+v_{\mathrm{shift}})\bmod N_{\mathrm{sc}}^{\mathrm{RB}}+N_{\mathrm{sc}}^{\mathrm{RB}}\cdot n_{\mathrm{PRB}}$；

[0046] 其中，u 为大于 1 的正整数；$m'=0,1,\ldots,\frac{12}{u}N_{\mathrm{RB}}^{\mathrm{PDSCH}}-1$；$v_{\mathrm{shift}}$ 为频率偏移；$N_{\mathrm{sc}}^{\mathrm{RB}}$为以子载波个数表示的资源块的频域大小；$n_{\mathrm{PRB}}$ 表示资源块的频域索引，$N_{\mathrm{RB}}^{\mathrm{PDSCH}}$表示 PDSCH 传输时，以资源块个数表示的带宽。

[0047] 此外，所述天线端口 n1 对应的专用导频在相邻的时隙中的频域映射位置不同；

[0048] 所述天线端口 n2 对应的专用导频在相邻的时隙中的频域映射位置不同。

[0049] 此外，v_{shift} 可以采用如下方式之一取值：

[0050] (A) 令$v_{\mathrm{shift}}=N_{\mathrm{ID}}^{\mathrm{cell}}\bmod u$；或

[0051] (B) 令 v_{shift} 为小于 u 的固定常数值；或

[0052] (C) 令 v_{shift} ＝协作域 ID mod w；

[0053] 其中，N_{ID}^{cell} 为接入节点标识符 ID，，w 为大于 1 的正整数，不同协作域的协作域 ID 不同。

[0054] 本发明还提供一种专用导频传输方法，该方法包括：

[0055] 接入节点在天线端口 n1 和天线端口 n2 分别发送用于实现多点协作传输的专用导频；

[0056] 所述天线端口 n1 和天线端口 n2 对应的专用导频仅存在于用于传输 PDSCH 的资源块上；

[0057] 所述天线端口 n1 和天线端口 n2 对应的专用导频分别映射到不同的 OFDM 符号上。

[0058] 此外，所述天线端口 n1 和天线端口 n2 对应的专用导频的时域导频密度为每一子帧占用 1 或 2 个 OFDM 符号。

[0059] 此外，在正常 CP 情况下，所述天线端口 n1 对应的专用导频映射到第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号；所述天线端口 n2 对应的专用导频映射到第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号；

[0060] i 为大于等于 0 的整数。

[0061] 此外，在扩展 CP 情况下，所述天线端口 n1 对应的专用导频映射到第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 5 个 OFDM 符号，所述天线端口 n2 对应的专用导频映射到第 2i+1 个时隙的第 2 个 OFDM 符号；

[0062] i 为大于等于 0 的整数。

[0063] 此外，所述天线端口 n1 和天线端口 n2 对应的专用导频在频域的映射位置按照以下公式中的一个或全部确定：

[0064] $(u*\mathrm{m}'+(2+v_{\mathrm{shift}}) \bmod u) \bmod N_{\mathrm{sc}}^{\mathrm{RB}}+N_{\mathrm{sc}}^{\mathrm{RB}} \cdot n_{\mathrm{PRB}}$，和

[0065] $(u*m'+v_{\mathrm{shift}}) \bmod N_{\mathrm{sc}}^{\mathrm{RB}}+N_{\mathrm{sc}}^{\mathrm{RB}} \cdot n_{\mathrm{PRB}}$；

[0066] 其中，u 为大于 1 的正整数；$m'=0,1,\ldots,\frac{12}{u} N_{\mathrm{RB}}^{\mathrm{PDSCH}}-1$；$v_{shift}$ 为频率偏移；N_{sc}^{RB} 为以子载波个数表示的资源块的频域大小；n_{PRB} 表示资源块的频域索引；N_{RB}^{PDSCH} 表示 PDSCH 传输时，以资源块个数表示的带宽。

[0067] 此外，所述天线端口 n1 对应的专用导频在相邻的时隙中的频域映射位置不同；

[0068] 所述天线端口 n2 对应的专用导频在相邻的时隙中的频域映射位置不同。

[0069] 此外，v_{shift} 可以采用如下方式之一取值：

[0070] (A) 令 $v_{\mathrm{shift}}=N_{\mathrm{ID}}^{\mathrm{cell}} \bmod u$；或

[0071] (B) 令 v_{shift} 为小于 u 的固定常数值；或

[0072] (C) 令 v_{shift} ＝协作域 ID mod w；

[0073] 其中，N_{ID}^{cell} 为接入节点标识符 ID，，w 为大于 1 的正整数，不同协作域的协作域 ID 不同。

[0074] 采用本发明的方法，使 CoMP 技术能够支持空间复用，并能够获得更合理的导频开

销。此外，由于 CoMP 的专用导频仅存在于用于传输物理下行共享信道 (PDSCH) 数据的资源块上，在需要兼容 LTE 终端的情况下，可以用 LTE 中定义的天线端口 5 传输；当为 CoMP 分配的资源针对低速 LTE-A 终端时，可以使用新定义的端口传输，并获得空间复用增益。

附图说明

[0075] 图 1a 为现有技术中正常 CP 情况下天线端口 5 的专用导频映射示意图；

[0076] 图 1b 为现有技术中扩展 CP 情况下天线端口 5 的专用导频映射示意图；

[0077] 图 2 是本发明实施例专用导频的传输方法流程图；

[0078] 图 3a 为本发明第一实施例正常 CP 情况下天线端口 n1 和天线端口 n2 的专用导频映射示意图；

[0079] 图 3b 为本发明第一实施例扩展 CP 情况下天线端口 n1 和天线端口 n2 的专用导频映射示意图；

[0080] 图 4a 为本发明第二实施例正常 CP 情况下天线端口 n1 和天线端口 n2 的专用导频映射示意图；

[0081] 图 4b 为本发明第二实施例扩展 CP 情况下天线端口 n1 和天线端口 n2 的专用导频映射示意图；

[0082] 图 5a 为本发明第三实施例正常 CP 情况下天线端口 n1 和天线端口 n2 的专用导频映射示意图；

[0083] 图 5b 为本发明第三实施例扩展 CP 情况下天线端口 n1 和天线端口 n2 的专用导频映射示意图。

具体实施方式

[0084] 本发明的核心思想是，为了使 CoMP 支持空间复用，定义两个或多个天线端口（以下仅以定义两个天线端口为例，记作天线端口 n1 和天线端口 n2）以及相应的专用导频用于多点协作传输时 PDSCH 的传输。

[0085] 下面将结合附图和实施例对本发明进行详细描述。

[0086] 图 2 是本发明实施例专用导频的传输方法流程图，如图 2 所示，该方法包括如下步骤：

[0087] 200：为了使 CoMP 支持空间复用，定义天线端口 n1 和天线端口 n2 及相应的用户特定的专用导频（简称专用导频）；天线端口 n1 和天线端口 n2 及相应的专用导频用于多接入节点（例如，基站、中继站）协作时 PDSCH 的传输；天线端口 n1 和天线端口 n2 对应的专用导频仅仅存在于用于传输 PDSCH 的资源块上（即仅在传输为某一用户分配的 PDSCH 时传输天线端口 n1 和天线端口 n2 对应的专用导频），通信系统高层通知用户天线端口 n1 和天线端口 n2 对应的专用导频是否存在（即是否发送天线端口 n1 和天线端口 n2 对应的专用导频）。

[0088] 201：将天线端口 n1 和天线端口 n2 对应的专用导频映射在用于传输 PDSCH 的资源块上。

[0089] 由于 CoMP，尤其是 CoMP 空间复用时，主要适用于低速用户，天线端口 n1 和天线端口 n2 对应的专用导频的时域插入密度（即时域导频密度）在正常 CP 情况下为天线端口 5

对应的专用导频的时域插入密度的 1/2，在扩展 CP 情况下为天线端口 5 对应的专用导频的时域插入密度的 2/3 或 1/3。

[0090] 多天线端口传输方式下，天线端口 n1 和天线端口 n2 的频域导频密度与 3GPP 36.211 中天线端口 5 的频域导频密度相同或相当。

[0091] 下面将结合附图对本发明的专用导频映射方法进行说明。

[0092] (1) 第一映射实施例

[0093] 本实施例中，天线端口 n1 和天线端口 n2 对应的专用导频映射到未被公共导频和天线端口 5 对应的专用导频占用的 OFDM 符号上，且天线端口 n1 和天线端口 n2 对应的专用导频映射到相同的 OFDM 符号上。

[0094] 正常 CP 情况下，公共导频占用的 OFDM 符号为 2i(i 为大于等于 0 的整数，以下同）个 slot(时隙）的第 1、2、5 个 OFDM 符号 (1 = 0、1、4) 和第 2i+1 个 slot 的第 1、2、5 个 OFDM 符号 (1 = 0、1、4)；天线端口 5 对应的专用导频位于第 2i 个时隙的第 4、7 个 OFDM 符号 (1 = 3、6) 和第 2i+1 个时隙的第 3、6 个 OFDM 符号 (1 = 2、5)。

[0095] 扩展 CP 情况下，公共导频占用的 OFDM 符号为第 2i 个时隙的第 1、2、4 个 OFDM 符号和第 2i+1 个时隙的第 1、2、4 个 OFDM 符号；天线端口 5 对应的专用导频位于第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 2、5 个 OFDM 符号。

[0096] (1.1) 正常 CP 情况

[0097] 在正常 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在时域均位于第 2i 个时隙的第 6 个 OFDM 符号和第 2i+1 个时隙的第 7 个或者第 4 个 OFDM 符号，如图 3a 所示。

[0098] 在正常 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在第 2i 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为 (a1) 和 (a2) 中的任意一组：

[0099] (a1) $(u*m'+v_{\text{shift}})\bmod N_{sc}^{RB}+N_{sc}^{RB}\cdot n_{PRB}$和

[0100] $(u*\mathrm{m}'+(2+v_{\text{shift}})\bmod\ u)\bmod N_{sc}^{RB}+N_{sc}^{RB}\cdot n_{PRB}$;

[0101] (a2) $(u*\mathrm{m}'+(2+v_{\text{shift}})\bmod\ u)\bmod N_{sc}^{RB}+N_{sc}^{RB}\cdot n_{PRB}$和

[0102] $(u*m'+v_{\text{shift}})\bmod N_{sc}^{RB}+N_{sc}^{RB}\cdot n_{PRB}$。

[0103] 在正常 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在第 2i+1 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为上述 (a1) 和 (a2) 中的任意一组。

[0104] 其中，以上公式中的 u 为大于 1 的正整数，优选为 4，其中$m'=0,1,\ldots,\frac{12}{u}N_{RB}^{PDSCH}-1$。

[0105] (1.2) 扩展 CP 情况

[0106] 在扩展 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置均为第 2i 个时隙的第 6 个 OFDM 符号和第 2i+1 个时隙的第 6 个或者第 3 个 OFDM 符号，如图 3b 所示。

[0107] 在扩展 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在第 2i 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为上述 (a1) 和 (a2) 中的任意一组；天线端口 n1 和天线端口 n2 对应的专用导频在第 2i+1 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为上述 (a1) 和 (a2) 中的任意一组。其中，优选的 u 取值为 3。

[0108] 上述 v_{shift} 为不同小区或不同协作域的频率偏移。在频域的偏移方式上，由于与

3GPP 36.211 中定义的公共导频及天线端口 5 对应的专用导频都不在相同的 OFDM 符号上，有利于根据协作的特点进行跳频的设计。例如 v_{shift} 可以根据协作域 ID 进行频域跳变。

[0109] (2) 第二映射实施例

[0110] 本实施例中，天线端口 n1 和天线端口 n2 对应的专用导频重用了天线端口 5 对应的专用导频占用的 OFDM 符号，在时域上降低了导频的插入密度，且天线端口 n1 和天线端口 n2 对应的专用导频映射到相同的 OFDM 符号上。

[0111] (2.1) 正常 CP 情况

[0112] 在正常 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置可以是以下任意一种：

[0113] (a) 天线端口 n1 和天线端口 n2 对应的专用导频均位于第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号，如图 4a 所示；或

[0114] (b) 天线端口 n1 和天线端口 n2 对应的专用导频均位于第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号；或

[0115] (c) 天线端口 n1 和天线端口 n2 对应的专用导频均位于第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号；或

[0116] (d) 天线端口 n1 和天线端口 n2 对应的专用导频均位于第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号。

[0117] 在正常 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在第 2i 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为上述 (a1) 和 (a2) 中的任意一组；天线端口 n1 和天线端口 n2 对应的专用导频在第 2i+1 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为上述 (a1) 和 (a2) 中的任意一组。

[0118] (2.2) 扩展 CP 情况

[0119] 在扩展 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置均为第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 5 个 OFDM 符号，如图 4b 所示。

[0120] 此外，在扩展 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置也可以是均为第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号。

[0121] 在扩展 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在第 2i 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为上述 (a1) 和 (a2) 中的任意一组；天线端口 n1 和天线端口 n2 对应的专用导频在第 2i+1 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为上述 (a1) 和 (a2) 中的任意一组。

[0122] 以上实施例的共性是：天线端口 n1 和天线端口 n2 对应的专用导频映射到相同的 OFDM 符号上且在频域上正交（即天线端口 n1 对应的专用导频映射到的资源单元 (resource elements) 与天线端口 n2 的专用导频映射到的资源单元位于同一个的 OFDM 符号上，但在频域上对应不同的资源单元，也即在频域上的位置不重叠）。

[0123] (3) 第三映射实施例

[0124] 本实施例中，天线端口 n1 和天线端口 n2 对应的专用导频重用了天线端口 5 对应的专用导频占用的 OFDM 符号，在时域上降低了导频的插入密度，且天线端口 n1 和天线端口 n2 对应的专用导频分别映射到不同的 OFDM 符号。

[0125] (3.1) 正常 CP 情况

[0126] 在正常 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置可以是以下情况之一：

[0127] (e) 天线端口 n1 对应的专用导频位于第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号，天线端口 n2 对应的专用导频位于第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号，如图 5a 所示；或

[0128] (f) 天线端口 n1 对应的专用导频位于第 2i 个时隙的第 7 个 OFDM 符号和第 2i+1 个时隙的第 6 个 OFDM 符号，天线端口 n2 对应的专用导频位于第 2i 个时隙的第 4 个 OFDM 符号和第 2i+1 个时隙的第 3 个 OFDM 符号。

[0129] 在正常 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在第 2i 个时隙和第 2i+1 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为：

[0130] $(u*m'+v_{\text{shift}})\bmod N_{\text{sc}}^{\text{RB}}+N_{\text{sc}}^{\text{RB}}\cdot n_{\text{PRB}}$，或

[0131] $(u*\text{m}'+(2+v_{\text{shift}})\bmod\ u)\bmod N_{\text{sc}}^{\text{RB}}+N_{\text{sc}}^{\text{RB}}\cdot n_{\text{PRB}}$。

[0132] 其中，以上公式中的 u 为大于 1 的正整数，优选的 u 取值 4。$m'=0,1,\ldots,\frac{12}{u}N_{\text{RB}}^{\text{PDSCH}}-1$。

[0133] 如图 5a 所示，天线端口 n1 对应的专用导频在第 2i 个时隙的第 4 个 OFDM 符号的频域位置与天线端口 n2 对应的专用导频在第 2i+1 个时隙的第 6 个 OFDM 符号的频域位置相同；天线端口 n1 对应的专用导频在第 2i 个时隙的第 7 个 OFDM 符号的频域位置与天线端口 n2 对应的专用导频在第 2i+1 个时隙的第 3 个 OFDM 符号的频域位置相同。

[0134] (3.2) 扩展 CP 情况

[0135] 在扩展 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在时域的映射位置可以是：天线端口 n1 位于第 2i 个时隙的第 5 个 OFDM 符号和第 2i+1 个时隙的第 5 个 OFDM 符号，天线端口 n2 位于第 2i+1 个时隙的第 2 个 OFDM 符号，如图 5b 所示，或者。

[0136] 在扩展 CP 情况下，天线端口 n1 和天线端口 n2 对应的专用导频在第 2i 个时隙和第 2i+1 个时隙的频域位置（即 OFDM 符号所在位置）用公式表示为：

[0137] $(u*m'+v_{\text{shift}})\bmod N_{\text{sc}}^{\text{RB}}+N_{\text{sc}}^{\text{RB}}\cdot n_{\text{PRB}}$，或

[0138] $(u*\text{m}'+(2+v_{\text{shift}})\bmod\ u)\bmod N_{\text{sc}}^{\text{RB}}+N_{\text{sc}}^{\text{RB}}\cdot n_{\text{PRB}}$。

[0139] 其中，以上公式中的 u 为大于 1 的正整数，优选的 u 取值为 3。$m'=0,1,\ldots,\frac{12}{u}N_{\text{RB}}^{\text{PDSCH}}-1$。

[0140] 此外，在上述各实施例中，v_{shift} 的取值可以采用如下几种方式之一：

[0141] (A) 按照 3GPP 36.211 中的方式进行偏移，即 $v_{\text{shift}}=N_{\text{ID}}^{\text{cell}}\bmod\ u$；或

[0142] (B) 令 v_{shift} 为小于 u 的固定常数值；或

[0143] (C) 每个协作域内的各个接入节点采用相同的 v_{shift}，不同协作域内的各个接入节点的采用不同的 v_{shift}；为不同的协作域定义协作域 ID，v_{shift} = 协作域 ID mod w，其中 w 为大于 1 的正整数；采用这种方式，可以使相同协作域内各接入节点跳变模式统一，按照统一的载波方式映射，易于进行空口合并。

[0144] 202：在天线端口 n1 和天线端口 n2 传输映射了 PDSCH 数据和专用导频的 RB。

[0145] 当然，也可以定义两类传输方式：单天线端口传输方式和多天线端口传输方式；在单天线端口传输时，采用 3GPP 36.211 定义的天线端口 5 传输；在多天线端口传输时，用新定义的两个或多个专用天线端口传输。

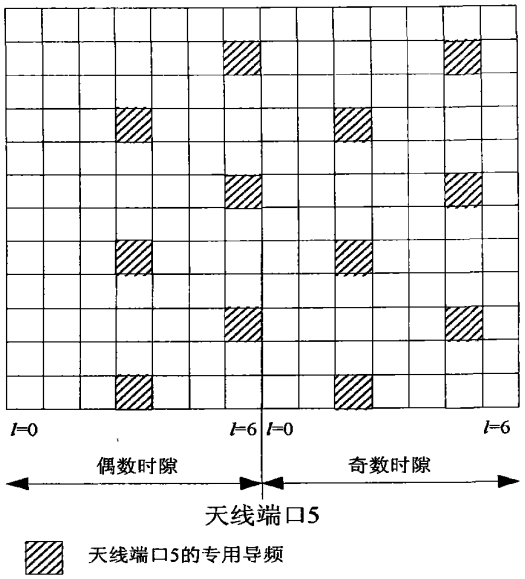

l=0
l=6
l=0
l=6
偶数时隙
奇数时隙
天线端口5
天线端口5的专用导频

图 1a

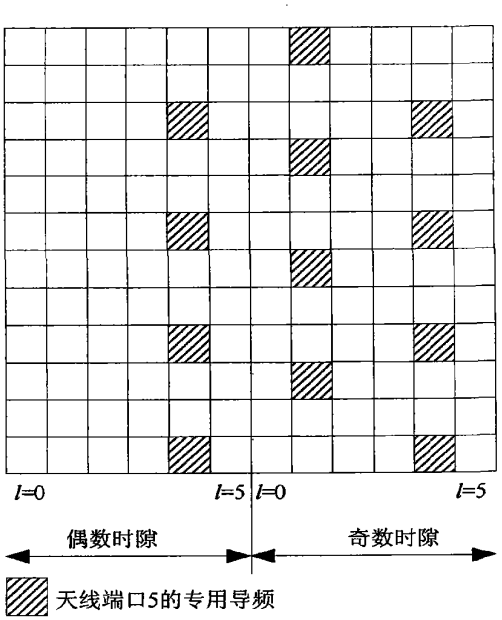

l=0
l=5
l=0
l=5
偶数时隙
奇数时隙
天线端口5的专用导频

图 1b

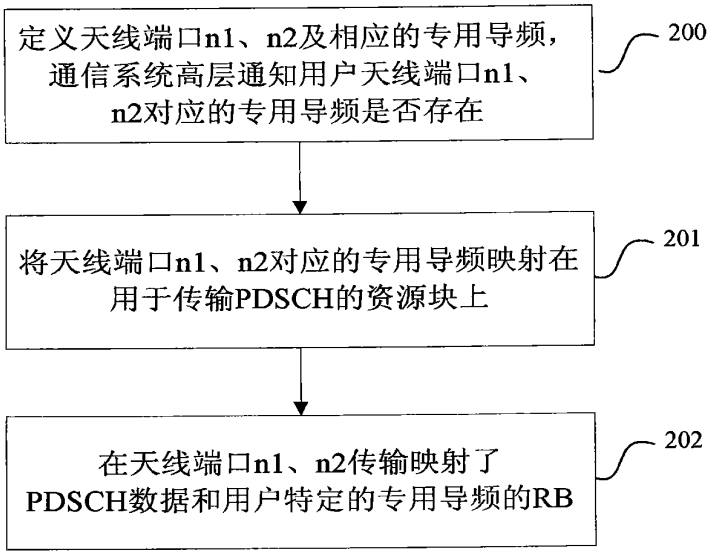

定义天线端口n1、n2及相应的专用导频，通信系统高层通知用户天线端口n1、n2对应的专用导频是否存在
200
将天线端口n1、n2对应的专用导频映射在用于传输PDSCH的资源块上
201
在天线端口n1、n2传输映射了PDSCH数据和用户特定的专用导频的RB
202

图 2

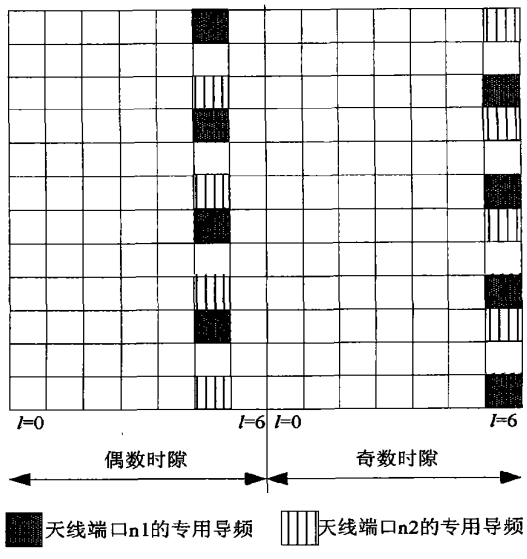


图 3a

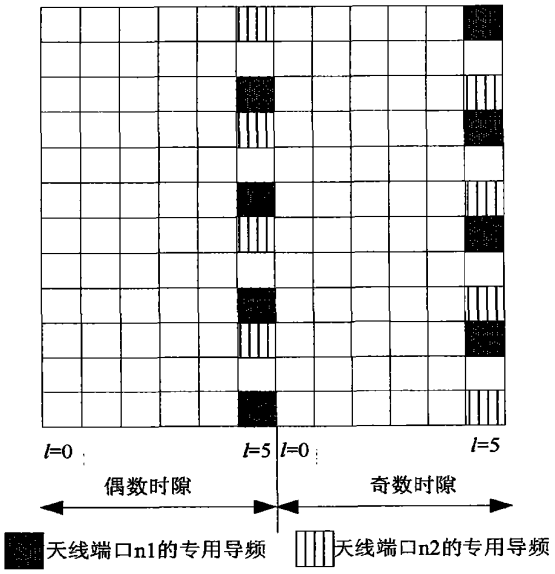


图 3b

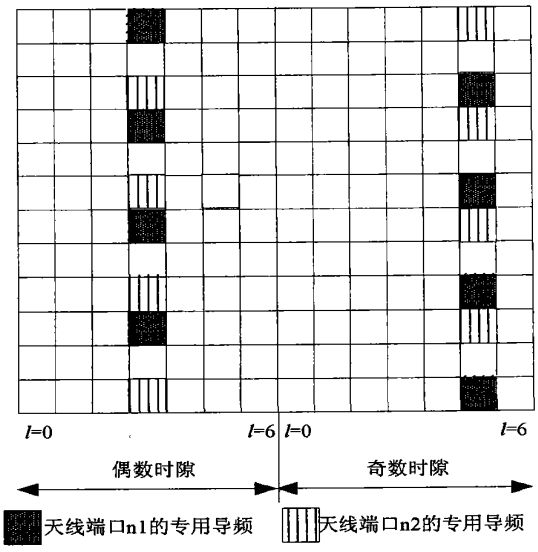


图 4a

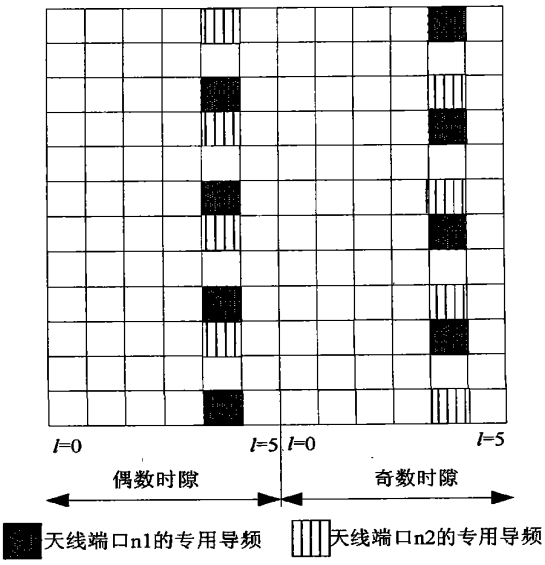


图 4b

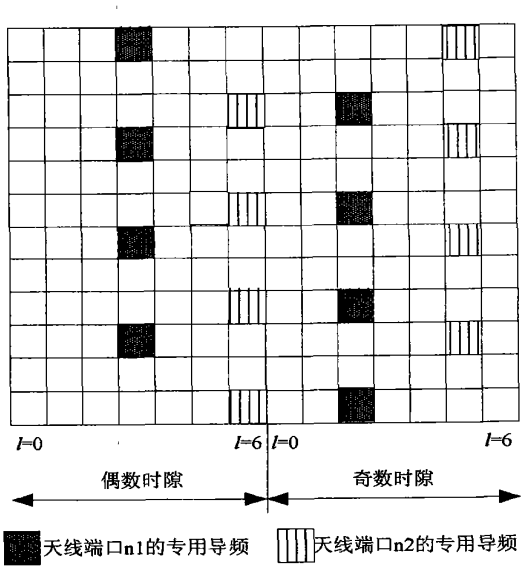

l=0
l=6
l=0
l=6
偶数时隙
奇数时隙
天线端口n1的专用导频
天线端口n2的专用导频

图 5a

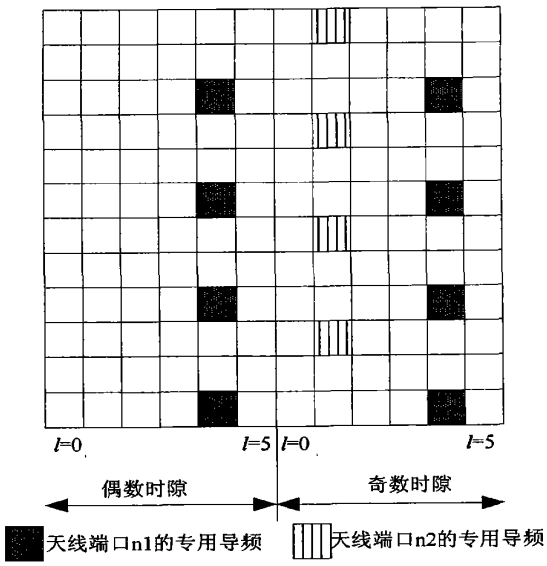

l=0
l=5
l=0
l=5
偶数时隙
奇数时隙
天线端口n1的专用导频
天线端口n2的专用导频

图 5b

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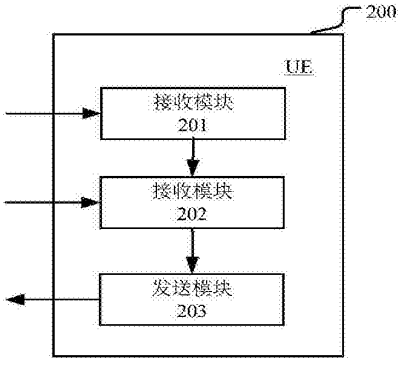
权利要求书3页 说明书11页 附图4页

(54)发明名称

无线通信中的一种低延迟的方法和装置

(57)摘要

本发明公开了无线通信中的一种低延迟的方法和装置。作为一个实施例，UE在步骤一中接收第一信令，第一信令调度N个传输块组的发送；在步骤二中接收N个传输块组，所述N个传输块组分别在N个LTE时隙发送；在步骤三中在N个子资源组中分别发送N个上行信令，所述N个上行信令分别指示所述N个传输块组中的传输块是否被正确接收。其中，第一信令是物理层信令，所述N是正整数。一个所述传输块组包括G个传输块，所述G是正整数。一个所述子资源组包括J个子资源，一个所述子资源的格式是PUCCH格式{1，1a，1b}在一个LTE时隙内的部分，所述J为1或者2。本发明能降低网络延时，同时尽可能保持和现有LTE设备的兼容性。



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1. 一种支持低延迟无线通信的 UE 中的方法，其中，包括如下步骤：

- 步骤 A. 接收第一信令，第一信令调度 N 个传输块组的发送

- 步骤 B. 接收 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送

- 步骤 C. 在 N 个子资源组中分别发送 N 个上行信令，所述 N 个子资源组分别位于 N 个后续 LTE 时隙，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

- 第一格式 . LTE PUCCH 格式 {1，1a，1b}

- 第二格式 . LTE PUCCH 格式 {2，2a，2b}。

- 第三格式 . LTE PUCCH 格式 3

- 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

2. 根据权利要求 1 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A0. 接收第二信令，第二信令指示 L 个候选资源，所述 L 是正整数。

其中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由所述 N 个子资源组组成，第二信令是高层信令，一个所述候选资源在所述 N 个后续 LTE 时隙中分别包括一个所述子资源组。

3. 根据权利要求 1 所述的方法，其特征在于，所述给定格式是第一格式，第一信令包括第一信息和第二信息，第一信息指示所述 N 个子资源组对应的频带边界，第二信息指示第一选定资源的索引相比第一关联资源的索引的偏移量。第一关联资源由第一信令所占用的第一个信道单元的索引确定，第一选定资源由所述 N 个子资源组组成，第一关联资源在所述 N 个后续 LTE 时隙中的每个频带边界分别包括一个所述子资源组。第一信令所占用的 RE 由一个或者多个所述信道单元组成，所述信道单元中包括 W 个 RE，所述 W 是大于 10 的正整数。

4. 根据权利要求 1 ～ 3 所述的方法，其特征在于，所述步骤 C 还包括如下步骤：

- 步骤 C0. 确定所述上行信令的发送功率为第一功率。

其中，第一功率随着总偏移值的变化而线性变化，所述总偏移值是由目标 TPC 命令集合中的每一个 TPC 命令所指示的调整功率的和，所述目标 TPC 命令集合包括所述 UE 在重置后截止到第一信令接收到的所有由物理层信令指示的 TPC 命令。

5. 根据权利要求 4 所述的方法，其特征在于，第一功率是按照 LTE 方案确定的所述给定格式的发送功率，除了如下修正：

-. 采用所述总偏移值代替 g(i)

-. 增加 3dB 的额外偏移。

6. 一种支持低延迟无线通信的基站中的方法，其中，包括如下步骤：

- 步骤 A. 发送第一信令，第一信令调度 N 个传输块组的发送

- 步骤 B. 发送 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送

- 步骤 C. 在 N 个后续 LTE 时隙分别接收 N 个上行信令，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，

所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

- 第一格式 . LTE PUCCH 格式 {1，1a，1b}

- 第二格式 . LTE PUCCH 格式 {2，2a，2b}。

- 第三格式 . LTE PUCCH 格式 3

- 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

7. 根据权利要求 6 所述的方法，其特征在于，所述步骤 A 还包括如下步骤：

- 步骤 A0. 发送第二信令，第二信令指示 L 个候选资源，所述 L 是正整数。

其中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由所述 N 个子资源组组成，第二信令是高层信令，一个所述候选资源在所述 N 个后续 LTE 时隙中分别包括一个所述子资源组。

8. 根据权利要求 6 所述的方法，其特征在于，所述给定格式是第一格式，第一信令包括第一信息和第二信息，第一信息指示所述 N 个子资源组对应的频带边界，第二信息指示第一选定资源的索引相比第一关联资源的索引的偏移量。第一关联资源由第一信令所占用的第一个信道单元的索引确定，第一选定资源由所述 N 个子资源组组成，第一关联资源在所述 N 个后续 LTE 时隙中的每个频带边界分别包括一个所述子资源组。第一信令所占用的 RE 由一个或者多个所述信道单元组成，所述信道单元中包括 W 个 RE，所述 W 是大于 10 的正整数。

9. 根据权利要求 6 ～ 8 所述的方法，其特征在于，所述步骤 C 还包括如下步骤：

- 步骤 C0. 确定所述上行信令的发送功率为第一功率。

其中，第一功率随着总偏移值的变化而线性变化，所述总偏移值是由目标 TPC 命令集合中的每一个 TPC 命令所指示的调整功率的和，所述目标 TPC 命令集合包括所述 UE 在重置后截止到第一信令接收到的所有由物理层信令指示的 TPC 命令。

10. 根据权利要求 9 所述的方法，其特征在于，第一功率是按照 LTE 方案确定的所述给定格式的发送功率，除了如下修正：

-. 采用所述总偏移值代替 g(i)

-. 增加 3dB 的额外偏移。

11. 一种支持低延迟无线通信的用户设备，其中，包括如下模块：

第一模块：用于接收第一信令，第一信令调度 N 个传输块组的发送

第二模块：用于接收 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送

第三模块：用于在 N 个子资源组中分别发送 N 个上行信令，所述 N 个子资源组分别位于 N 个后续 LTE 时隙，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

- 第一格式 . LTE PUCCH 格式 {1，1a，1b}

- 第二格式 . LTE PUCCH 格式 {2，2a，2b}。

- 第三格式 . LTE PUCCH 格式 3

- 第四格式．用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

12. 一种支持低延迟无线通信的基站设备，其中，包括如下模块：

第一模块：用于发送第一信令，第一信令调度 N 个传输块组的发送

第二模块：用于发送 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送

第三模块：用于在 N 个后续 LTE 时隙分别接收 N 个上行信令，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

- 第一格式．LTE PUCCH 格式 {1，1a，1b}
- 第二格式．LTE PUCCH 格式 {2，2a，2b}。
- 第三格式．LTE PUCCH 格式 3
- 第四格式．用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

无线通信中的一种低延迟的方法和装置

技术领域

[0001] 本发明涉及无线通信系统中的传输方案，特别是涉及基于长期演进（LTE-Long Term Evolution）的低延迟传输的方法和装置。

背景技术

[0002] 在3GPP(3rd Generation Partner Project，第三代合作伙伴项目)RAN(Radio Access Network，无线接入网)#63次全会上，降低LTE网络的延迟这一课题被讨论。LTE网络的延迟包括空口延迟，信号处理延时，节点之间的传输延时等。随着无线接入网和核心网的升级，传输延时被有效降低了。随着具备更高处理速度的新的半导体的应用，信号处理延时被显著降低了。

[0003] LTE中，TTI(Transmission Time Interval，传输时间间隔）或者子帧或者PRB(Physical Resource Block)对(Pair)在时间上对应一个ms(milli-second，毫秒）。一个LTE子帧包括两个时隙(Time Slot)-分别是第一时隙和第二时隙。PDCCH(Physical Downlink Control Channel，物理下行控制信道）占用PRB对的前R个OFDM(Orthogonal Frequency Division Multiplexing，正交频分复用）符号，所述R是不超过4的正整数，所述R由PCFICH(Physical Control Format Indicator Channel，物理控制格式指示信道）配置。对于FDD(Frequency Division Duplex，频分双工)LTE，HARQ(Hybrid Automatic Repeat reQuest，混合自动重传请求）回环时间是8ms，少量的HARQ重传将带来数十ms的网络延时。因此降低空口延迟成为降低LTE网络延时的有效手段。

[0004] 针对LTE中存在较长的空口延迟这一问题，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(User Equipment，用户设备）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。

发明内容

[0005] 为了降低空口延迟，一个直观的方法是采用短的TTI，例如0.5ms的TTI。发明人通过研究发现，TTI的长度只是空口延迟的一个因素，长达1ms的上行物理层控制信令所带来的延时也显著影响空口延迟。进一步的，新的控制信令的方案应当尽可能兼容现有的LTE设备。

[0006] 本发明针对上述问题提供了解决方案。

[0007] 本发明公开了一种支持低延迟无线通信的UE中的方法，其中，包括如下步骤：

[0008] -步骤A. 接收第一信令，第一信令调度N个传输块组的发送

[0009] -步骤B. 接收N个传输块组，所述N个传输块组分别在N个LTE时隙发送

[0010] -步骤C. 在N个子资源组中分别发送N个上行信令，所述N个子资源组分别位于N个后续LTE时隙，所述N个上行信令分别指示所述N个传输块组中的传输块是否被正确接收。

[0011] 其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

[0012] - 第一格式 . LTE PUCCH 格式 {1，1a，1b}

[0013] - 第二格式 . LTE PUCCH 格式 {2，2a，2b}。

[0014] - 第三格式 . LTE PUCCH 格式 3

[0015] - 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

[0016] 上述方法中，上行信令在一个 LTE 时隙中发送，减少了空口延迟。另一方面，基站根据信道质量等参数为所述上行信令动态选择合适的频域资源，降低了 BLER(Blocking Error Rate，误块率）。此外，减少第一频域位置所包括的 PRB 数量能够（在给定最大上行发送功率的条件下）提高提高上行覆盖范围。

[0017] 上述方面的另一个优点是，在所述 N 个 LTE 时隙中，所述上行信令可能和现有的 LTE PUCCH 格式（例如第一格式和第二格式）在一个 PRB 中共存，即所述上行信令和 LTE PUCCH 资源共享 PRB，提高了传输效率。

[0018] 本发明中，PUCCH 资源是 LTE 中的 PUCCH Resource。详细的定义参考 TS36.213 和 TS36.211 中的 PUCCH resource 的定义。

[0019] 作为一个实施例，所述 N 个子资源组在每个所述后续 LTE 时隙中所占用的（一个或者多个）PRB 是相同的。

[0020] 作为一个实施例，一个所述子资源组所占用的多（大于 1）个 PRB 在频域上是连续的。

[0021] 作为一个实施例，所述子资源的格式和所述给定格式分别包括 {RS(Reference Signal，参考信号）所占用的 SC-FDMA(Single Carrier Frequency Division Multiple Access，单载波频分复用）符号的数量和位置，RS 序列，调制符号所占用的 SC-FDMA 符号的位置，调制符号映射到 RE 所采用的正交序列 }，所述调制符号由 HARQ-ACK 比特调制而成。

[0022] 作为一个实施例，所述子资源的格式和所述给定格式分别包括 HARQ-ACK 比特数。

[0023] 作为一个实施例，所述 N 为 1。

[0024] 作为一个实施例，所述 N 为 2，所述 N 个 LTE 时隙属于一个 LTE 子帧。

[0025] 作为一个实施例，第一选定资源对应的 PRB 属于 PUCCH 区域。即所述上行信令能够和第一格式或第二格式在一个 PRB 中共存

[0026] 作为一个实施例，第一信令是用于下行调度 (Downlink Grant) 的 DCI(Downlink Control Information，下行控制信息）。作为上述实施例的一个子实施例，第一信令是 DCI 格式 {1，1A，1B，1C，1D，2，2A，2B，2C，2D} 中的一种。

[0027] 作为一个实施例，所述传输块是 MAC(Medium Access Control，媒体接入控制）PDU(Protocol Data Unit，协议数据单元）。

[0028] 作为一个实施例，所述 G 为 1。

[0029] 作为一个实施例，所述 G 为 2，所述 G 个传输块分别由不同的天线端口发送。

[0030] 作为一个实施例，第一信令中包括 G 个调制编码索引，所述 G 个调制编码索引分别用于指示所述传输块组中的所述 G 个传输块所采用的调制方式和编码速率（即所述 N 个传输块组共享相同的 G 个 MCS)。作为上述实施例的一个子实施例，所述调制编码索引是 LTE

中的MCS(Modulation and Coding Scheme,调制编码方案)。

[0031] 作为一个实施例,所述给定格式是第一格式,所述J为1。

[0032] 作为一个实施例,所述给定格式是第二格式,所述J为1。

[0033] 作为一个实施例,所述给定格式是第三格式,所述J为2。

[0034] 作为一个实施例,所述给定格式是第四格式,所述J大于2。

[0035] 作为一个实施例,第四格式是在聚合载波数大于5的场景中用于传输HARQ-ACK的PUCCH格式。

[0036] 作为一个实施例,第四格式的一个PUCCH资源占用的PRB对的数量大于1。

[0037] 作为一个实施例,所述上行信令还用于指示{SR(Scheduling Request,调度请求),RI(Rank Indicator,秩指示),PMI(Precoding Matrix Indicator,预编码矩阵指示),CQI(Channel Quality Indicator,信道质量指示),PTI(Prcoding Type Indicator,预编码类型指示)}中的一种或者多种。

[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A0.接收第二信令,第二信令指示L个候选资源,所述L是正整数。

[0040] 其中,第一信令指示第一选定资源在所述L个候选资源中的索引,第一选定资源由所述N个子资源组组成,第二信令是高层信令,一个所述候选资源在所述N个后续LTE时隙中分别包括一个所述子资源组。

[0041] 对于{第二格式,第三格式,第四格式},LTE的传统终端设备所占用的PUCCH资源是由高层信令配置的。因此,第二信令能够避免所述上行信令和传统的PUCCH信令发生冲突。

[0042] 作为上述方面的一个实施例,所述给定格式是第一格式之外的PUCCH格式。

[0043] 作为一个实施例,第一信令在辅小区上传输。

[0044] 作为一个实施例,所述上行信令还指示目标传输块是否被正确接收,所述目标传输块是所述N个传输块组之外的传输块。

[0045] 作为一个实施例,第二信令是RRC(Radio Resource Control,无线资源控制)层信令。

[0046] 作为一个实施例,所述L是2的正整数次幂。

[0047] 具体的,根据本发明的一个方面,其特征在于,所述给定格式是第一格式,第一信令包括第一信息和第二信息,第一信息指示所述N个子资源组对应的频带边界,第二信息指示第一选定资源的索引相比第一关联资源的索引的偏移量。第一关联资源由第一信令所占用的第一个信道单元的索引确定,第一选定资源由所述N个子资源组组成,第一关联资源在所述N个后续LTE时隙中的每个频带边界分别包括一个所述子资源组。第一信令所占用的RE由一个或者多个所述信道单元组成,所述信道单元中包括W个RE,所述W是大于10的正整数。

[0048] 对于第一格式,LTE的传统终端设备所占用的PUCCH资源是由PDCCH(Physical Downlink Control Channel)所占用的第一个CCE(Control Channel Element,控制信道单元)的索引所指示的。上述方面中,第一信息有助于基站为所述UE选择传输质量较好的频带,第二信息有助于避免和第一格式的PUCCH信令的冲突。

[0049] 所述频带边界是能用于传输第一格式的系统带宽的两个边界中的一个。作为一个

实施例，第一信息由 1 个信息比特指示。

[0050] 作为一个实施例，所述 W 是 {32,36} 中的一个。

[0051] 作为一个实施例，第一信令在 PDCCH 上传输，所述信道单元是 CCE。

[0052] 作为一个实施例，第一信令在 ePDCCH 上传输，所述信道单元是 eCCE。

[0053] 作为一个实施例，第一信令在一个 LTE 子帧中的第二时隙中传输，第一信令所占用的 RE 在 LTE 时隙中的图案和一个 PDCCH 所占用的 RE 在 LTE 时隙内的图案相同，所述信道单元所占用的 RE 在 LTE 时隙内的图案和一个 CCE 所占用的 RE 在 LTE 时隙内的图案相同。

[0054] 作为一个实施例，第一信令在一个 LTE 时隙内传输，所述信道单元在 LTE 时隙内所占用的 RE 包括第一部分和第二部分，其中第一部分和第二部分所占用的 RE 在 LTE 时隙内的图案分别和两个 CCE 所占用的 RE 在一个 LTE 时隙内的图案相同。

[0055] 具体的，根据本发明的上述方面，其特征在于，所述步骤 C 还包括如下步骤：

[0056] - 步骤 C0. 确定所述上行信令的发送功率为第一功率。

[0057] 其中，第一功率随着总偏移值的变化而线性变化，所述总偏移值是由目标 TPC 命令 (Command) 集合中的每一个 TPC 命令所指示的调整功率的和，所述目标 TPC 命令集合包括所述 UE 在重置 (Reset) 后截止到第一信令接收到的所有由物理层信令指示的 TPC 命令。

[0058] 上述方面的本质是（最小调度单位为 LTE 时隙）的第一信令中的 TPC 命令所指示的调整功率值和传统（最小调度单位为 LTE 子帧）的下行 DCI 中的 TPC 命令所指示的调整功率值能够叠加。

[0059] 作为一个实施例，第一功率到所述总偏移值的线性斜率为 1。作为一个实施例，第一功率的单位是 dBm（毫分贝）。

[0060] 作为一个实施例，上述物理层信令中包括最小调度单位为 LTE 时隙的信令和最小调度单位为 LTE 子帧的信令。

[0061] 具体的，根据本发明的上述方面，其特征在于，第一功率是按照 LTE 方案确定的所述给定格式的发送功率，除了如下修正：

[0062] -. 采用所述总偏移值代替 g(i)

[0063] -. 增加 3dB 的额外偏移。

[0064] 本发明的上述方面确保了所述上行信令的 BLER 和传统的 PUCCH 信令相比不会降低。

[0065] 本发明公开了一种支持低延迟无线通信的基站中的方法，其中，包括如下步骤：

[0066] - 步骤 A. 发送第一信令，第一信令调度 N 个传输块组的发送

[0067] - 步骤 B. 发送 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送

[0068] - 步骤 C. 在 N 个子资源组中分别接收 N 个上行信令，所述 N 个子资源组分别位于 N 个后续 LTE 时隙，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

[0069] 其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

[0070] - 第一格式 . LTE PUCCH 格式 {1,1a,1b}

[0071] - 第二格式 . LTE PUCCH 格式 {2,2a,2b}。

[0072] - 第三格式 . LTE PUCCH 格式 3

[0073] - 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

[0074] 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 ：

[0075] - 步骤 A0. 发送第二信令，第二信令指示 L 个候选资源，所述 L 是正整数。

[0076] 其中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由所述 N 个子资源组组成，第二信令是高层信令，一个所述候选资源在所述 N 个后续 LTE 时隙中分别包括一个所述子资源组。

[0077] 具体的，根据本发明的一个方面，其特征在于，所述给定格式是第一格式，第一信令包括第一信息和第二信息，第一信息指示所述 N 个子资源组对应的频带边界，第二信息指示第一选定资源的索引相比第一关联资源的索引的偏移量。第一关联资源由第一信令所占用的第一个信道单元的索引确定，第一选定资源由所述 N 个子资源组组成，第一关联资源在所述 N 个后续 LTE 时隙中的每个频带边界分别包括一个所述子资源组。第一信令所占用的 RE 由一个或者多个所述信道单元组成，所述信道单元中包括 W 个 RE，所述 W 是大于 10 的正整数。

[0078] 具体的，根据本发明的一个方面，其特征在于，所述步骤 C 还包括如下步骤 ：

[0079] - 步骤 C0. 确定所述上行信令的发送功率为第一功率。

[0080] 其中，第一功率随着总偏移值的变化而线性变化，所述总偏移值是由目标 TPC 命令 (Command) 集合中的每一个 TPC 命令所指示的调整功率的和，所述目标 TPC 命令集合包括所述 UE 在重置后截止到第一信令接收到的所有由物理层信令指示的 TPC 命令。

[0081] 具体的，根据本发明的上述方面，其特征在于，第一功率是按照 LTE 方案确定的所述给定格式的发送功率，除了如下修正 ：

[0082] -. 采用所述总偏移值代替 g(i)

[0083] -. 增加 3dB 的额外偏移。

[0084] 本发明公开了一种支持低延迟无线通信的用户设备，其中，包括如下模块 ：

[0085] 第一模块 :用于接收第一信令，第一信令调度 N 个传输块组的发送

[0086] 第二模块 :用于接收 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送

[0087] 第三模块 :用于在 N 个子资源组中分别发送 N 个上行信令，所述 N 个子资源组分别位于 N 个后续 LTE 时隙，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

[0088] 其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一 ：

[0089] - 第一格式 . LTE PUCCH 格式 {1，1a，1b}

[0090] - 第二格式 . LTE PUCCH 格式 {2，2a，2b}。

[0091] - 第三格式 . LTE PUCCH 格式 3

[0092] - 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

[0093] 作为一个实施例，上述用户设备的特征在于，第一模块还用于接收第二信令，第二信令指示 L 个候选资源，所述 L 是正整数。其中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由所述 N 个子资源组组成，第二信令是高层信令，一个所述

候选资源在所述 N 个后续 LTE 时隙中分别包括一个所述子资源组。

[0094] 作为一个实施例，上述用户设备的特征在于，所述给定格式是第一格式，第一信令包括第一信息和第二信息，第一信息指示所述 N 个子资源组对应的频带边界，第二信息指示第一选定资源的索引相比第一关联资源的索引的偏移量。第一关联资源由第一信令所占用的第一个信道单元的索引确定，第一选定资源由所述 N 个子资源组组成，第一关联资源在所述 N 个后续 LTE 时隙中的每个频带边界分别包括一个所述子资源组。第一信令所占用的 RE 由一个或者多个所述信道单元组成，所述信道单元中包括 W 个 RE，所述 W 是大于 10 的正整数。

[0095] 作为一个实施例，上述用户设备的特征在于，第三模块还用于确定所述上行信令的发送功率为第一功率。其中，第一功率随着总偏移值的变化而线性变化，所述总偏移值是由目标 TPC 命令 (Command) 集合中的每一个 TPC 命令所指示的调整功率的和，所述目标 TPC 命令集合包括所述 UE 在重置后截止到第一信令接收到的所有由物理层信令指示的 TPC 命令。第一功率是按照 LTE 方案确定的所述给定格式的发送功率，除了如下修正：

[0096] -. 采用所述总偏移值代替 g(i)

[0097] -. 增加 3dB 的额外偏移。

[0098] 本发明公开了一种支持低延迟无线通信的基站设备，其中，包括如下模块：

[0099] 第一模块：用于发送第一信令，第一信令调度 N 个传输块组的发送

[0100] 第二模块：用于发送 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送

[0101] 第三模块：用于在 N 个子资源组中分别接收 N 个上行信令，所述 N 个子资源组分别位于 N 个后续 LTE 时隙，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

[0102] 其中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

[0103] - 第一格式 . LTE PUCCH 格式 {1，1a，1b}

[0104] - 第二格式 . LTE PUCCH 格式 {2，2a，2b}。

[0105] - 第三格式 . LTE PUCCH 格式 3

[0106] - 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

[0107] 作为一个实施例，上述基站设备的特征在于，第一模块还用于发送第二信令，第二信令指示 L 个候选资源，所述 L 是正整数。其中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由所述 N 个子资源组组成，第二信令是高层信令，一个所述候选资源在所述 N 个后续 LTE 时隙中分别包括一个所述子资源组。

[0108] 作为一个实施例，上述基站设备的特征在于，所述给定格式是第一格式，第一信令包括第一信息和第二信息，第一信息指示所述 N 个子资源组对应的频带边界，第二信息指示第一选定资源的索引相比第一关联资源的索引的偏移量。第一关联资源由第一信令所占用的第一个信道单元的索引确定，第一选定资源由所述 N 个子资源组组成，第一关联资源在所述 N 个后续 LTE 时隙中的每个频带边界分别包括一个所述子资源组。第一信令所占用的 RE 由一个或者多个所述信道单元组成，所述信道单元中包括 W 个 RE，所述 W 是大于 10 的正整数。

[0109] 作为一个实施例，上述基站设备的特征在于，第三模块还用于确定所述上行信令的发送功率为第一功率。其中，第一功率随着总偏移值的变化而线性变化，所述总偏移值是由目标 TPC 命令 (Command) 集合中的每一个 TPC 命令所指示的调整功率的和，所述目标 TPC 命令集合包括所述 UE 在重置后截止到第一信令接收到的所有由物理层信令指示的 TPC 命令。第一功率是按照 LTE 方案确定的所述给定格式的发送功率，除了如下修正：

[0110] -. 采用所述总偏移值代替 g(i)

[0111] -. 增加 3dB 的额外偏移。

[0112] 相比现有公开技术，本发明具有如下技术优势：

[0113] -. 降低 PUCCH 所带来的空口延迟

[0114] -. 兼容现有的 LTE 设备，避免和传统的 PUCCH 信令相冲突

[0115] -. 提高频谱利用效率，同时确保上行信令的 BLER。

附图说明

[0116] 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：

[0117] 图 1 示出了根据本发明的一个实施例的下行传输的流程图；

[0118] 图 2 示出了根据本发明的一个实施例的上行信令位于 PUCCH 区域的示意图；

[0119] 图 3 示出了根据本发明的一个实施例的给定格式是第三格式的示意图；

[0120] 图 4 示出了根据本发明的一个实施例的第一信令的调度时序的示意图；

[0121] 图 5 示出了根据本发明的一个实施例的第二信令的传输流程图；

[0122] 图 6 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；

[0123] 图 7 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

[0124] 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。

[0125] 实施例 1

[0126] 实施例 1 示例了下行传输流程图，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，方框 F1 中标识的步骤是可选步骤。

[0127] 对于基站 N1，在步骤 S11 中发送第一信令，第一信令调度 N 个传输块组的发送。在步骤 S12 中发送 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送。在步骤 S13 中确定所述 N 个上行信令的发送功率是第一功率。在步骤 S14 中在 N 个子资源组中分别接收 N 个上行信令，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

[0128] 对于 UE U2，在步骤 S21 中接收第一信令。在步骤 S22 中接收 N 个传输块组。在步骤 S23 中确定所述 N 个上行信令的发送功率是第一功率。在步骤 S24 中在 N 个子资源组中分别发送 N 个上行信令。

[0129] 实施例 1 中，第一信令是物理层信令，所述 N 是正整数。所述 N 个子资源组分别位于 N 个后续 LTE 时隙。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子

资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述 N 个后续 LTE 时隙分别在所述 N 个 LTE 时隙之后。所述给定格式是以下之一：

[0130] - 第一格式 . LTE PUCCH 格式 {1，1a，1b}

[0131] - 第二格式 . LTE PUCCH 格式 {2，2a，2b}。

[0132] - 第三格式 . LTE PUCCH 格式 3

[0133] - 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

[0134] 作为实施例 1 的子实施例 1，所述 N 个后续 LTE 时隙位于 LTE 子帧 #i，第一功率为：

[0135] $$\min\left\{\begin{array}{l} P_{CMAX,c}(i), \\ P_{0\_PUCCH}+PL_c+h\left(n_{CQI},n_{HARQ},n_{SR}\right)+\Delta_{F\_PUCCH}(F)+\Delta_{TxD}(F')+G(i)+3 \end{array}\right\}$$ [dBm]

[0136] 其中，$P_{CMAX,c}(i)$ 是 UE U2 在主服务小区上的 LTE 子帧 #i 上的最大发送功率，P_{0_PUCCH} 和 $\Delta_{F\_PUCCH}(F)$ 分别是由高层信令配置的值，PL_c 是 UE U2 测量到的路径损耗，$h(n_{CQI}, n_{HARQ}, n_{SR})$ 是和所述给定格式相关的值，$\Delta_{TxD}(F')$ 是和发送所述上行信令的天线端口的数量相关的值。$P_{CMAX,c}(i)$，P_{0_PUCCH}，$\Delta_{F\_PUCCH}(F)$，PL_c，$h(n_{CQI}, n_{HARQ}, n_{SR})$，$\Delta_{TxD}(F')$ 的详细定义参考 TS36.213。G(i) 是总偏移值，所述总偏移值是由目标 TPC 命令集合中的每一个 TPC 命令所指示的调整功率的和，所述目标 TPC 命令集合包括所述 UE 在重置（即接收到 Meg 2）后截止到（包括）第一信令接收到的所有由物理层信令指示的 TPC 命令。

[0137] 作为实施例 1 的子实施例 2，所述 N 个后续 LTE 时隙位于 LTE 子帧 #i，第一功率为：

[0138] $P_{PUCCH}(i) = \min\{P_{CMAX,c}(i), P_{0\_PUCCH}+PL_c+G(i)+3\}$ [dBm]

[0139] 其中，$P_{CMAX,c}(i)$，P_{0_PUCCH}，PL_c，G(i) 分别参考上述子实施例 1 中的描述。

[0140] 上述 2 个子实施例的本质是：第一功率是按照 LTE 方案确定的所述给定格式的发送功率，除了如下修正：

[0141] -. 采用所述总偏移值 G(i) 代替 g(i)

[0142] -. 增加 3dB 的额外偏移。

[0143] 实施例 2

[0144] 实施例 2 示例了上行信令位于 PUCCH 区域的示意图，如附图 2 所示。附图 2 中，黑点填充的方格标识组成一个 PUCCH 区域的两个 PRB，所述两个 PRB 分别位于当前系统带宽的两个频带边界，所述两个 PRB 分别位于一个 LTE 子帧中的第一时隙和第二时隙。当前系统带宽中的 Z 个 PRB 对的索引分别是从 0 到 Z-1 的整数。

[0145] 实施例 2 中，本发明中的所述 N 是 2，所述 J 为 1，所述 N 个 LTE 时隙位于一个 LTE 子帧。

[0146] 作为所述实施例 2 的子实施例 1，基站发送第二信令给 UE，第二信令指示 L 个候选资源，所述 L 为 2。其中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由本发明中的所述 N 个子资源组组成，第二信令是高层信令，所述 L 个候选资源包括：

[0147] - 第一候选资源 . 包括第一子资源和第三子资源。

[0148] - 第二候选资源 . 包括第二子资源和第四子资源。

[0149] 作为所述实施例 2 的子实施例 2，本发明中的所述给定格式是第一格式，第一信令包括第一信息和第二信息，第一信息指示本发明中的所述 N 个子资源组对应的频带边界是上频带边界（靠近 PRB#Z-1）还是下频带边界（靠近 PRB#0），第二信息指示第一选定资源的索引相比第一关联资源的索引的偏移量。第一关联资源由第一信令所占用的第一个信道单元的索引确定，第一选定资源由所述 N 个子资源组组成。第一关联资源在第一时隙的上频带边界包括第一子资源，在第一时隙的下频带边界包括第二子资源，在第二时隙的上频带边界包括第三子资源，在第二时隙的下频带边界包括第四子资源。第一信息和第二信息共同指示了第一选定资源。

[0150] 作为实施例 2 的子实施例 3，本发明中的所述给定格式是第一格式，第一选定资源对应的（即所占用）的 PRB 的索引小于等于第一索引，或者大于等于第二索引，第一索引是目标子帧的第一时隙中能用于第一格式的 PRB 的索引中的最大值，第二索引和第一索引的和等于系统带宽中的 PRB 总数减 1，所述目标子帧是所述 N 个上行信令的传输子帧。第一索引的详细描述参考 TS36.211 的 5.4.3 节中针对 PUCCH 格式 {1，1a，1b} 的变量 m 的最大值。

[0151] 作为所述实施例 2 的子实施例 4，第一子资源和第四子资源组成一个第一格式的 PUCCH 资源，第二子资源和第三子资源组成一个第一格式的 PUCCH 资源。上述子实施例 4 的本质是，一个第一格式的 PUCCH 资源在两个 LTE 时隙中的部分只能同时，或者同时避免被用于传输针对短 TTI 的 HARQ-ACK。上述子实施例 4 最小化本发明中的所述子资源和 PUCCH 资源的冲突。

[0152] 实施例 3

[0153] 实施例 3 示例了给定格式是第三格式的示意图，如附图 3 所示。附图 3 中，粗线标识的方格是候选资源对应的 PRB，

[0154] 实施例 3 中，本发明中的所述 N 为 1，所述 J 为 2，所述给定格式是第三格式。基站发送第二信令给 UE，第二信令指示 L 个候选资源，所述 L 为 2。其中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由本发明中的所述 N 个子资源组组成，第二信令是高层信令，所述 L 个候选资源包括 { 第一候选资源，第二候选资源，第三候选资源，第四候选资源 }。

[0155] 实施例 3 中，一个所述候选资源包括 2 个子资源，所述 2 个子资源分别占用两个连续的 PRB。

[0156] 作为实施例 3 的子实施例 1，所述 2 个子资源分别用于传输不同的信息比特。

[0157] 实施例 4

[0158] 实施例 4 示例了第一信令的调度时序的示意图，如附图 4 所示。附图 4 中，斜线标识的方格是第一信令的传输时隙。

[0159] 实施例 4 中，本发明中的所述 N 个时隙是位于同一个 LTE 子帧中的 2 个 LTE 时隙，即第一信令和所述 N 个时隙的调度时序关系分别如箭头 A7 和 A8 指示。

[0160] 本发明中的所述 N 个后续 LTE 时隙分别是所述 N 个时隙之后的第 D 个时隙。所述 D 是正整数。即本发明中的所述 N 个上行信令和本发明中的所述 N 个传输块组的调度时序关系分别如箭头 R7 和 R8 所示。

[0161] 作为实施例 4 的子实施例 1，所述 D 为 4。

[0162] 作为实施例 4 的子实施例 1，所述 D 为 6

[0163] 实施例 5

[0164] 实施例 5 示例了第二信令的传输流程图，如附图 5 所示。附图 5 中，基站 N3 是 UE U4 的服务小区的维持基站。

[0165] 基站 N3 在步骤 S30 中发送第二信令。UE U4 在步骤 S40 中接收第二信令，第二信令指示 L 个候选资源，所述 L 是正整数。

[0166] 实施例 5 中，第一信令指示第一选定资源在所述 L 个候选资源中的索引，第一选定资源由本发明中的所述 N 个子资源组组成，第二信令是高层信令，一个所述候选资源在所述 N 个后续 LTE 时隙中分别包括一个所述子资源组。

[0167] 作为实施例 5 的子实施例 1，第二信令指示 L 个资源索引，所述 L 个索引分别对应所述 L 个候选资源。所述资源索引是非负整数。

[0168] 实施例 6

[0169] 实施例 6 示例了一个 UE 中的处理装置的结构框图，如附图 6 所示。附图 6 中，UE 处理装置 200 主要由接收模块 201，接收模块 202 和发送模块 203 组成。

[0170] 接收模块 201 用于接收第一信令，第一信令调度 N 个传输块组的发送。接收模块 202 用于接收 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送。发送模块 203 用于在 N 个子资源组中分别发送 N 个上行信令，所述 N 个子资源组分别位于 N 个后续 LTE 时隙，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

[0171] 实施例 6 中，第一信令是物理层信令，所述 N 是小于 3 的正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

[0172] - 第一格式 . LTE PUCCH 格式 {1，1a，1b}

[0173] - 第三格式 . LTE PUCCH 格式 3

[0174] - 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

[0175] 作为实施例 6 的子实施例 1，第一信令是 DCI 格式 {1，1A，1B，1C，1D，2，2A，2B，2C，2D} 中的一个。

[0176] 作为实施例 6 的子实施例 2，第一信令所占用的 RE 由一个或者多个所述信道单元组成，所述信道单元中包括 W 个 RE，对于普通 CP(Cyclic Prefix，循环前缀)，所述 W 是 36，对于扩展 CP，所述 W 是 32。

[0177] 实施例 7

[0178] 实施例 7 示例了一个基站中的处理装置的结构框图，如附图 7 所示。附图 7 中，基站处理装置 300 主要由发送模块 301，发送模块 302 和接收模块 303 组成。

[0179] 发送模块 301 用于发送第一信令，第一信令调度 N 个传输块组的发送。发送模块 302 用于发送 N 个传输块组，所述 N 个传输块组分别在 N 个 LTE 时隙发送。接收模块 303 用于在 N 个子资源组中分别接收 N 个上行信令，所述 N 个上行信令分别指示所述 N 个传输块组中的传输块是否被正确接收。

[0180] 实施例 7 中，第一信令是物理层信令，所述 N 是正整数。一个所述传输块组包括 G 个传输块，所述 G 是正整数。一个所述子资源组包括 J 个子资源，一个所述子资源的格式是

给定格式在一个 LTE 时隙内的部分，所述 J 为 1 或者 2。所述给定格式是以下之一：

[0181] - 第一格式 . LTE PUCCH 格式 {1，1a，1b}

[0182] - 第三格式 . LTE PUCCH 格式 3

[0183] - 第四格式 . 用于支持超过 20 个 ACK/NACK 比特的 PUCCH 格式。

[0184] 作为实施例 7 的子实施例 1，一个所述上行信令包括 G 个比特，所述 G 个比特分别指示相应传输块组中的 G 个传输块是否被正确译码。

[0185] 作为实施例 7 的子实施例 2，一个所述上行信令包括 1 个比特，所述 1 个比特指示相应传输块组中的 G 个传输块是否全部被正确译码。

[0186] 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 或者移动终端包括但不限于手机，平板电脑，笔记本，上网卡，车载通信设备，无线传感器等无线通信设备。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。

[0187] 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。

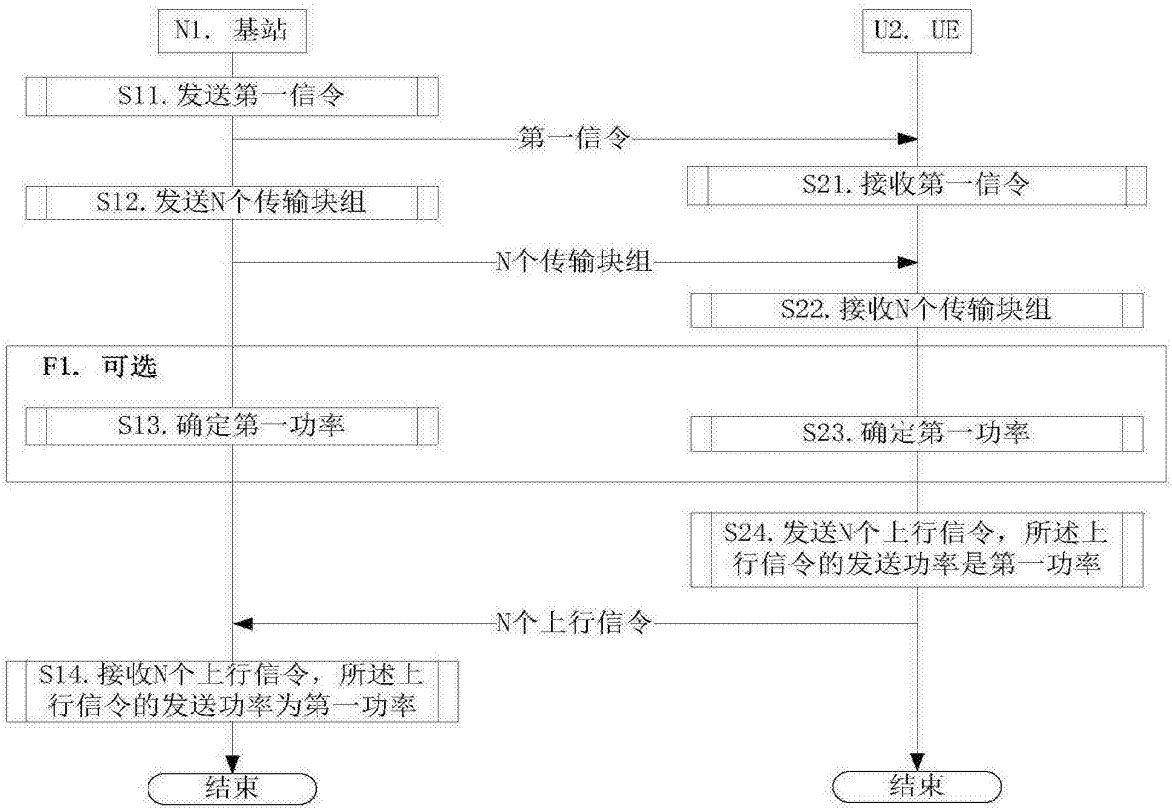

N1. 基站
U2. UE
S11. 发送第一信令
第一信令
S21. 接收第一信令
S12. 发送N个传输块组
N个传输块组
S22. 接收N个传输块组
F1. 可选
S13. 确定第一功率
S23. 确定第一功率
S24. 发送N个上行信令，所述上行信令的发送功率是第一功率
N个上行信令
S14. 接收N个上行信令，所述上行信令的发送功率为第一功率
结束
结束

图 1

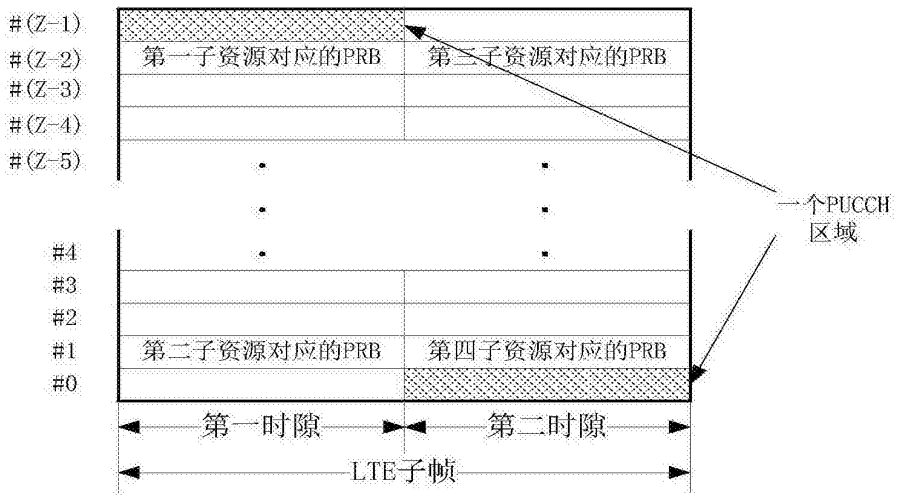

#(Z-1)
#(Z-2)
#(Z-3)
#(Z-4)
#(Z-5)
第一子资源对应的PRB
第三子资源对应的PRB
一个PUCCH区域
#4
#3
#2
#1
#0
第二子资源对应的PRB
第四子资源对应的PRB
第一时隙
第二时隙
LTE子帧

图 2

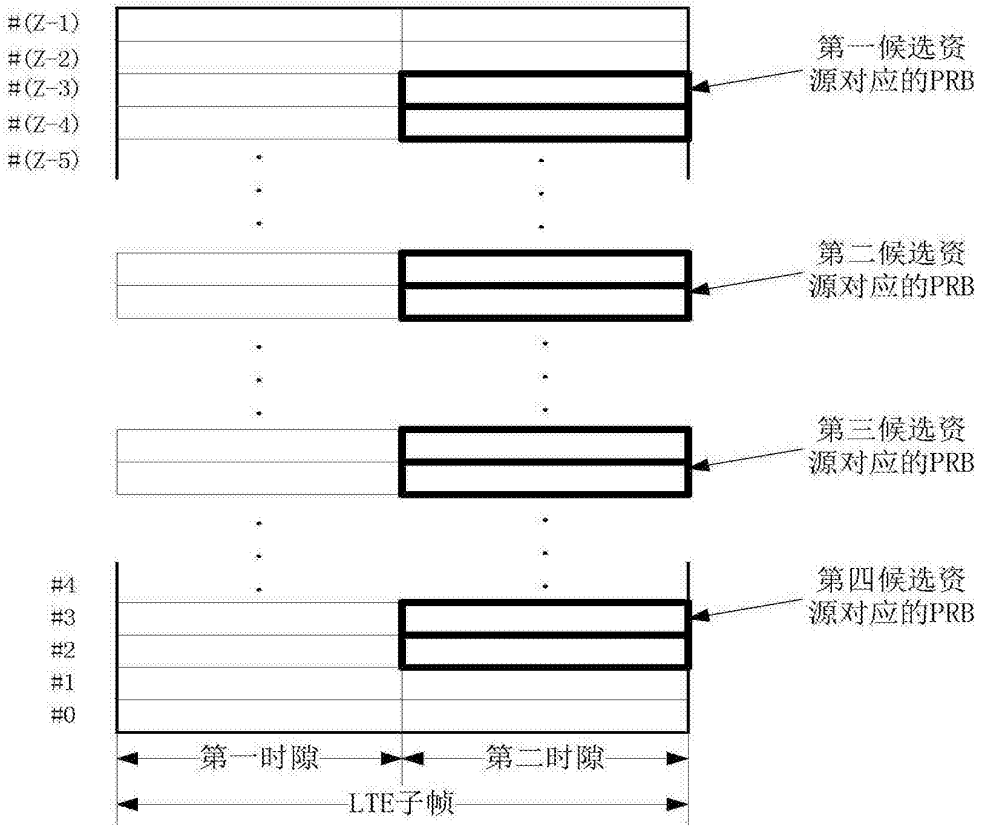

#(Z-1)
#(Z-2)
#(Z-3)
#(Z-4)
#(Z-5)
第一候选资源对应的PRB
第二候选资源对应的PRB
第三候选资源对应的PRB
#4
#3
#2
#1
#0
第四候选资源对应的PRB
第一时隙
第二时隙
LTE子帧

图 3

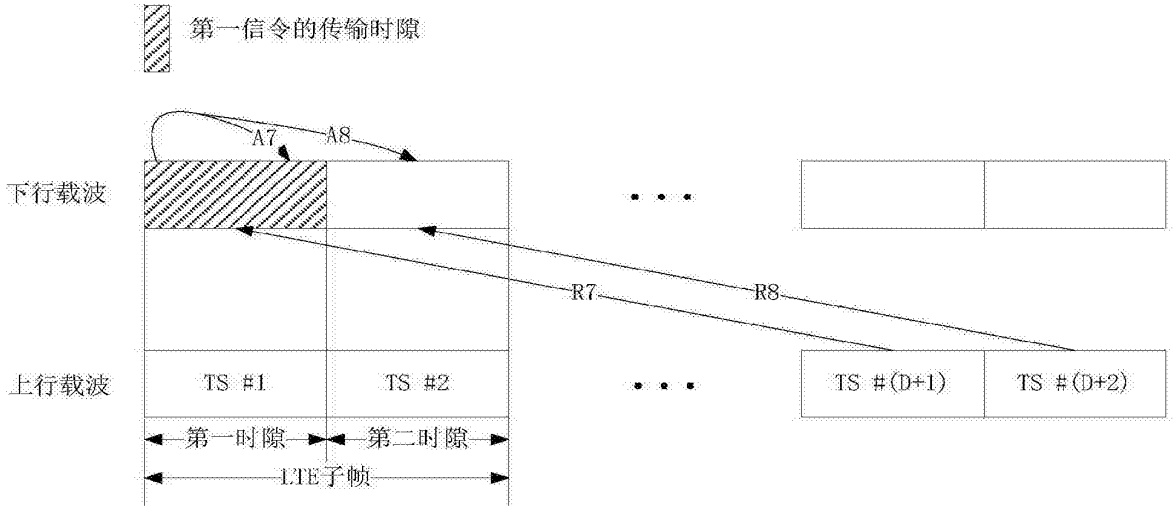

第一信令的传输时隙
A7
A8
下行载波
R7
R8
上行载波
TS #1
TS #2
TS #(D+1)
TS #(D+2)
第一时隙
第二时隙
LTE子帧

图 4

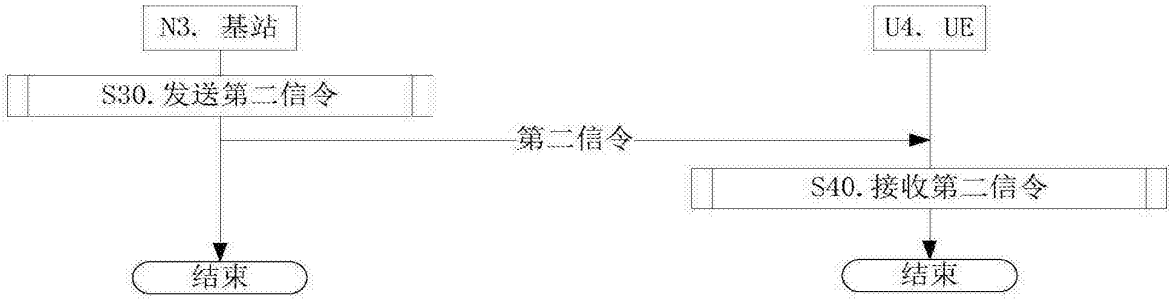

N3. 基站
U4. UE
S30. 发送第二信令
第二信令
S40. 接收第二信令
结束
结束

图 5

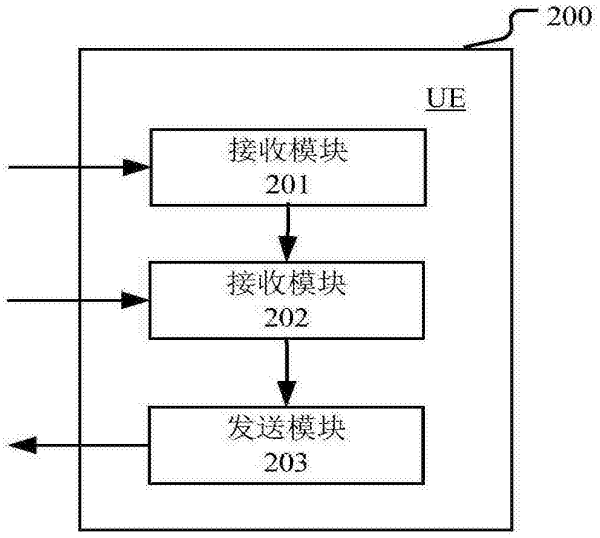

200
UE
接收模块
201
接收模块
202
发送模块
203

图 6

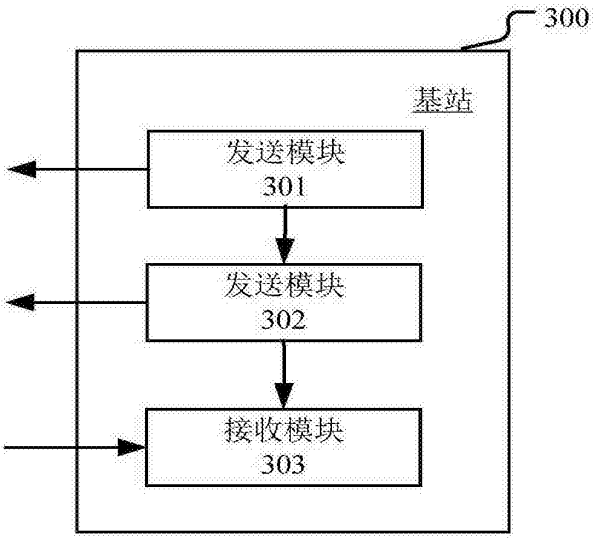


图 7

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(43) **Pub. Date: May 7, 2015**

(54) **METHOD AND APPARATUS FOR REPORTING CHANNEL STATE INFORMATION IN WIRELESS COMMUNICATION SYSTEM**

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§ 371 (c)(1),
(2) Date: **Dec. 12, 2014**

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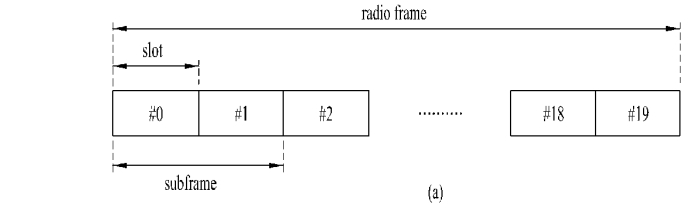
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H04L 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H04L 5/0053*** (2013.01)

(57) **ABSTRACT**

The present invention relates to a method and an apparatus for reporting channel status information (CSI). According to one embodiment of the present invention, the method comprises receiving a first CSI-reference signal (CSI-RS) based on CSI-RS configuration information with respect to a first domain antenna group of a two-dimensional antenna structure; reporting a first piece of CSI with respect to the first domain antenna group, which is generated using the first CSI-RS; receiving a second CSI-RS, based on CSI-RS configuration information with respect to a second domain antenna group of the two-dimensional antenna structure; and reporting a second piece of CSI with respect to the second domain antenna group, which is generated using the second CSI-RS, wherein the CSI-RS configuration information with respect to the second domain antenna group can be determined based on the first piece of CSI.



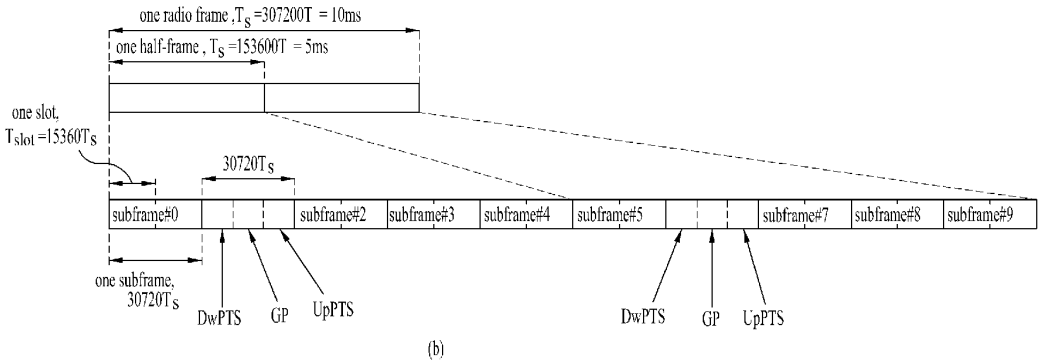


FIG. 1

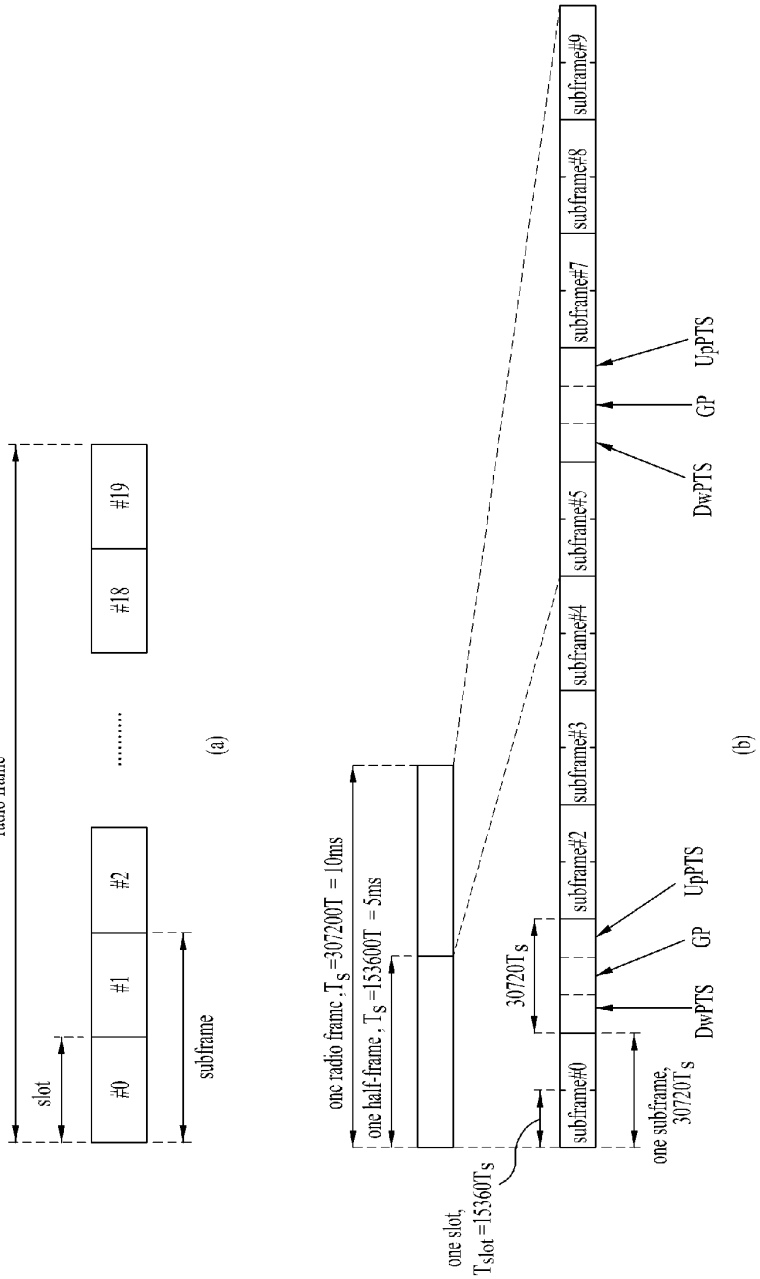

radio frame
slot
#0
#1
#2
.....
#18
#19
subframe
(a)
one radio frame, T_S =307200T = 10ms
one half-frame, T_S =153600T = 5ms
30720T_S
one slot, T_{slot} =15360T_S
subframe#0
subframe#2
subframe#3
subframe#4
subframe#5
subframe#7
subframe#8
subframe#9
DwPTS
GP
UpPTS
one subframe, 30720T_S
(b)

FIG. 2

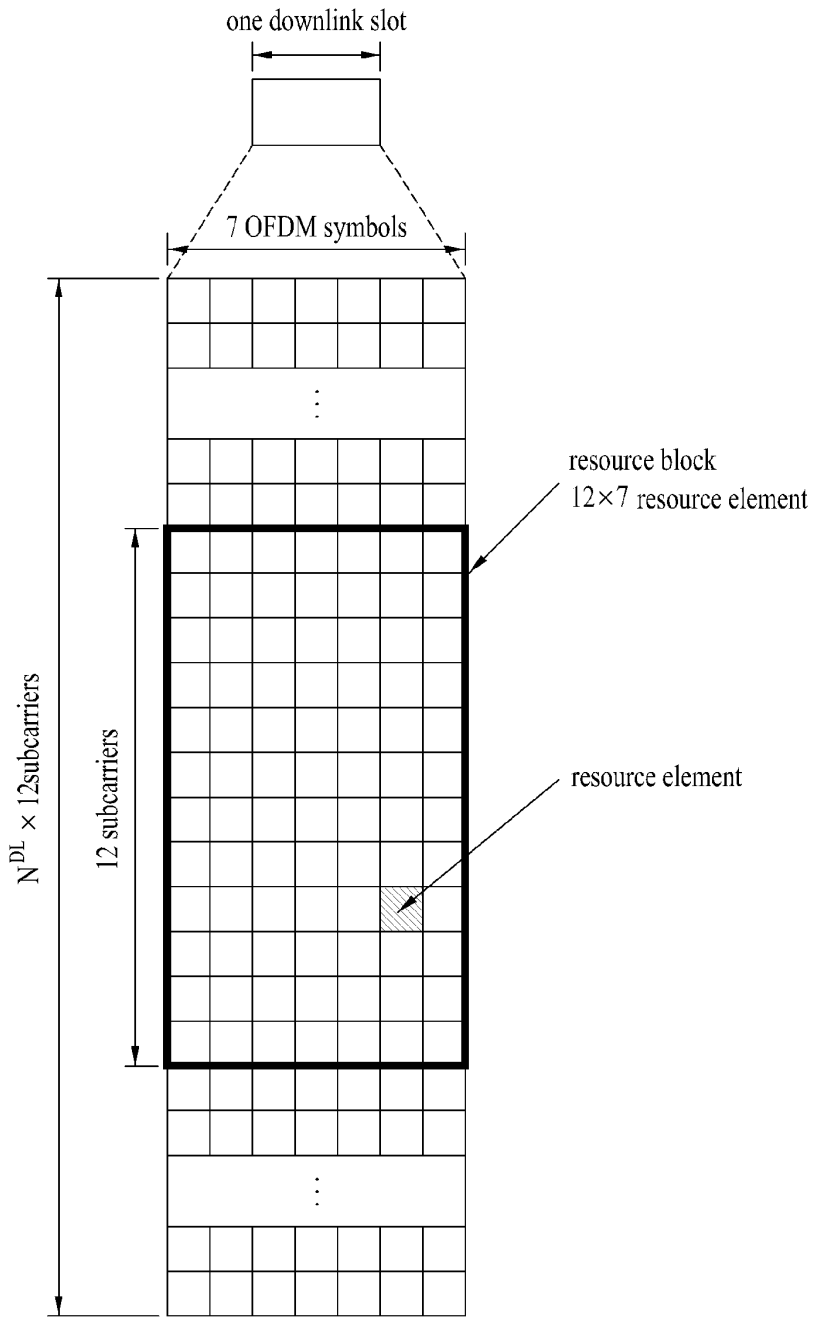

one downlink slot
7 OFDM symbols
resource block
12×7 resource element
resource element
N^{DL} × 12subcarriers
12 subcarriers

FIG. 3

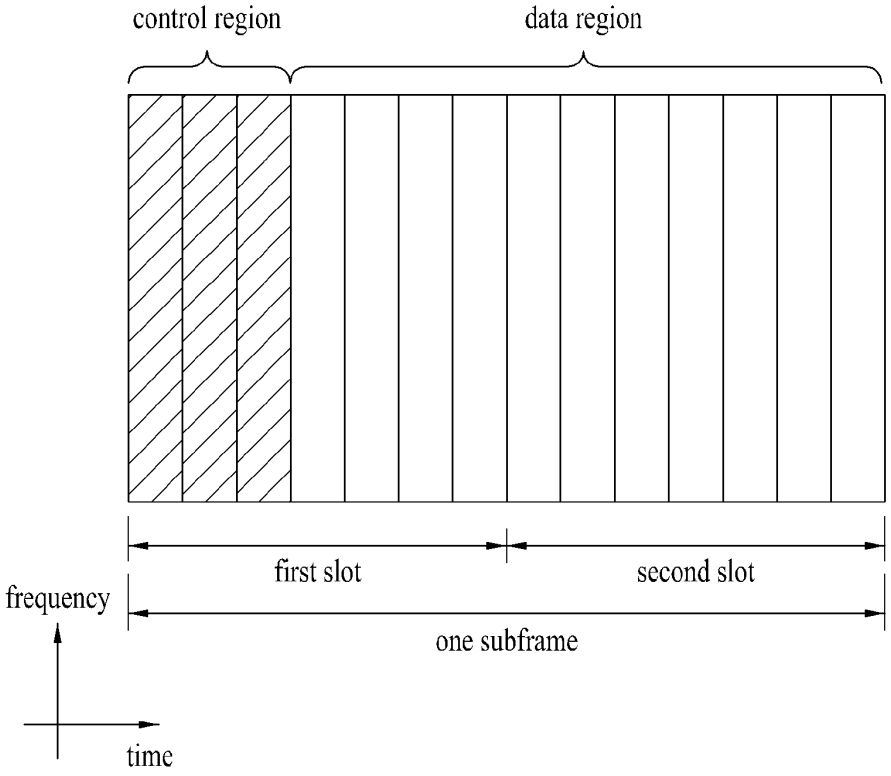

control region
data region
first slot
second slot
frequency
one subframe
time

FIG. 4

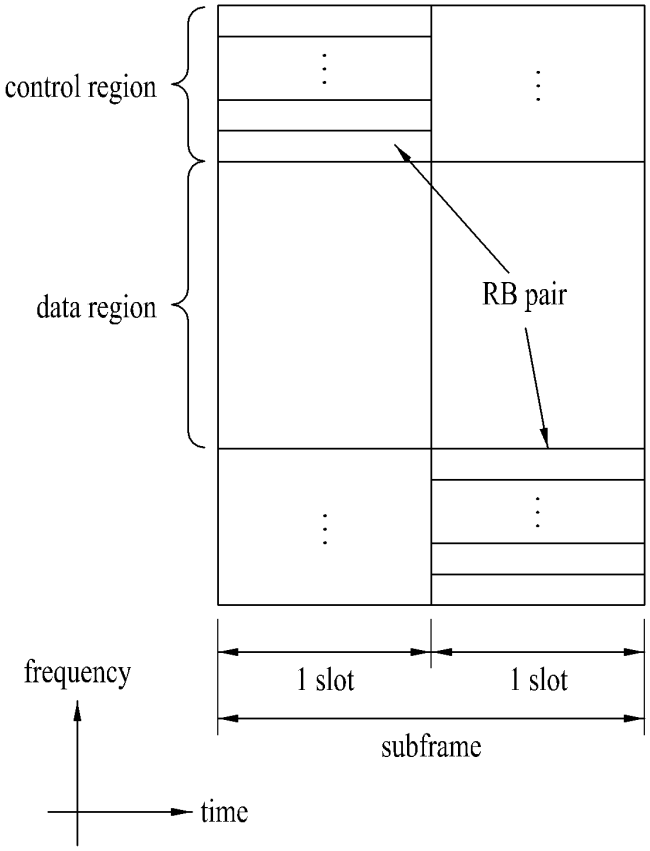
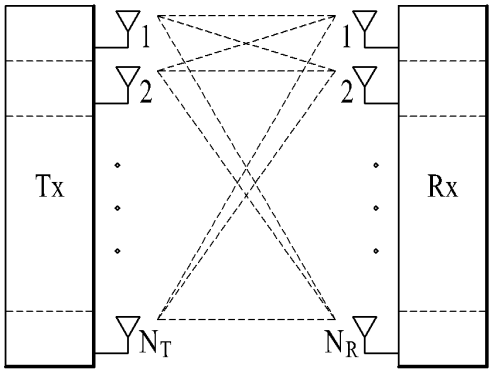
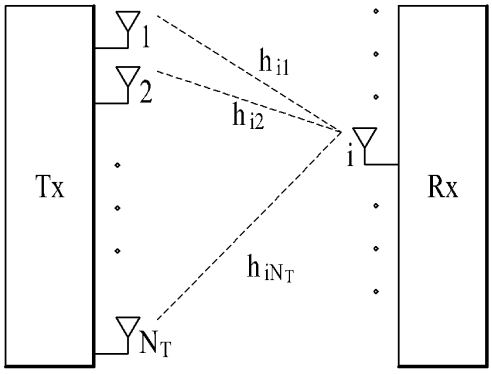

control region
data region
RB pair
frequency
time
1 slot
1 slot
subframe

FIG. 5



(a)



(b)

FIG. 6

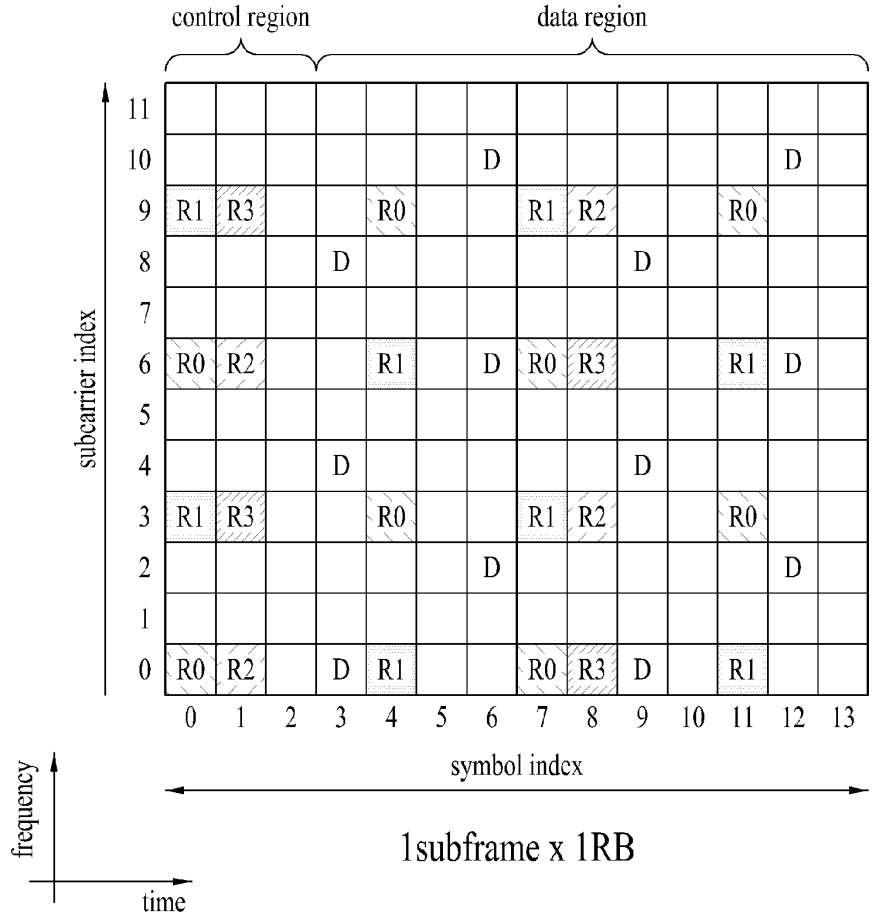

control region
data region
subcarrier index
11
10
9
8
7
6
5
4
3
2
1
0
R1 R3 R0 R1 R2 R0
D
R0 R2 R1 R0 R3 R1
0 1 2 3 4 5 6 7 8 9 10 11 12 13
symbol index
frequency
time
1subframe x 1RB

FIG. 7

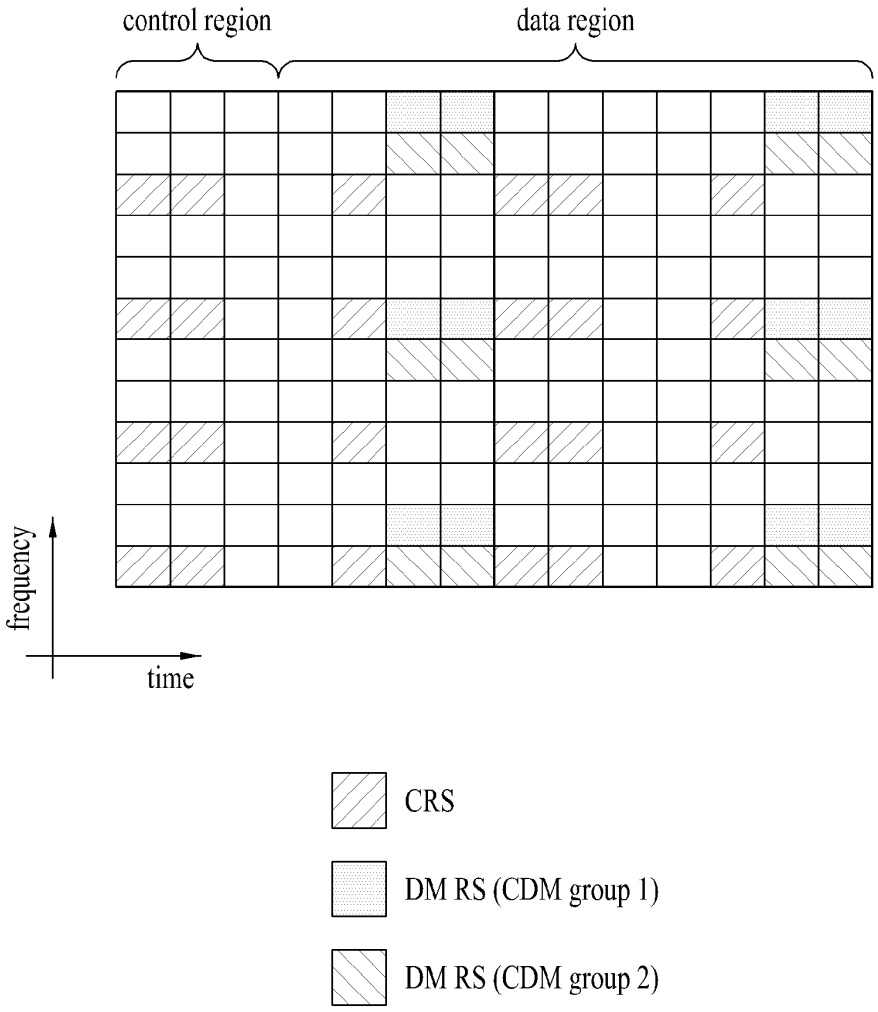

control region
data region
frequency
time
CRS
DM RS (CDM group 1)
DM RS (CDM group 2)

FIG. 8

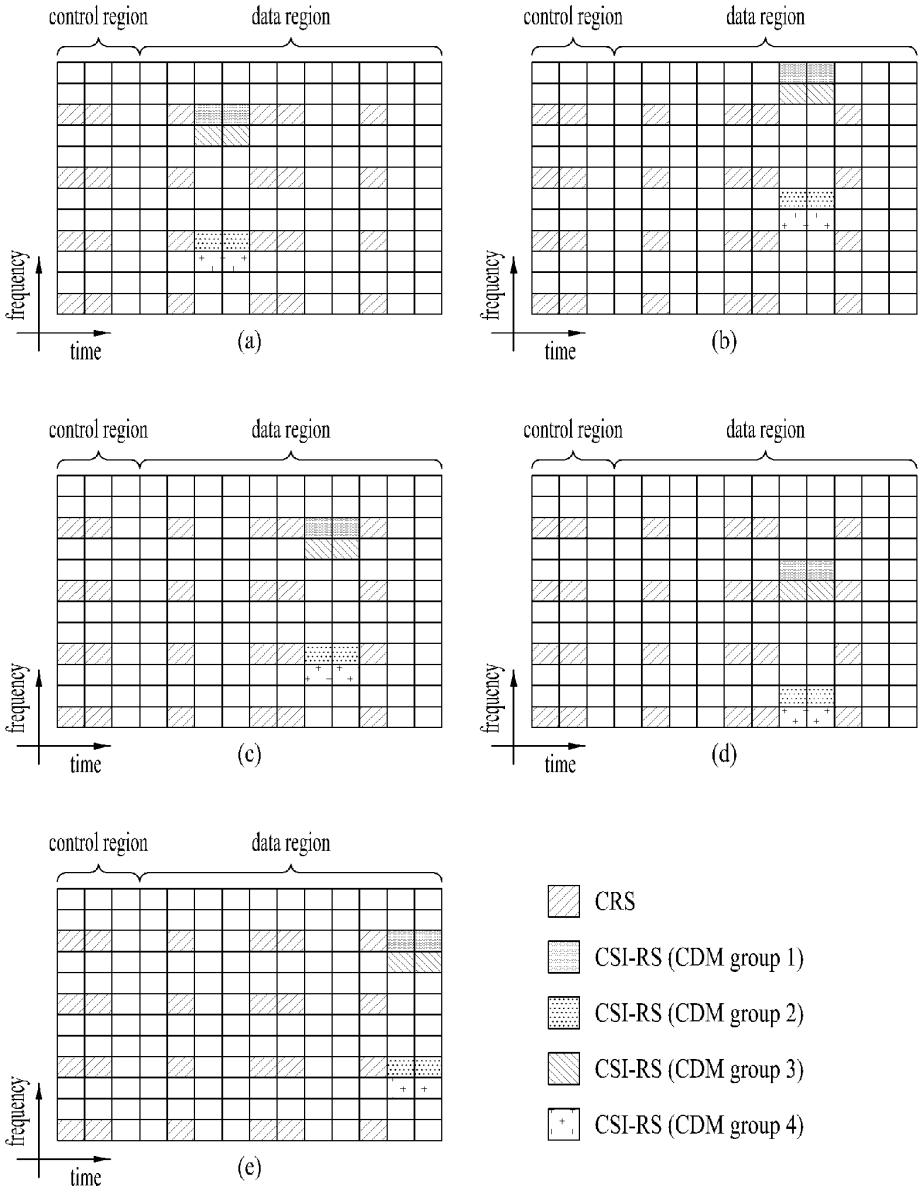

control region
data region
frequency
time
(a)
(b)
(c)
(d)
(e)
CRS
CSI-RS (CDM group 1)
CSI-RS (CDM group 2)
CSI-RS (CDM group 3)
CSI-RS (CDM group 4)

FIG. 9

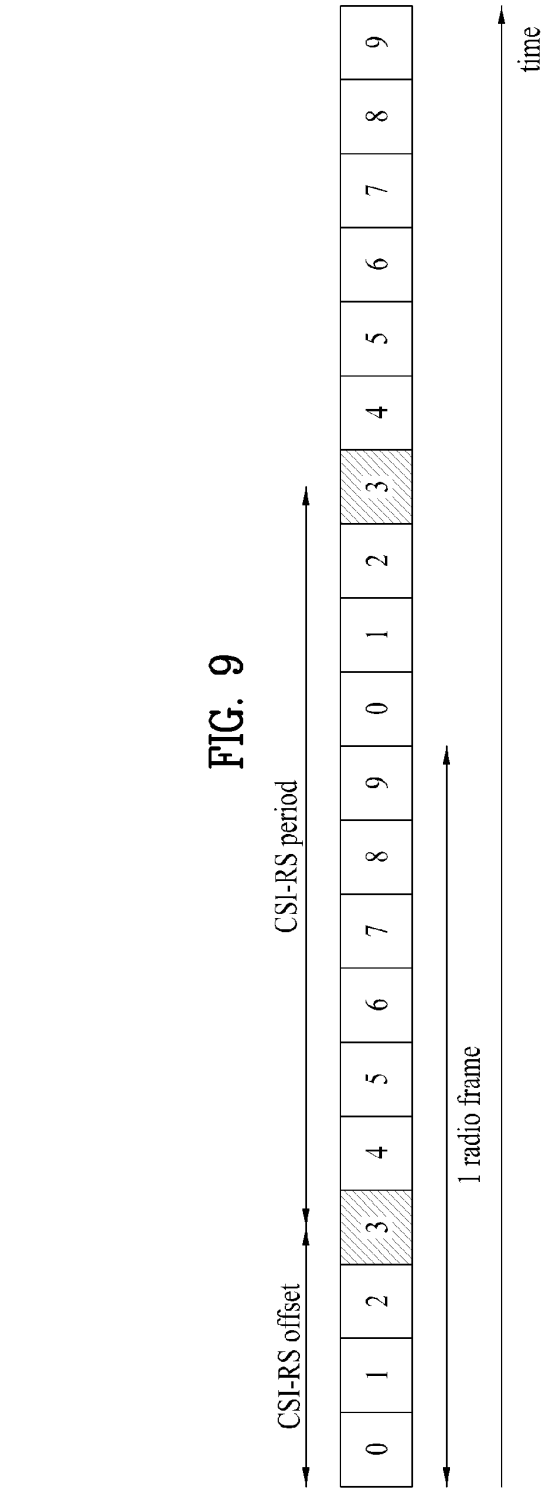


FIG. 10

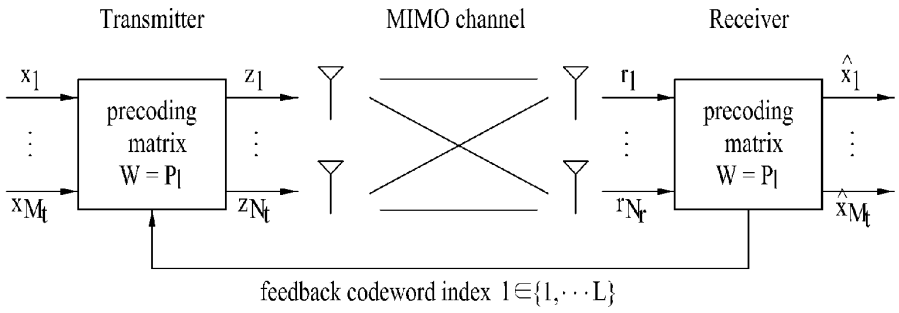

Transmitter
MIMO channel
Receiver
precoding matrix W = Pl
precoding matrix W = Pl
feedback codeword index l∈{1,···L}

FIG. 11

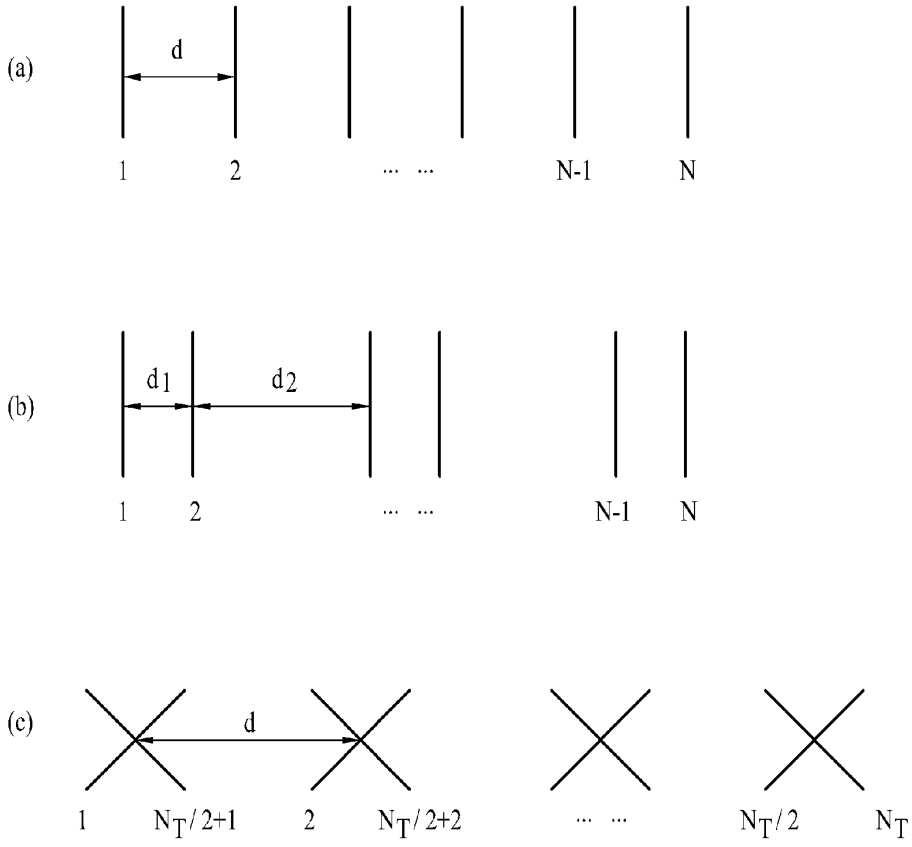
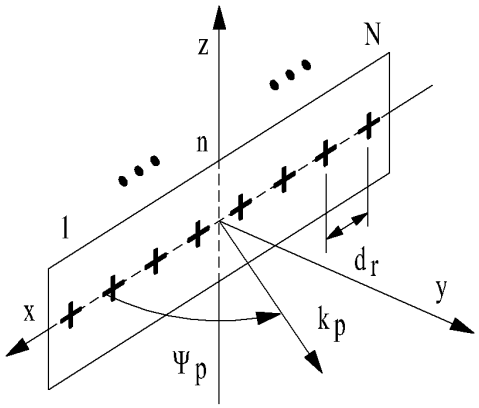
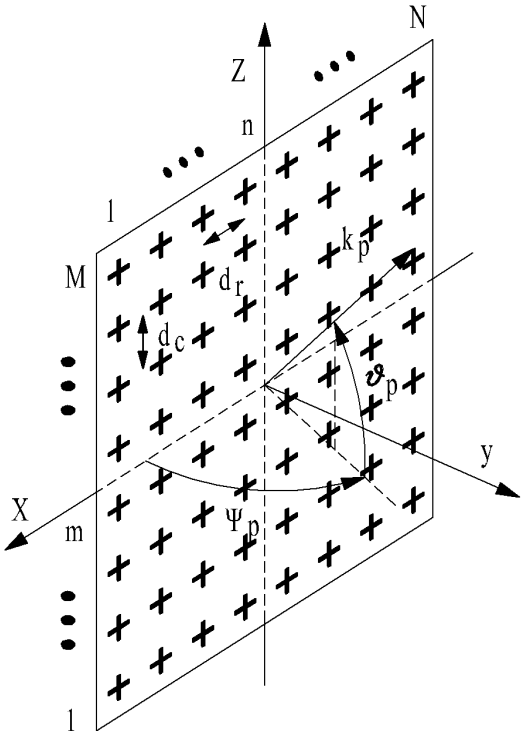


FIG. 12

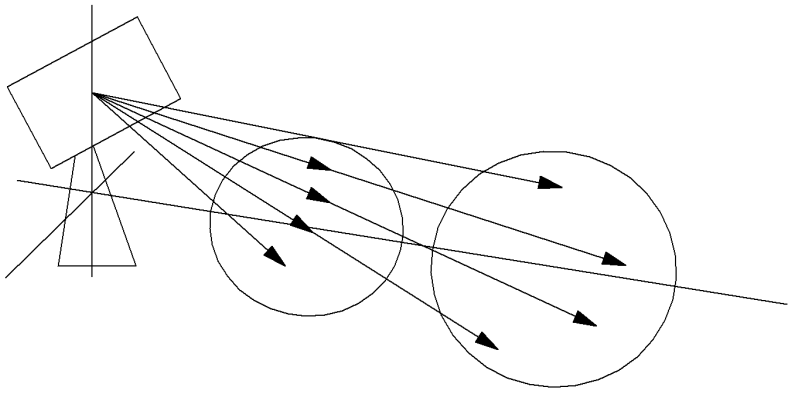


(a)

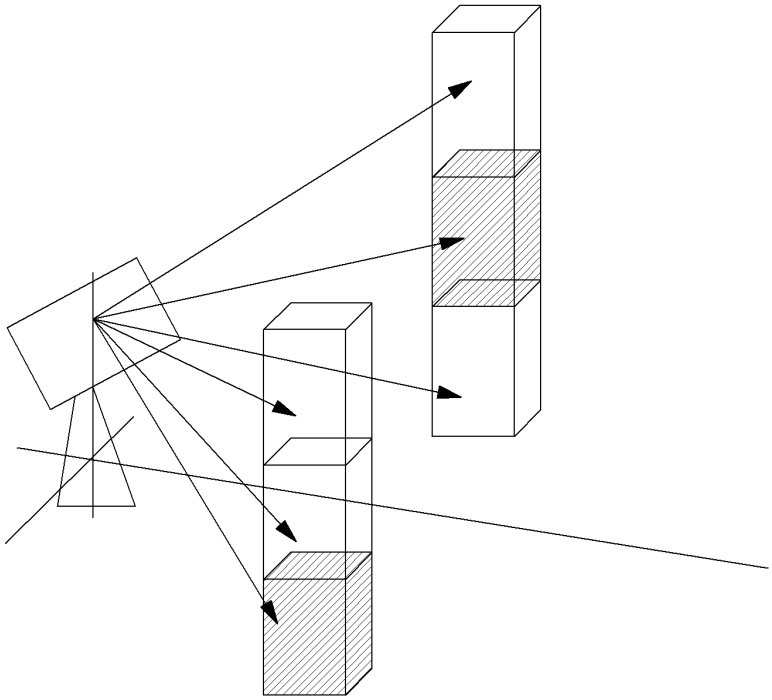


(b)

FIG. 13

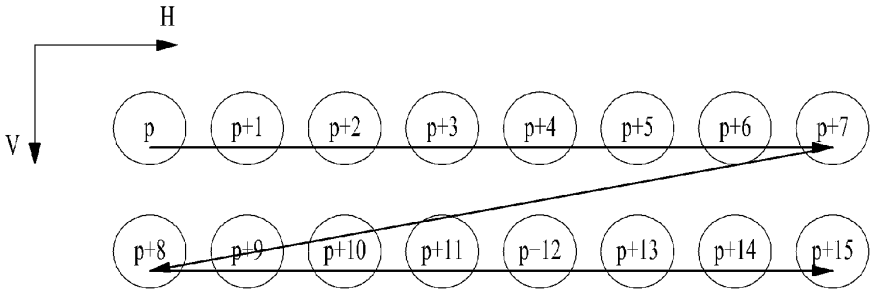


(a)

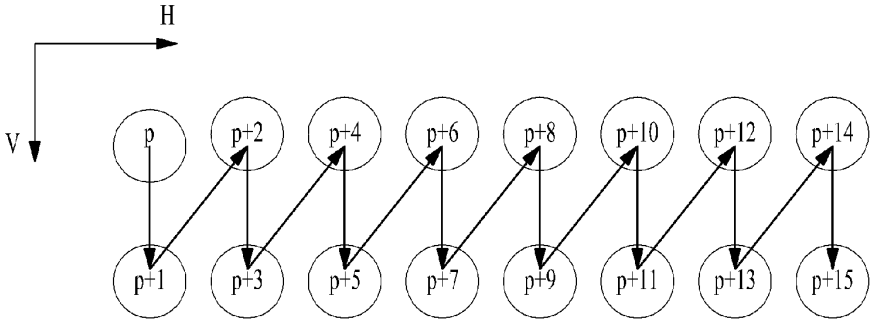


(b)

FIG. 14

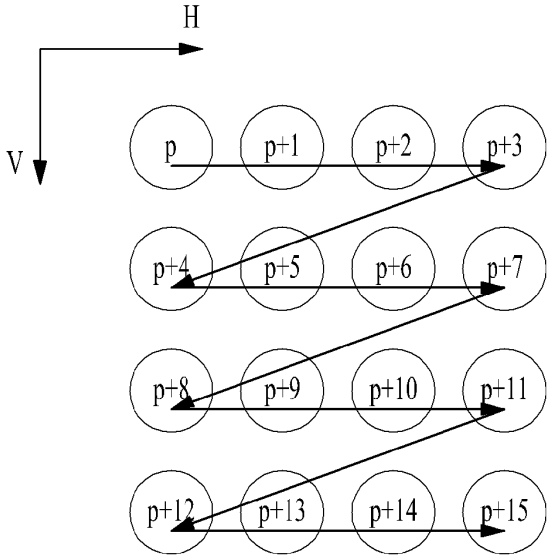

H
V
p
p+1
p+2
p+3
p+4
p+5
p+6
p+7
p+8
p+9
p+10
p+11
p−12
p+13
p+14
p+15

(a)

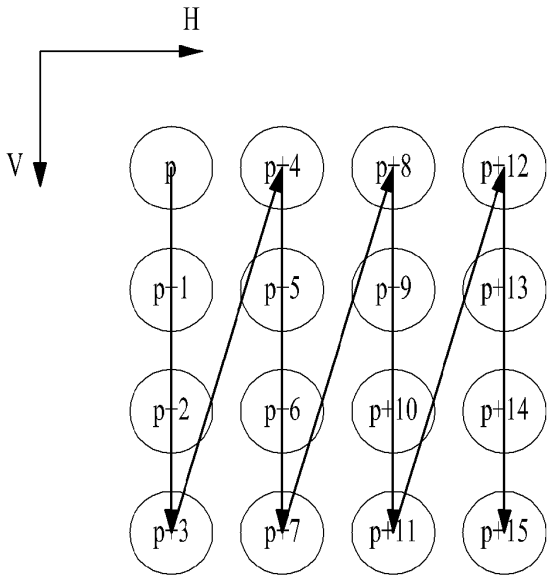

H
V
p
p+2
p+4
p+6
p+8
p+10
p+12
p+14
p+1
p+3
p+5
p+7
p+9
p+11
p+13
p+15

(b)

FIG. 15


H
V
p
p+1
p+2
p+3
p+4
p+5
p+6
p+7
p+8
p+9
p+10
p+11
p+12
p+13
p+14
p+15

(a)


H
V
p
p+4
p+8
p+12
p+1
p+5
p+9
p+13
p+2
p+6
p+10
p+14
p+3
p+7
p+11
p+15

(b)

FIG. 16

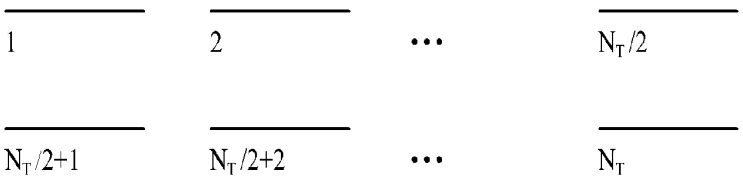

1
2
...
$N_T/2$
$N_T/2+1$
$N_T/2+2$
...
N_T

FIG. 17

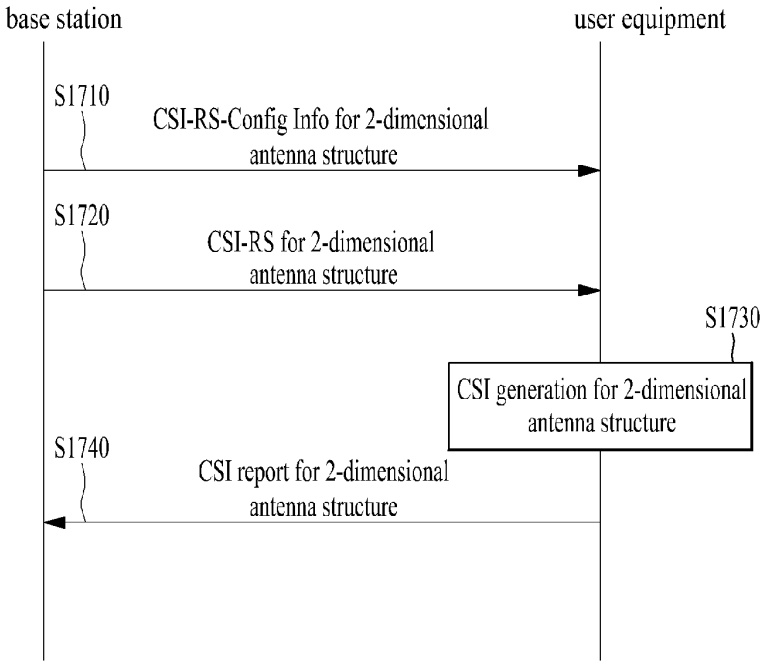
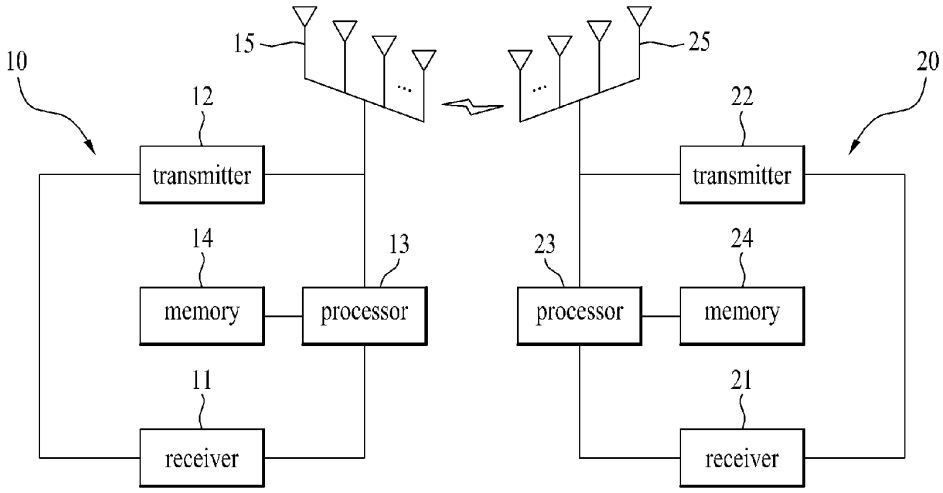

base station
user equipment
S1710
CSI-RS-Config Info for 2-dimensional antenna structure
S1720
CSI-RS for 2-dimensional antenna structure
S1730
CSI generation for 2-dimensional antenna structure
S1740
CSI report for 2-dimensional antenna structure

FIG. 18


10
15
25
20
12
22
transmitter
transmitter
14
13
23
24
memory
processor
processor
memory
11
21
receiver
receiver

METHOD AND APPARATUS FOR REPORTING CHANNEL STATE INFORMATION IN WIRELESS COMMUNICATION SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to a wireless communication system, and more particularly, to a method and apparatus for reporting channel status information.

BACKGROUND ART

[0002] Multi-Input Multi-Output (MIMO) technology is to improve efficiency in data transmission and reception by using multiple transmitting antennas and multiple receiving antennas instead of a single transmitting antenna and a single receiving antenna. If a single antenna is used, a receiver receives data through a single antenna path. However, if multiple antennas are used, the receiver receives data through various paths. Accordingly, speed and amount in data transmission may be increased, and coverage may be increased.

[0003] In order to increase multiplexing gain of MIMO operation, channel status information (CSI) may be fed back from a MIMO receiver to a MIMO transmitter. The receiver may determine CSI by performing channel measurement through a predetermined reference signal (RS) from the transmitter.

DISCLOSURE

Technical Problem

[0004] An object of the present invention is to provide a method for configuring reference signal configuration information for supporting a 2-dimensional antenna structure normally efficiently, a method for transmitting a reference signal, and a method for generating and reporting CSI.

[0005] It will be appreciated by persons skilled in the art that the objects that could be achieved with the present invention are not limited to what has been particularly described hereinabove and the above and other objects that the present invention could achieve will be more clearly understood from the following detailed description.

Technical Solution

[0006] To solve the aforementioned technical problem, according to one embodiment of the present invention, a method for reporting channel status information (CSI) from a user equipment in a wireless communication system comprises the steps of receiving from a base station a first channel status information-reference signal (CSI-RS) based on CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure, which is provided from the base station; reporting to the base station first CSI for the first domain antenna group, which is generated by using the first CSI-RS; receiving from the base station a second CSI-RS based on CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure, which is provided from the base station; and reporting to the base station second CSI for the second domain antenna group, which is generated by using the second CSI-RS, wherein the CSI-RS configuration information for the second domain antenna group may be determined based on the first CSI.

[0007] To solve the aforementioned technical problem, according to another embodiment of the present invention, a user equipment for reporting channel status information (CSI) in a wireless communication system comprises a receiver; a transmitter; and a processor, wherein the processor is configured to receive from a base station a first channel status information-reference signal (CSI-RS) by using the receiver based on CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure, which is provided from the base station, report to the base station first CSI for the first domain antenna group, which is generated by using the first CSI-RS, by using the transmitter, receive from the base station a second CSI-RS by using the receiver based on CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure, which is provided from the base station, and report to the base station second CSI for the second domain antenna group, which is generated by using the second CSI-RS, by using the transmitter, wherein the CSI-RS configuration information for the second domain antenna group may be determined based on the first CSI.

[0008] To solve the aforementioned technical problem, according to still another embodiment of the present invention, a method for receiving channel status information (CSI) in a base station of a wireless communication system comprises the steps of providing a user equipment with CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure of the base station and transmitting a first channel status information-reference signal (CSI-RS) to the user equipment based on CSI-RS configuration information for the first domain antenna group; receiving first CSI for the first domain antenna group, which is generated in the user equipment by using the first CSI-RS, from the user equipment; providing the user equipment with CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure and transmitting a second CSI-RS to the user equipment based on the CSI-RS configuration information for the second domain antenna group; and receiving the second CSI-RS for the second domain antenna group, which is generated in the user equipment by using the second CSI-RS, from the user equipment, wherein the CSI-RS configuration information for the second domain antenna group may be determined based on the first CSI.

[0009] To solve the aforementioned technical problem, according to further still another embodiment of the present invention, a base station for receiving channel status information (CSI) in a wireless communication system comprises a receiver; a transmitter; and a processor, wherein the processor is configured to provide a user equipment with CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure of the base station and transmit a first channel status information-reference signal (CSI-RS) to the user equipment based on CSI-RS configuration information for the first domain antenna group, receive first CSI for the first domain antenna group, which is generated in the user equipment by using the first CSI-RS, from the user equipment, provide the user equipment with CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure and transmit a second CSI-RS to the user equipment based on the CSI-RS configuration information for the second domain antenna group, and receive the second CSI-RS for the second domain antenna group, which is generated in the user equipment by

using the second CSI-RS, from the user equipment, wherein the CSI-RS configuration information for the second domain antenna group may be determined based on the first CSI.

[0010] The followings may commonly be applied to the aforementioned embodiments according to the present invention.

[0011] The first CSI includes a precoding vector preferred for the first domain, and beamforming in the first domain may be determined by considering the precoding vector preferred for the first domain.

[0012] The second CSI-RS configuration information may be determined by assuming that beamforming in the first domain is applied based on the first CSI.

[0013] The second CSI includes a precoding vector preferred for the second domain, beamforming in the second domain may be determined by considering the precoding vector preferred for the second domain, and the precoding vector preferred for the second domain may be determined by assuming that beamforming in the first domain is applied.

[0014] Three-dimensional beamforming for the two-dimensional antenna structure may be determined by combination of beamforming in the first domain and beamforming in the second domain, wherein the beamformings are determined considering the first CSI and the second CSI, respectively.

[0015] The CSI-RS configuration information for the first domain antenna group may be provided statically, and the CSI-RS configuration information for the second domain antenna group may be provided dynamically.

[0016] A transmission period of the first CSI-RS may be set to a value greater than that of a transmission period of the second CSI-RS.

[0017] The CSI-RS configuration information for the first domain antenna group may include a first antenna port count parameter, a first resource configuration parameter, a first subframe configuration parameter, and a first transmission power rate parameter.

[0018] The CSI-RS configuration information for the second domain antenna group may include a second antenna port count parameter, a second resource configuration parameter, a second subframe configuration parameter, and a second transmission power rate parameter.

[0019] The two-dimensional antenna structure may be configured by the number of antennas of the second domain antenna group×the number of antennas of the first domain antenna group.

[0020] The first domain may be a horizontal domain, and the second domain may be a vertical domain.

[0021] The first domain may be a vertical domain, and the second domain may be a horizontal domain.

[0022] The aforementioned embodiments and the following detailed description of the present invention are only exemplary, and are intended for additional description of the present invention cited in claims.

Advantageous Effects

[0023] According to the present invention, a method for configuring new reference signal configuration information, a method for transmitting a reference signal, and a method for generating and reporting CSI may be provided, whereby a 2-dimensional antenna structure may be supported normally and efficiently.

[0024] It will be appreciated by persons skilled in the art that that the effects that could be achieved with the present invention are not limited to what has been particularly described hereinabove and other advantages of the present invention will be more clearly understood from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0026] FIG. **1** is a diagram illustrating a structure of a radio frame;

[0027] FIG. **2** is a diagram illustrating a resource grid at a downlink slot;

[0028] FIG. **3** is a diagram illustrating a structure of a downlink subframe;

[0029] FIG. **4** is a diagram illustrating a structure of an uplink subframe;

[0030] FIG. **5** is a diagram illustrating a wireless communication system having multiple antennas;

[0031] FIG. **6** is a diagram illustrating an exemplary pattern of CRS and DRS on one resource block pair;

[0032] FIG. **7** is a diagram illustrating an example of a DMRS pattern defined in an LTE-A system;

[0033] FIG. **8** is a diagram illustrating examples of a CSI-RS pattern defined in an LTE-A system;

[0034] FIG. **9** is a diagram illustrating an example of a method for periodically transmitting CSI-RS;

[0035] FIG. **10** is a diagram illustrating a basic concept of codebook based precoding;

[0036] FIG. **11** is a diagram illustrating examples constituting **8** transmitting antennas;

[0037] FIG. **12** is a diagram illustrating ULA and URA;

[0038] FIG. **13** is a diagram illustrating examples of beamforming based on 2-dimensional antenna configuration;

[0039] FIGS. **14** and **15** are diagrams illustrating a method for allocating antenna port numbers in a 2-dimensional antenna structure;

[0040] FIG. **16** is a diagram illustrating an example of 2-dimensional antenna array;

[0041] FIG. **17** is a flow chart illustrating CSI-RS related operation for a 2-dimensional antenna structure according to the present invention; and

[0042] FIG. **18** is a diagram illustrating a base station and a user equipment according the preferred embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0043] The following embodiments are achieved by combination of structural elements and features of the present invention in a predetermined type. Each of the structural elements or features should be considered selectively unless specified separately. Each of the structural elements or features may be carried out without being combined with other structural elements or features. Also, some structural elements and/or features may be combined with one another to constitute the embodiments of the present invention. The order of operations described in the embodiments of the present invention may be changed. Some structural elements or features of one embodiment may be included in another

embodiment, or may be replaced with corresponding structural elements or features of another embodiment.

[0044] In this specification, the embodiments of the present invention will be described based on data transmission and reception between a base station and a user equipment. In this case, the base station means a terminal node of a network, which performs direct communication with the user equipment. A specific operation which has been described as being performed by the base station may be performed by an upper node of the base station as the case may be.

[0045] In other words, it will be apparent that various operations performed for communication with the user equipment in the network which includes a plurality of network nodes along with the base station may be performed by the base station or network nodes other than the base station. At this time, the 'base station' (BS) may be replaced with terminologies such as a fixed station, Node B, eNode B (eNB), and an access point (AP). Also, a relay may be replaced with terminologies such as a relay node (RN) and a relay station (RS). Also, a 'terminal' may be replaced with terminologies such as a user equipment (UE), a mobile station (MS), a mobile subscriber station (MSS), and a subscriber station (SS).

[0046] Specific terminologies used in the following description are provided to assist understanding of the present invention, and various modifications may be made in the specific terminologies within the range that they do not depart from technical spirits of the present invention.

[0047] In some cases, to prevent the concept of the present invention from being ambiguous, structures and apparatuses of the known art will be omitted, or will be shown in the form of a block diagram based on main functions of each structure and apparatus. Also, wherever possible, the same reference numbers will be used throughout the drawings and the specification to refer to the same or like parts.

[0048] The embodiments of the present invention may be supported by standard documents disclosed in at least one of wireless access systems, i.e., IEEE 802 system, 3GPP system, 3GPP LTE system, 3GPP LTE, 3GPP LTE-A (LTE-Advanced) system, and 3GPP2 system. Namely, among the embodiments of the present invention, apparent steps or parts, which are not described to clarify technical spirits of the present invention, may be supported by the above documents. Also, all terminologies disclosed herein may be described by the above standard documents.

[0049] The following technology may be used for various wireless access technologies such as CDMA (code division multiple access), FDMA (frequency division multiple access), TDMA (time division multiple access), OFDMA (orthogonal frequency division multiple access), and SC-FDMA (single carrier frequency division multiple access). The CDMA may be implemented by the radio technology such as UTRA (universal terrestrial radio access) or CDMA2000. The TDMA may be implemented by the radio technology such as global system for mobile communications (GSM)/general packet radio service (GPRS)/enhanced data rates for GSM evolution (EDGE). The OFDMA may be implemented by the radio technology such as IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, and evolved UTRA (E-UTRA). The UTRA is a part of a universal mobile telecommunications system (UMTS). A 3^{rd} generation partnership project long term evolution (3GPP LTE) is a part of an evolved UMTS (E-UMTS) that uses E-UTRA, and adopts OFDMA in a downlink and SC-FDMA in an uplink. LTE-advanced (LTE-A) is an evolved version of the 3GPP LTE. WiMAX may be described by the IEEE 802.16e standard (WirelessMAN-OFDMA Reference System) and the advanced IEEE 802.16m standard (WirelessMAN-OFDMA Advanced system). For clarification of the description, although the present invention will be described based on the 3GPP LTE/LTE-A, it is to be understood that technical spirits of the present invention are not limited to the 3GPP LTE/LTE-A.

[0050] FIG. **1** is a diagram illustrating a structure of a radio frame.

[0051] In a cellular OFDM communication system, uplink/downlink data packet transmission is performed in a subframe unit, wherein one subframe is defined by a given time interval that includes a plurality of OFDM symbols. The 3GPP LTE standard supports a type 1 radio frame structure applicable to frequency division duplex (FDD) and a type 2 radio frame structure applicable to time division duplex (TDD).

[0052] FIG. **1**(*a*) is a diagram illustrating a structure of a type 1 radio frame. The downlink radio frame includes 10 subframes, each of which includes two slots in a time domain. A time required to transmit one subframe will be referred to as a transmission time interval (TTI). For example, one subframe may have a length of 1 ms, and one slot may have a length of 0.5 ms. One slot includes a plurality of OFDM symbols in a time domain and a plurality of resource blocks (RB) in a frequency domain. Since the 3GPP LTE system uses OFDM in a downlink, OFDM symbols represent one symbol interval. The OFDM symbol may be referred to as SC-FDMA symbol or symbol interval. The resource block (RB) is a resource allocation unit and may include a plurality of continuous subcarriers in one slot.

[0053] The number of OFDM symbols included in one slot may be varied depending on configuration of a cyclic prefix (CP). Examples of the CP include an extended CP and a normal CP. For example, if the OFDM symbols are configured by the normal CP, the number of OFDM symbols included in one slot may be 7. If the OFDM symbols are configured by the extended CP, since the length of one OFDM symbol is increased, the number of OFDM symbols included in one slot is smaller than that of OFDM symbols in case of the normal CP. For example, in case of the extended CP, the number of OFDM symbols included in one slot may be 6. If a channel status is unstable like the case where the user equipment moves at high speed, the extended CP may be used to reduce inter-symbol interference.

[0054] If the normal CP is used, since one slot includes seven OFDM symbols, one subframe includes 14 OFDM symbols. At this time, first two or three OFDM symbols of each subframe may be allocated to a physical downlink control channel (PDCCH), and the other OFDM symbols may be allocated to a physical downlink shared channel (PDSCH).

[0055] FIG. **1**(*b*) is a diagram illustrating a structure of a type 2 radio frame. The type 2 radio frame includes two half frames, each of which includes five subframes, a downlink pilot time slot (DwPTS), a guard period (GP), and an uplink pilot time slot (UpPTS). One subframe includes two slots. The DwPTS is used for initial cell search, synchronization or channel estimation at the user equipment. The UpPTS is used for channel estimation at the base station and uplink transmission synchronization of the user equipment. Also, the guard period is to remove interference occurring in the uplink due to multipath delay of downlink signals between the

uplink and the downlink. Meanwhile, one subframe includes two slots regardless of the type of the radio frame.

[0056] The structure of the radio frame is only exemplary, and various modifications may be made in the number of subframes included in the radio frame, the number of slots included in the subframe, or the number of symbols included in the slot.

[0057] FIG. **2** is a diagram illustrating a resource grid at a downlink slot.

[0058] One downlink slot includes, but not limited to, seven OFDM symbols in a time domain, and one resource block (RB) includes, but not limited to, twelve subcarriers in a frequency domain. For example, although one slot includes seven OFDM symbols in case of the normal CP, one slot may include six OFDM symbols in case of the extended CP. Each element on the resource grid will be referred to as a resource element (RE). One resource block (RB) includes 12×7(**6**) resource elements. The number N^{DL} of resource blocks (RBs) included in the downlink slot depends on a downlink transmission bandwidth. A structure of an uplink slot may be the same as that of the downlink slot.

[0059] FIG. **3** is a diagram illustrating a structure of a downlink subframe.

[0060] Maximum three OFDM symbols located at the front of the first slot within one subframe correspond to a control region to which a control channel is allocated. The other OFDM symbols correspond to a data region to which a physical downlink shared channel (PDSCH) is allocated.

[0061] Examples of the downlink control channel used in the 3GPP LTE system include a PCFICH (Physical Control Format Indicator CHannel), a PDCCH (Physical Downlink Control CHannel), and a PHICH (Physical Hybrid ARQ Indicator CHannel). The PCFICH is transmitted from the first OFDM symbol of the subframe, and includes information on the number of OFDM symbols used for transmission of the control channel within the subframe. The PHICH is a response to uplink transmission, and includes HARQ ACK/NACK (acknowledgement/negative-acknowledgement) signal. The control information transmitted through the PDCCH will be referred to as downlink control information (DCI). The DCI includes uplink or downlink scheduling information or uplink transmission (Tx) power control command for a random user equipment group. The PDCCH includes transport format and resource allocation information of a downlink shared channel (DL-SCH), resource allocation information of an uplink shared channel (UL-SCH), paging information of a paging channel (PCH), system information on the DL-SCH, resource allocation information of an upper layer control message such as a random access response transmitted onto the PDSCH, a set of transmission power control commands of an individual user equipment within a random user equipment group, transmission power control information, and activation of voice over Internet protocol (VoIP). A plurality of PDCCHs may be transmitted within the control region, and the user equipment may monitor the plurality of PDCCHs.

[0062] The PDCCH is transmitted by aggregation of one or more continuous control channel elements (CCEs). The CCE is a logic allocation unit used to provide a PDCCH at a predetermined coding rate based on the status of a radio channel. The CCE corresponds to a plurality of resource element groups (REGs). The format of the PDCCH and the number of available bits of the PDCCH are determined depending on the correlation between the number of CCEs and the coding rate provided by the CCE.

[0063] The base station determines a PDCCH format depending on the DCI transmitted to the user equipment, and attaches cyclic redundancy check (CRC) to the control information. The CRC is masked with a radio network temporary identifier (RNTI) depending on owner or usage of the PDCCH. For example, if the PDCCH is for a specific user equipment, the CRC may be masked with cell-RNTI (C-RNTI) of the corresponding user equipment. If the PDCCH is for a paging message, the CRC may be masked with a paging indicator identifier (P-RNTI). If the PDCCH is for system information (in more detail, system information block (SIB)), the CRC may be masked with system information identifier and system information RNTI (SI-RNTI). The CRC may be masked with a random access RNTI (RA-RNTI) to indicate a random access response that is a response to transmission of a random access preamble of the user equipment.

[0064] FIG. **4** is a diagram illustrating a structure of an uplink subframe.

[0065] The uplink subframe may be divided into a control region and a data region on a frequency domain. A physical uplink control channel (PUCCH) which includes uplink control information is allocated to the control region. A physical uplink shared channel (PUSCH) which includes user data is allocated to the data region. In order to maintain single carrier features, one user equipment does not transmit the PUCCH and the PUSCH at the same time. The PUCCH for one user equipment is allocated to resource block (RB) pair for the subframe. Resource blocks (RBs) belonging to the RB pair reserve different subcarriers for two slots. The RB pair allocated to the PUCCH is subjected to frequency hopping at a slot boundary.

[0066] Modeling of MIMO System

[0067] FIG. **5** is a schematic view illustrating a wireless communication system having multiple antennas.

[0068] As shown in FIG. **5**(*a*), if the number of transmitting antennas is increased to N_T and the number of receiving antennas is increased to N_R, channel transmission capacity is increased theoretically in proportion to the number of antennas unlike that a plurality of antennas are used in only a transmitter or a receiver. Accordingly, it is possible to improve a transmission rate and remarkably improve frequency efficiency. As channel transmission capacity is increased, a transmission rate may be increased theoretically as much as a value obtained by multiplying a maximum transmission rate R_0, which corresponds to a case where a single antenna is used, by an increase rate R_i.

$$R_i=\min(N_T,N_R) \quad \text{[Equation 1]}$$

[0069] For example, in a MIMO communication system that uses four transmitting antennas and four receiving antennas, a transmission rate theoretically four times greater than that of a single antenna system may be obtained. After theoretical capacity increase of the MIMO system has been proved in the middle of 1990, various technologies have been actively studied to substantially improve a data transmission rate. Also, some of the technologies have been already reflected in the standard of various wireless communications such as third generation mobile communication and next generation wireless LAN.

[0070] Upon reviewing the recent trend of studies related to the MIMO system, active studies are ongoing in view of

various aspects such as the study of information theoretical aspect related to MIMO communication capacity calculation under various channel environments and multiple access environments, the study of radio channel measurement and modeling of a MIMO system, and the study of time space signal processing technology for improvement of transmission reliability and transmission rate.

[0071] A communication method in a MIMO system will be described in more detail with reference to mathematical modeling. In the MIMO system, it is assumed that N_T transmitting antennas and N_R receiving antennas exist.

[0072] First of all, a transmitting signal will be described. If there exist N_T transmitting antennas, the number of maximum transmission information is N_T. The transmission information may be expressed as follows.

$$s=[s_1,s_2,\ldots,s_{N_T}]^T \quad \text{[Equation 2]}$$

[0073] Different kinds of transmission power may be applied to each of the transmission information $s_1, s_2, \ldots, s_{N_T}$. At this time, supposing that each transmission power is $P_1, P_2, \ldots, P_{N_T}$, transmission information of which transmission power is controlled may be expressed as follows.

$$\hat{s}=[\hat{s}_1,\hat{s}_2,\ldots,\hat{s}_{N_T}]^T=[P_1s_1,P_2s_2,\ldots,P_{N_T}s_{N_T}]^T \quad \text{[Equation 3]}$$

[0074] Also, $\hat{S}$ may be expressed as follows using a diagonal matrix P.

$$\hat{s}=\begin{bmatrix} P_1 & & 0 \\ & P_2 & \\ & & \ddots \\ 0 & & P_{N_T} \end{bmatrix}\begin{bmatrix} s_1 \\ s_2 \\ \vdots \\ s_{N_T} \end{bmatrix}=Ps \quad \text{[Equation 4]}$$

[0075] It is considered that a weight matrix W is applied to the information vector $\hat{S}$ of which transmission power is controlled, so as to obtain N_T transmitting signals $x_1, x_2, \ldots, x_{N_T}$. In this case, the weight matrix W serves to properly distribute the transmission information to each antenna. Such transmitting signals $x_1, x_2, \ldots, x_{N_T}$ may be expressed as follows using a vector X.

$$x= \quad \text{[Equation 5]}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_i \\ \vdots \\ x_{N_T} \end{bmatrix}=\begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1N_T} \\ w_{21} & w_{22} & \cdots & w_{2N_T} \\ \vdots & & \ddots & \\ w_{i1} & w_{i2} & \cdots & w_{iN_T} \\ \vdots & & \ddots & \\ w_{N_T1} & w_{N_T2} & \cdots & w_{N_TN_T} \end{bmatrix}\begin{bmatrix} \hat{s}_1 \\ \hat{s}_2 \\ \vdots \\ \hat{s}_j \\ \vdots \\ \hat{s}_{N_T} \end{bmatrix}=W\hat{s}=WPs$$

[0076] In this case, W_{ij} means a weight value between the ith transmitting antenna and the jth information. W may be referred to as a precoding matrix.

[0077] If there exist N_R receiving antennas, receiving signals $y_1, y_2, \ldots, y_{N_R}$ of the respective antennas may be expressed by a vector as follows.

$$y=[y_1,y_2,\ldots,y_{N_R}]^T \quad \text{[Equation 6]}$$

[0078] In case of channel modeling in the MIMO communication system, channels may be classified depending on indexes of transmitting and receiving antenna indexes. In this case, a channel that passes from the jth transmitting antenna to the ith receiving antenna will be expressed as h_{ij}. It is noted that index of the receiving antenna is prior to index of the transmitting antenna in index of h_{ij}.

[0079] Meanwhile, FIG. **5**(*b*) illustrates channels from N_T transmitting antennas from the receiving antenna i. Several channels may be grouped into one and then may be expressed by a vector type or a matrix type. As shown in FIG. **5**(*b*), the channels from N_T transmitting antennas to the ith receiving antenna may be expressed as follows.

$$h_i^T=[h_{i1},h_{i2},\ldots,h_{iN_T}] \quad \text{[Equation 7]}$$

[0080] Accordingly, all channels from N_T transmitting antennas to N_R receiving antennas may be expressed as follows.

$$H=\begin{bmatrix} h_1^T \\ h_2^T \\ \vdots \\ h_i^T \\ \vdots \\ h_{N_R}^T \end{bmatrix}=\begin{bmatrix} h_{11} & h_{12} & \cdots & h_{1N_T} \\ h_{21} & h_{22} & \cdots & h_{2N_T} \\ \vdots & & \ddots & \\ h_{i1} & h_{i2} & \cdots & h_{iN_T} \\ \vdots & & \ddots & \\ h_{N_R1} & h_{N_R2} & \cdots & h_{N_RN_T} \end{bmatrix} \quad \text{[Equation 8]}$$

[0081] Since additive white Gaussian noise (AWGN) is actually added to the channels after the above channel matrix H. AWGN $n_1, n_2, \ldots, n_{N_R}$ added to each of the N_R receiving antennas may be expressed as follows.

$$n=[n_1,n_2,\ldots,n_{N_R}]^T \quad \text{[Equation 9]}$$

[0082] The receiving signals obtained using the above equation modeling may be expressed as follows.

$$y=\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_i \\ \vdots \\ y_{N_R} \end{bmatrix}=\begin{bmatrix} h_{11} & h_{12} & \cdots & h_{1N_T} \\ h_{21} & h_{22} & \cdots & h_{2N_T} \\ \vdots & & \ddots & \\ h_{i1} & h_{i2} & \cdots & h_{iN_T} \\ \vdots & & \ddots & \\ h_{N_R1} & h_{N_R2} & \cdots & h_{N_RN_T} \end{bmatrix} \quad \text{[Equation 10]}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_j \\ \vdots \\ x_{N_T} \end{bmatrix}+\begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_i \\ \vdots \\ n_{N_R} \end{bmatrix}=Hx+n$$

[0083] In the meantime, the number of rows and columns of the channel matrix H indicating the channel state is determined by the number of transmitting antennas and the number of receiving antennas. The number of rows in the channel matrix H is the same as the number N_R of receiving antennas, and the number of columns is the same as the number N_T of transmitting antennas. In other words, the channel matrix H may be expressed by $N_R \times N_T$ matrix.

[0084] A rank of the matrix is defined by a minimum number of the number of rows and the number of columns, which are independent from each other. Therefore, the rank of the

matrix cannot have a value greater than the number of rows or the number of columns. Rank (rank(H)) of the channel matrix H may be limited as follows.

$$\text{rank}(H) \leq \min(N_T, N_R) \quad \text{[Equation 11]}$$

[0085] The rank may also be defined by the number of eigen values not 0 when eigen value decomposition is performed for the matrix. Similarly, the rank may be defined by the number of singular values not 0 when singular value decomposition (SVD) is performed for the matrix. Accordingly, in the channel matrix, the rank may physically mean a maximum number of columns or rows that may transmit different kinds of information from a given channel.

[0086] In this specification, 'Rank' for MIMO transmission represents the number of paths that may transmit a signal independently at a specific time and a specific frequency resource, and 'the number of layers' represents the number of signal streams transmitted through each path. Generally, since the transmitter transmits layers corresponding to the number of ranks used for signal transmission, the ranks are the same as the number of layers unless mentioned otherwise.

[0087] Reference Signal (RS)

[0088] When a packet is transmitted in the wireless communication system, signal distortion may occur during transmission of the packet because the packet is transmitted through a radio channel. In order to normally receive the distorted signal, a receiver should correct distortion of the received signal by using channel information. In order to discover the channel information, it is required to transmit the signal known by both a transmitter and the receiver and discover the channel information using a distortion level of the signal when the signal is transmitted through the channel. In this case, the signal known by both the transmitter and the receiver will be referred to as a pilot signal or a reference signal.

[0089] In case that the transmitter or the receiver of the wireless communication system transmits and receives data by using multiple antennas, a channel status between each transmitter and each receiver should be known to receive a normal signal. Accordingly, a separate reference signal should be provided per transmitting antenna.

[0090] In the wireless communication system, the reference signal (RS) may be divided into two types in accordance with its purpose. Examples of the reference signal include a reference signal used for acquisition of channel information and a reference signal used for data demodulation. Since the former reference signal is intended for acquisition of channel information on the downlink through the user equipment, it needs to be transmitted through a wideband. Also, the former reference signal should be received and measured even by a user equipment that does not receive downlink data for a specific subframe. This reference signal for acquisition of channel information may be used even for measurement of handover. The latter reference signal is transmitted from the base station together with a corresponding resource when the base station transmits downlink data. In this case, the user equipment may perform channel estimation by receiving the corresponding reference signal, whereby the user equipment may demodulate the data. This reference signal for data demodulation should be transmitted to a region to which data are transmitted.

[0091] The existing 3GPP LTE system (for example, 3GPP LTE release-8) defines two types of downlink RSs for unicast service. The one of the downlink reference signals is a common reference signal (CRS), and the other one is a dedicated reference signal (DRS). The CRS is used for both information acquisition of channel status and measurement for handover, and may be referred to as a cell-specific RS. The DRS is used for data demodulation, and may be referred to as a UE-specific RS. In the existing 3GPP LTE system, the DRS may be used for data demodulation only, and the CRS may be used for both acquisition of channel information and data demodulation.

[0092] The CRS is a cell-specific RS and is transmitted to a wideband per subframe. The CRS for maximum four antenna ports may be transmitted in accordance with the number of transmitting antennas of the base station. For example, if the number of transmitting antennas of the base station is 2, CRS for antenna ports 0 and 1 may be transmitted. If the number of transmitting antennas of the base station is 4, CRS for antenna ports 0 to 3 may be transmitted respectively.

[0093] FIG. **6** is a diagram illustrating an exemplary pattern of CRS and DRS on one resource block pair.

[0094] In the example of the reference signal pattern in FIG. **6**, patterns of CRS and DRS are provided on one resource block pair (in case of normal CP, 14 OFDM symbols on the time×12 subcarriers on the frequency) in the system that the base station supports four transmitting antennas. In FIG. **6**, resource elements remarked with 'R0', 'R1', 'R2' and 'R3' represent positions of the CRS for antenna port indexes 0, 1, 2 and 3. Meanwhile, in FIG. **6**, a resource element marked with 'D' represents the position of the DRS defined in the LTE system.

[0095] The LTE-A system which is an evolved version of the LTE system may support maximum eight transmitting antennas on the downlink. Accordingly, reference signals for maximum eight transmitting antennas should also be supported. In the LTE system, since downlink reference signals are defined for maximum four antenna ports only, if the base station includes minimum four downlink transmitting antennas to maximum eight downlink transmitting antennas in the LTE-A system, reference signals for these antenna ports should additionally be defined. The reference signals for maximum eight transmitting antenna ports may be considered for two types of reference signals, i.e., the reference signal for channel measurement and the reference signal for data demodulation as described above.

[0096] One of important considerations in designing the LTE-A system is backward compatibility. Backward compatibility means that the LTE user equipment of the related art should be operated normally even in the LTE-A system. In view of reference signal transmission, if reference signals for maximum eight transmitting antenna ports should be defined additionally in the time-frequency domain to which CRS defined in the LTE standard is transmitted to a full band every subframe, RS overhead becomes too great. Accordingly, it should be considered that RS overhead is reduced in newly designing RS for maximum eight antenna ports.

[0097] The reference signal newly introduced in the LTE-A system may be divided into two types. One of the reference signals is a channel status information-reference signal (CSI-RS) which is the RS for channel measurement for selecting transmission rank, modulation and coding scheme (MCS), and precoding matrix index (PMI), and the other one is a demodulation RS (DMRS) which is the RS for demodulation of data transmitted through maximum eight transmitting antennas.

[0098] The CSI-RS for channel measurement is designed for channel measurement mainly unlike the existing CRS used for channel measurement, handover measurement, and data demodulation. The CSI-RS may also be used for handover measurement. Since the CSI-RS is transmitted only to obtain channel status information, it may not be transmitted per subframe unlike the CRS of the existing LTE system. Accordingly, in order to reduce overhead of the CSI-RS, the CSI-RS may be designed to be intermittently (for example, periodically) be transmitted on the time axis.

[0099] If data are transmitted on a random downlink subframe, a dedicated DMRS is transmitted to the user equipment for which data transmission is scheduled. In other words, the DMRS may be referred to as a UE-specific RS. The DMRS dedicated for a specific user equipment may be designed to be transmitted from only the resource region for which the corresponding user equipment is scheduled, that is, the time-frequency domain to which data for the corresponding user equipment are transmitted.

[0100] FIG. **7** is a diagram illustrating an example of DMRS pattern defined in the LTE-A system.

[0101] FIG. **7** illustrates a position of a resource element where DMRSs are transmitted on one resource block pair (in case of normal CP, 14 OFDM symbols on the time×12 subcarriers on the frequency) to which downlink data are transmitted. The DMRS may be transmitted four antenna ports (antenna port indexes 7, 8, 9 and 10) defined additionally in the LTE-A system. The DMRSs for different kinds of antenna ports may be identified from one another in such a manner that they are located on different frequency resources (subcarriers) and/or different time resources (OFDM symbols) (that is, the DMRSs may be multiplexed in accordance with FDM and/or TDM mode). Also, the DMRSs for different antenna ports located on the same time-frequency resource may be identified from one another by orthogonal codes (that is, the DMRSs may be multiplexed in accordance with CDM mode). In the example of FIG. **7**, the DMRSs for the antenna ports 7 and 8 may be located on the resource elements (REs) of DMRS CDM group 1, and may be multiplexed by orthogonal codes. Likewise, in the example of FIG. **7**, the DMRSs for the antenna ports 9 and 10 may be located on the resource elements (REs) of DMRS CDM group 2, and may be multiplexed by orthogonal codes.

[0102] When the base station transmits the DMRS, the same precoding as that applied to data is applied to the DMRS. Accordingly, channel information estimated by the user equipment using the DMRS (or UE-specific RS) is the precoded channel information. The user equipment may easily perform data demodulation by using the precoded channel information estimated through the DMRS. However, since the user equipment cannot know the precoding information applied to the DMRS, the user equipment cannot acquire channel information, which is not precoded, from the DMRS. The user equipment may acquire channel information, which is not precoded, by using a separate reference signal in addition to the DMRS, that is, the aforementioned CSI-RS.

[0103] FIG. **8** is a diagram illustrating examples of CSI-RS patterns defined in the LTE-A system.

[0104] FIG. **8** illustrates a position of a resource element where CSI-RSs are transmitted on one resource block pair (in case of normal CP, 14 OFDM symbols on the time×12 subcarriers on the frequency) to which downlink data are transmitted. One of CSI-RS patterns in FIG. **8**(*a*) to FIG. **8**(*e*) may be used for a random downlink subframe. The CSI-RS may be transmitted for eight antenna ports (antenna port indexes 15, 16, 17, 18, 19, 20, 21 and 22) defined additionally in the LTE-A system. The CSI-RSs for different antenna ports may be identified from one another in such a manner that they are located on different frequency resources (subcarriers) and/or different time resources (OFDM symbols) (that is, the CSI-RSs may be multiplexed in accordance with FDM and/or TDM mode). Also, the CSI-RSs for different antenna ports located on the same time-frequency resource may be identified from one another by orthogonal codes (that is, the CSI-RSs may be multiplexed in accordance with CDM mode). In the example of FIG. **8**(*a*), the CSI-RSs for the antenna ports 15 and 16 may be located on the resource elements (REs) of CSI-RS CDM group 1, and may be multiplexed by orthogonal codes. In the example of FIG. **8**(*a*), the CSI-RSs for the antenna ports 17 and 18 may be located on the resource elements (REs) of CSI-RS CDM group 2, and may be multiplexed by orthogonal codes. In the example of FIG. **8**(*a*), the CSI-RSs for the antenna ports 19 and 20 may be located on the resource elements (REs) of CSI-RS CDM group 3, and may be multiplexed by orthogonal codes. In the example of FIG. **8**(*a*), the CSI-RSs for the antenna ports 21 and 22 may be located on the resource elements (REs) of CSI-RS CDM group 4, and may be multiplexed by orthogonal codes. The same principle described based on FIG. **8**(*a*) may be applied to FIG. **8**(*b*) to FIG. **8**(*e*).

[0105] The RS patterns of FIGS. **6** and **8** are only exemplary, and various embodiments of the present invention are not limited to a specific RS pattern. In other words, various embodiments of the present invention may equally be applied to even a case where RS pattern different from those of FIGS. **6** and **8** is defined and used.

[0106] CSI-RS Configuration

[0107] As described above, in the LTE-A system that supports maximum eight transmitting antennas on the downlink, the base station should transmit CSI-RSs for all antenna ports. Since transmission of the CSI-RSs for maximum eight transmitting antenna ports every subframe has a drawback in that overhead is too great, the CSI-RSs should be transmitted intermittently on the time axis without being transmitted every subframe, to reduce overhead. Accordingly, the CSI-RSs may be transmitted periodically at a period of integer multiple of one subframe or may be transmitted at a specific transmission pattern.

[0108] At this time, the transmission period or transmission pattern of the CSI-RS may be configured by the network (for example, base station). In order to perform measurement based on the CSI-RS, the user equipment should know CSI-RS configuration for each antenna port of a cell (or transmission point (TP) to which the user equipment belongs. CSI-RS configuration may include downlink subframe index for which the CSI-RS is transmitted, time-frequency positions (for example, CSI-RS patterns the same as those of FIG. **8**(*a*) to FIG. **8**(*e*)) of CSI-RS resource elements (REs) within a transmission subframe, and CSI-RS sequence (used for CSI-RS and generated pseudo-randomly in accordance with a predetermined rule on the basis of slot number, cell ID, CP length, etc.). In other words, a plurality of CSI-RS configurations may be used by a given base station, and the base station indicate CSI-RS configuration, which will be used for user equipment(s) within a cell, among the plurality of CSI-RS configurations.

[0109] The plurality of CSI-RS configurations may include or not include one CSI-RS configuration assumed by the user

equipment that transmission power of the CSI-RS is not 0 (non-zero). Also, the plurality of CSI-RS configurations may include or not include one or more CSI-RS configurations assumed by the user equipment that transmission power of the CSI-RS is 0.

[0110] Also, each bit of parameters (for example, 16-bit bitmap ZeroPowerCSI-RS parameter) for CSI-RS configuration of the transmission power of 0 may correspond to CSI-RS configuration (or REs to which the CSI-RS may be allocated in accordance with CSI-RS configuration) in accordance with an upper layer, and the user equipment may assume that the transmission power at the CSI-RS REs of CSI-RS configuration corresponding to a bit set to 1 in the corresponding parameter is 0.

[0111] Also, since the CSI-RSs for the respective antenna ports are required to be identified from one another, resources to which the CSI-RSs for the respective antenna ports are transmitted should be orthogonal to one another. As described with reference to FIG. **8**, the CSI-RSs for the respective antenna ports may be multiplexed in accordance with FDM, TDM and/or CDM mode by using orthogonal frequency resources, orthogonal time resources and/or orthogonal code resources.

[0112] When the base station notifies the user equipment within the cell of CSI-RS information (CSI-RS configuration), the base station should first notify the user equipment of time-frequency information into which the CSI-RSs for the respective antenna ports are mapped. In more detail, the time information may include subframe numbers to which the CSI-RSs are transmitted, a transmission period of CSI-RSs, offset of subframe to which the CSI-RSs are transmitted, and OFDM symbol number to which CSI-RS resource element (RE) of a specific antenna is transmitted. The frequency information may include frequency spacing to which CSI-RS resource element (RE) of a specific antenna is transmitted, offset or shift value of RE on a frequency axis, etc.

[0113] FIG. **9** is a diagram illustrating an example of a method for periodically transmitting CSI-RS.

[0114] The CSI-RS may be transmitted at a period of integer multiple (for example, 5-subframe period, 10-subframe period, 20-subframe period, 40-subframe period, or 80-subframe period) of one subframe.

[0115] In FIG. **9**, one radio frame includes 10 subframes (subframe numbers 0 to 9). For example, in FIG. **9**, a transmission period of the CSI-RS of the base station is 10 ms (that is, 10 subframes), and CSI-RS transmission offset is 3. The offset value may be varied depending on respective base stations such that the CSI-RSs of several cells may uniformly be distributed on the time. If the CSI-RS is transmitted at a period of 10 ms, the offset value may have one of 0 to 9. Similarly, if the CSI-RS is transmitted at a period of 5 ms, the offset value may have one of 0 to 4, if the CSI-RS is transmitted at a period of 20 ms, the offset value may have one of 0 to 19, if the CSI-RS is transmitted at a period of 40 ms, the offset value may have one of 0 to 39, and if the CSI-RS is transmitted at a period of 80 ms, the offset value may have one of 0 to 79. This offset value represents a value of subframe at which the base station starts CSI-RS transmission at a predetermined period. If the base station notifies the user equipment of the transmission period and offset value of the CSI-RS, the user equipment may receive the CSI-RS of the base station at the corresponding subframe position by using the corresponding value. The user equipment may measure a channel through the received CSI-RS and, as a result, report information such as CQI, PMI and/or RI (Rank Indicator) to the base station. In this specification, CQI, PMI, and RI may be referred to as CQI (or CSI) except that they are described separately. Also, the information related to the CSI-RS may commonly be applied to the user equipments within the cell as cell-specific information. Also, the CSI-RS transmission period and offset may be designated separately for each CSI-RS configuration. For example, separate CSI-RS transmission period and offset may be set to the CSI-RS configuration indicating CSI-RS transmitted at a transmission power of 0 as described later and CSI-RS configuration indicating CSI-RS transmitted at a transmission power of non-zero.

[0116] Unlike the CRS transmitted at all the subframes at which the PDSCH may be transmitted, the CSI-RS may be set such that the CSI-RS is transmitted at some subframes only. For example, CSI subframe sets $C_{CSI,0}$ and $C_{CSI,1}$ may be configured by the upper layer. CSI reference resource (that is, predetermined resource region which becomes a reference of CSI calculation) may belong to either $C_{CSI,0}$ or $C_{CSI,1}$, or may not belong to both $C_{CSI,0}$ and $C_{CSI,1}$. Accordingly, if the CSI subframe sets $C_{CSI,0}$ and $C_{CSI,1}$ are configured by the upper layer, the user equipment may not expect that CSI reference resource existing at a subframe that does not belong to any one of the CSI subframe sets will be triggered (or indication of CSI calculation).

[0117] Also, the CSI reference resource may be set on a valid downlink subframe. The valid downlink subframe may be set as a subframe that satisfies various requirements. One of the requirements may be the subframe that belongs to the CSI subframe set linked to periodic CSI report if the CSI subframe set is configured for the user equipment in case of periodic CSI report.

[0118] Also, the user equipment may obtain CQI indexes from the CSI reference resource by considering the following assumptions (for details, see 3GPP TS 36.213).

[0119] First three OFDM symbols of one subframe are reserved by control signaling.

[0120] There is no resource element used by a primary synchronization signal, a secondary synchronization signal, or physical broadcast signal (PBCH).

[0121] CP length of non-MBSFN subframe

[0122] Redundancy version is 0

[0123] If the CSI-RS is used for channel measurement, a PDSCH EPRE (Energy Per Resource Element) to CSI-RS EPRE ratio depends on a predetermined rule.

[0124] In case of CSI report in a transmission mode 9 (that is, mode that supports maximum eight-layer transmission), if PMI/RI report is configured for the user equipment, it is assumed that DMRS overhead is matched with rank which is reported most recently (for example, since DMRS overhead on one resource block pair is 12 REs in case of two or more antenna ports (that is, less than rank 2) as described with reference to FIG. **7** but is 24 REs in case of three or more antenna ports (that is, more than rank 3), CQI index may be calculated by assuming DMRS overhead corresponding to the rank value which is reported most recently).

[0125] RE is not allocated to CSI-RS and 0-power CSI-RS.

[0126] RE is not allocated to positioning RS (PRS).

[0127] PDSCH transmission scheme depends on a transmission mode (which may be default mode) currently set for the user equipment.

[0128] A PDSCH EPRE to cell-specific reference signal EPRE ratio depends on a predetermined rule.

[0129] This CSI-RS configuration may be notified from the base station to the user equipment by using RRC (Radio Resource Control) signaling, for example. In other words, information on the CSI-RS configuration may be provided to each user equipment within the cell by using dedicated RRC signaling. For example, the base station may notify the user equipment of CSI-RS configuration through RRC signaling when the user equipment establishes connection with the base station through initial access or handover. Alternatively, when the base station transmits RRC signaling message, which requires channel status feedback based on CSI-RS measurement, to the user equipment, the base station may notify the user equipment of the CSI-RS configuration through corresponding RRC signaling message.

[0130] In the meantime, the time position where the CSI-RS exists, that is, cell-specific subframe setup period and cell-specific subframe offset may be listed as illustrated in Table 1 below.

TABLE 1

CSI-RS subframe configuration I_{CSI-RS}	CSI-RS period T_{CSI-RS} (subframe)	CSI-RS subframe offset Δ_{CSI-RS} (subframe)
0-4	5	I_{CIS-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

[0131] As described above, the parameter I_{CSI-RS} may be set separately for the CSI-RS assumed by the user equipment that the transmission power is not 0 and the CSI-RS assumed by the user equipment that the transmission power is 0. The subframe that includes the CSI-RS may be expressed by the following Equation 12 (in Equation 12, n_f is a system frame number, and n_s is a slot number).

$$(10n_f+\lfloor n_s/2\rfloor-\Delta_{CSI-RS})\bmod T_{CSI-RS}=0 \quad \text{[Equation 12]}$$

[0132] A CSI-RS-Config information element (IE) defined as illustrated in Table 2 below may be used to specify CSI-RS configuration.

TABLE 2

CSI-RS-Config information elements

```
-- ASN1START
CSI-RS-Config-r10 ::=          SEQUENCE {
    csi-RS-r10                    CHOICE {
        release                      NULL,
        setup                        SEQUENCE {
            antennaPortsCount-r10        ENUMERATED {an1, an2, an4, an8},
            resourceConfig-r10           INTEGER (0..31),
            subframeConfig-r10              INTEGER (0..154),
            p-C-r10                      INTEGER (-8..15)
        }
    }                                                    OPTIONAL,          --
Need ON
    zeroTxPowerCSI-RS-r10         CHOICE {
        release                      NULL,
        setup                        SEQUENCE {
            zeroTxPowerResourceConfigList-r10    BIT STRING (SIZE (16)),
            zeroTxPowerSubframeConfig-r10        INTEGER (0..154)
        }
    }                                                    OPTIONAL           --
Need ON
}
-- ASN1STOP
```

[0133] In Table 2, the antenna port count parameter antennaPortsCount represents the number of antenna ports (that is, CSI-RS ports) used for CSI-RS transmission, and an1 corresponds to 1 and an2 corresponds to 2.

[0134] In Table 2, the p_C parameter represents a PDSCH EPRE (Energy Per Resource Element) to CSI-RS EPRE ratio assumed when the user equipment UE derives CSI feedback.

[0135] In Table 2, the resource configuration parameter resourceConfig has a value that determines a position of a resource element to which the CSI-RS is mapped on the RB pair as illustrated in FIG. **8**.

[0136] In Table 2, the subframe configuration parameter subframeConfig corresponds to I_{CSI-RS} in Table 1.

[0137] In Table 2, zeroTxPowerResourceConfigList and zeroTxPowerSubframeConfig respectively correspond to resourceConfig and subframeConfig for the CSI-RS of the transmission power of 0.

[0138] Details of the CSI-RS configuration IE in Table 2 will be understood with reference to the standard document TS 36.331.

[0139] Channel Status Information (CSI)

[0140] The MIMO scheme may be divided into an open-loop system and a closed-loop system. The open-loop MIMO scheme means that a MIMO transmitter performs MIMO transmission without feedback of channel status information from a MIMO receiver. The closed-loop MIMO scheme means that the MIMO transmitter performs MIMO transmission by using the channel status information fed back from the MIMO receiver. In the closed-loop MIMO scheme, each of the transmitter and the receiver may perform beamforming on the basis of the channel status information to obtain multiplexing gain of MIMO transmitting antennas. The transmitter (for example, base station) may allocate an uplink control channel or an uplink shared channel to the receiver (for example, user equipment), so that the receiver may feed the channel status information back.

[0141] The user equipment may perform estimation and/or measurement for a downlink channel by using the CRS and/or the CSI-RS. The channel status information (CSI) which is fed back from the user equipment to the base station may

include a rank indicator (RI), a precoding matrix index (PMI), and a channel quality indicator (CQI).

[0142] The RI is information for a channel rank. The rank of the channel means a maximum number of layers (or streams) that may transmit different kinds of information through the same time-frequency resources. Since the rank value is mainly determined by long term padding of a channel, the rank value may generally be fed back in accordance with a longer period (that is, less frequently) than those of the PMI and the CQI.

[0143] The PMI is information for a precoding matrix used for transmission from the transmitter, and is a value that reflects spatial features of a channel. Precoding means that transmission layers are mapped into transmitting antennas, and layer-antenna mapping relation may be determined by a precoding matrix. The PMI corresponds to a precoding matrix index of the base station preferred by the user equipment on the basis of a metric such as a signal-to-interference plus noise ratio (SINR). In order to reduce feedback overhead of precoding information, the transmitter and the receiver previously share a codebook that includes various precoding matrixes, and only an index indicating a specific precoding matrix in the corresponding codebook may be fed back. For example, the PMI may be determined on the basis of RI which is reported most recently.

[0144] The CQI is the information indicating channel quality or channel strength. The CQI may be expressed by MCS combination which is previously determined. In other words, the CQI index represents a corresponding modulation scheme and a code rate. The CQI may be calculated by assuming that the PDSCH may be received without exceeding a predetermined error probability (for example, 0.1) on the assumption that a specific resource region (for example, region specified by valid subframe and/or physical resource block) is set to CQI reference resource and PDSCH transmission exists in the corresponding CQI reference resource. Generally, the CQI becomes a value that reflects received SINR that may be obtained if the base station configures a spatial channel by using the PMI. For example, the CQI may be calculated on the basis of RI and/or PMI which is reported most recently.

[0145] In the system (for example, LTE-A system) that supports extended antenna configuration, it is considered that additional multi-user diversity is acquired using a multi-user-MIMO (MU-MIMO) scheme. In case of the MU-MIMO scheme, since an interference channel exists between the user equipments multiplexed in an antenna domain, if the base station performs downlink transmission by using channel status information fed back from one of multiple user equipments, it is required that interference should not occur with the other user equipments. Accordingly, in order that MU-MIMO operation is performed normally, channel status information having exactness higher than that of the SU-MIMO scheme should be fed back.

[0146] A new CSI feedback method improved from CSI, which includes the existing RI, PMI and CQI, may be used such that the channel status information may be measured and reported more exactly. For example, the precoding information fed back from the receiver may be indicated by combination of two PMIs (for example, i1 and i2). As a result, more exact PMI may be fed back, and more exact CQI may be calculated and reported on the basis of the more exact PMI.

[0147] In the meantime, the CSI may periodically be transmitted through the PUCCH, or may aperiodically be transmitted through the PUSCH. Also, various report modes may be defined depending on which one of RI, first PMI (for example, W1), second PMI (for example, W2) and CQI is fed back and whether PMI and/or CQI which is fed back is for wideband (WB) or subband (SB).

[0148] CQI Calculation

[0149] Hereinafter, CQI calculation will be described in detail on the assumption that a downlink receiver is a user equipment. However, the description in the present invention may equally be applied to a relay as a downlink reception entity.

[0150] A method for configuring/defining a resource (hereinafter, referred to as reference resource), which becomes a reference of CQI calculation, when the user equipment reports CSI will be described. First of all, definition of CQI will be described in more detail.

[0151] The CQI reported by the user equipment corresponds to a specific index value. The CQI index is a value indicating a modulation scheme, code rate, etc., which correspond to the channel status. For example, the CQI indexes and their definition may be given as illustrated in Table 3.

TABLE 3

CQI index	modulation	code rate × 1024	efficiency
0		out of range	
1	QPSK	78	0.1523
2	QPSK	120	0.2344
3	QPSK	193	0.3770
4	QPSK	308	0.6016
5	QPSK	449	0.8770
6	QPSK	602	1.1758
7	16QAM	378	1.4766
8	16QAM	490	1.9141
9	16QAM	616	2.4063
10	64QAM	466	2.7305
11	64QAM	567	3.3223
12	64QAM	666	3.9023
13	64QAM	772	4.5234
14	64QAM	873	5.1152
15	64QAM	948	5.5547

[0152] Based on observation which is not limited by time and frequency, the user equipment may determine the highest CQI index, which satisfies a predetermined requirement of CQI indexes 1 to 15 of Table 3, for each CQI value reported at an uplink subframe n. The predetermined requirement may be defined that a single PDSCH transmission block, which reserves a group of downlink physical resource blocks referred to as CQI reference resources, may be received at a transmission block error probability that does not exceed 0.1 (that is, 10%), in accordance with combination of a modulation scheme (for example, MCS) and a transmission block size (TBS), which correspond to the corresponding CQI index. If the CQI index 1 does not satisfy the above requirement, the user equipment may determine CQI index 0.

[0153] In case of a transmission mode 9 (corresponding to maximum 8-layer transmission) and a feedback report mode, the user equipment may perform channel measurement for calculating a CQI value reported at an uplink subframe n, on the basis of the CSI-RS only. In case of the other transmission mode and corresponding report modes, the user equipment may perform channel measurement for CQI calculation on the basis of the CRS.

[0154] If the following requirements are all satisfied, combination of the modulation scheme and the transmission block size may correspond to one CQI index. The combination may be signaled for transmission on the PDSCH at the CQI reference resource in accordance with a related transmission block size table, the modulation scheme is indicated by the corresponding CQI index, and if combination of the transmission block size and the modulation scheme is applied to the reference resource, a valid channel code rate closest to a code rate indicated by the corresponding CQI index corresponds to the above requirement. If two or more combinations of the transmission block size and the modulation scheme are close to the code rate indicated by the corresponding CQI index at the same level, combination having the minimum transmission block size may be determined.

[0155] The CQI reference resource is defined as follows.

[0156] The CQI reference resource in the frequency domain is defined by a group of downlink physical resource blocks corresponding to a band to which the obtained CQI value is related.

[0157] The CQI reference resource in the time domain is defined by single downlink subframe n-nCQI_ref. In this case, in case of periodic CQI report, nCQI_ref is determined as a value which enables the downlink subframe n-nCQI_ref to correspond to a valid downlink subframe while being the smallest of values greater than 4. In case of aperiodic CQI report, nCQI_ref is determined as CQI reference resource which is the same downlink subframe as a valid downlink subframe corresponding to CQI request (or subframe for which CQI request is received) at an uplink DCI format (that is, PDCCH DCI format for providing uplink scheduling control information to the user equipment). Also, in case of aperiodic CQI report, nCQI_ref is 4 and the downlink subframe n-nCQI_ref corresponds to the valid downlink subframe, wherein the downlink subframe n-nCQI_ref may be received after the subframe corresponding to CQI request (or subframe for which CQI request is received) at a random access response grant. In this case, the valid downlink subframe means the downlink subframe that is set to the downlink subframe for the corresponding user equipment UE, is not the MBSFN subframe except the transmission mode 9, does not include a DwPTS field if the length of DwPTS is less than 7680*Ts (Ts=1/(15000×2048) second), and does not belong to a measurement gap configured for the corresponding UE. If there is no valid downlink subframe for the CQI reference resource, CQI report may be omitted for the uplink subframe n.

[0158] The CQI reference resource in a layer region is defined as random RI and PMI based on CQI.

[0159] In order that the user equipment derives CQI index from the CQI reference resource, the followings may be assumed: (1) first three OFDM symbols of the downlink subframe are used for control signaling; (2) there is no resource element used by a primary synchronization signal, a secondary synchronization signal or a physical broadcast channel; (3) the CQI reference resource has a CP length of non-MBSFN subframe; (4) redundancy version is 0; (5) if CSI-RS is used for channel measurement, a PDSCH EPRE to CSI-RS EPRE ratio has a predetermined value signaled by the upper layer; (6) PDSCH transmission scheme (single antenna port transmission, transmission diversity, spatial multiplexing, MU-MIMO, etc.) defined for each transmission mode is currently set for the corresponding UE (default mode may be provided); and (7) if CRS is used for channel measurement, the PDSCH EPRE to CRS EPRE ratio may be determined depending on a predetermined rule. Details related to CQI definition may be understood with reference to 3GPP TS36.213.

[0160] In short, the downlink receiver (for example, user equipment) may set a previous specific single subframe to the CQI reference resource based on the time when CQI calculation is currently performed, and may calculate CQI value from the corresponding CQI reference resource to satisfy the condition that error probability does not exceed 10% when the PDSCH is transmitted from the base station.

[0161] Codebook Based Precoding Scheme

[0162] Precoding for properly distributing transmission information in accordance with a channel status of each antenna may be used to support multi-antenna transmission. A codebook based precoding scheme means that a transmitter and a receiver previously defines a set of precoding matrixes, the receiver feeds the most suitable precoding matrix (that is, precoding matrix index (PMI)) back to the transmitter by measuring channel information from the transmitter, and the transmitter applies proper precoding to signal transmission on the basis of PMI. Since the codebook based precoding scheme selects a proper precoding matrix of the set of the precoding matrixes, although optimized precoding is always not used, feedback overhead may be reduced as compared with that optimized precoding information is explicitly fed back to actual channel information.

[0163] FIG. **10** is a diagram illustrating a basic concept of codebook based precoding.

[0164] According to the codebook based precoding scheme, the transmitter and the receiver shares codebook information that includes a predetermined number of precoding matrixes which are previously determined in accordance with a transmission rank, the number of antennas, etc. In other words, if feedback information is finite, the precoding based codebook scheme may be used. The receiver may measure the channel status through a received signal and feed information on infinite number of preferred precoding matrixes (that is, indexes of corresponding precoding matrixes) back to the transmitter on the basis of the aforementioned codebook information. For example, the receiver may select an optimized precoding matrix by measuring the received signal in accordance with a maximum likelihood (ML) scheme or a minimum mean square error (MMSE) scheme. Although FIG. **10** illustrates that the receiver transmits precoding matrix information per codeword to the transmitter, the present invention is not limited to the example of FIG. **10**.

[0165] The transmitter that has received feedback information from the receiver may select a specific precoding matrix from the codebook on the basis of the received information. The transmitter that has selected the precoding matrix may perform precoding in such a way to multiply layer signals

equivalent to transmission ranks by the selected precoding matrix, and may transmit the precoded signals through a plurality of antennas. The transmitter may notify the receiver what precoding information applied to the transmitting signals is. The number of rows in the precoding matrix is the same as the number of antennas, and the number of columns is the same as the rank value. Since the rank value is the same as the number of layers, the number of columns is the same as the number of layers. For example, if the number of transmitting antennas is 4 and the number of transmission layers is 2, the precoding matrix may be configured as a 4×2 matrix. Information transmitted through each layer may be mapped into each antenna through the precoding matrix.

[0166] The receiver that has received the signal precoded by and transmitted from the transmitter may perform inverse processing of precoding performed by the transmitter and recover the received signals. Generally, since the precoding matrix satisfies a unitary matrix (U) condition such as $U^*U^H=I$, the inverse processing of precoding may be performed in such a manner that a Hermit matrix P^H of the precoding matrix P used for precoding of the transmitter is multiplied by the received signals.

[0167] For example, the following Table 4 illustrates a codebook used for downlink transmission that two transmitting antennas are used in the 3GPP LTE release-8/9, and the following Table 5 illustrates a codebook used for downlink transmission that four transmitting antennas are used in the 3GPP LTE release-8/9.

TABLE 4

	Number of rank	
Codebook index	1	2
0	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1&0\\0&1\end{bmatrix}$
1	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-1\end{bmatrix}$	$\frac{1}{2}\begin{bmatrix}1&1\\1&-1\end{bmatrix}$
2	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\j\end{bmatrix}$	$\frac{1}{2}\begin{bmatrix}1&1\\j&-j\end{bmatrix}$
3	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	—

TABLE 5

Codebook		Numbers of layers υ			
index	u_n	1	2	3	4
0	$u_0=[1\ -1\ -1\ -1]^T$	$W_0^{\{1\}}$	$W_0^{\{14\}}/\sqrt{2}$	$W_0^{\{124\}}/\sqrt{3}$	$W_0^{\{1234\}}/2$
1	$u_1=[1\ -j\ 1\ j]^T$	$W_1^{\{1\}}$	$W_1^{\{12\}}/\sqrt{2}$	$W_1^{\{123\}}/\sqrt{3}$	$W_1^{\{1234\}}/2$
2	$u_2=[1\ 1\ -1\ 1]^T$	$W_2^{\{1\}}$	$W_2^{\{12\}}/\sqrt{2}$	$W_2^{\{123\}}/\sqrt{3}$	$W_2^{\{3214\}}/2$
3	$u_3=[1\ j\ 1\ -j]^T$	$W_3^{\{1\}}$	$W_3^{\{12\}}/\sqrt{2}$	$W_3^{\{123\}}/\sqrt{3}$	$W_3^{\{3214\}}/2$
4	$u_4=[1\ (-1-j)/\sqrt{2}\ -j\ (1-j)/\sqrt{2}]^T$	$W_4^{\{1\}}$	$W_4^{\{14\}}/\sqrt{2}$	$W_4^{\{124\}}/\sqrt{3}$	$W_4^{\{1234\}}/2$
5	$u_5=[1\ (1-j)/\sqrt{2}\ j\ (-1-j)/\sqrt{2}]^T$	$W_5^{\{1\}}$	$W_5^{\{14\}}/\sqrt{2}$	$W_5^{\{124\}}/\sqrt{3}$	$W_5^{\{1234\}}/2$
6	$u_6=[1\ (1+j)/\sqrt{2}\ -j\ (-1+j)/\sqrt{2}]^T$	$W_6^{\{1\}}$	$W_6^{\{13\}}/\sqrt{2}$	$W_6^{\{134\}}/\sqrt{3}$	$W_6^{\{1324\}}/2$
7	$u_7=[1\ (-1+j)/\sqrt{2}\ j\ (1+j)/\sqrt{2}]^T$	$W_7^{\{1\}}$	$W_7^{\{13\}}/\sqrt{2}$	$W_7^{\{134\}}/\sqrt{3}$	$W_7^{\{1324\}}/2$
8	$u_8=[1\ -1\ 1\ 1]^T$	$W_8^{\{1\}}$	$W_8^{\{12\}}/\sqrt{2}$	$W_8^{\{124\}}/\sqrt{3}$	$W_8^{\{1234\}}/2$
9	$u_9=[1\ -j\ -1\ -j]^T$	$W_9^{\{1\}}$	$W_9^{\{14\}}/\sqrt{2}$	$W_9^{\{134\}}/\sqrt{3}$	$W_9^{\{1234\}}/2$
10	$u_{10}=[1\ 1\ 1\ -1]^T$	$W_{10}^{\{1\}}$	$W_{10}^{\{13\}}/\sqrt{2}$	$W_{10}^{\{123\}}/\sqrt{3}$	$W_{10}^{\{1324\}}/2$
11	$u_{11}=[1\ j\ -1\ j]^T$	$W_{11}^{\{1\}}$	$W_{11}^{\{13\}}/\sqrt{2}$	$W_{11}^{\{134\}}/\sqrt{3}$	$W_{11}^{\{1324\}}/2$
12	$u_{12}=[1\ -1\ -1\ 1]^T$	$W_{12}^{\{1\}}$	$W_{12}^{\{12\}}/\sqrt{2}$	$W_{12}^{\{123\}}/\sqrt{3}$	$W_{12}^{\{1234\}}/2$
13	$u_{13}=[1\ -1\ 1\ -1]^T$	$W_{13}^{\{1\}}$	$W_{13}^{\{13\}}/\sqrt{2}$	$W_{13}^{\{123\}}/\sqrt{3}$	$W_{13}^{\{1324\}}/2$
14	$u_{14}=[1\ 1\ -1\ -1]^T$	$W_{14}^{\{1\}}$	$W_{14}^{\{13\}}/\sqrt{2}$	$W_{14}^{\{123\}}/\sqrt{3}$	$W_{14}^{\{3214\}}/2$
15	$u_{15}=[1\ 1\ 1\ 1]^T$	$W_{15}^{\{1\}}$	$W_{15}^{\{12\}}/\sqrt{2}$	$W_{15}^{\{123\}}/\sqrt{3}$	$W_{15}^{\{1234\}}/2$

[0168] In Table 5, $W_n^{\{s\}}$ is obtained by a set {s} configured from Equation expressed as $W_n=I-2u_nu_n^H/u_n^Hu_n$. In this case, I represents a 4×4 single matrix, and u_n is a value given by Table 5.

[0169] As illustrated in Table 4, a codebook for two transmitting antennas has a total of seven precoding vectors/matrixes. In this case, since the single matrix is intended for the open-loop system, a total of six precoding vectors/matrixes are obtained for precoding of the closed-loop system. Also, a codebook for four transmitting antennas as illustrated in Table 5 has a total of sixty-four precoding vectors/matrixes.

[0170] Additionally, in the system (for example, 3GPP LTE release-10 or advanced system) that supports extended antenna configuration, for example, MIMO transmission based on eight transmitting antennas may be performed. A codebook design for supporting MIMO transmission is required.

[0171] For CSI report for the channel transmitted through eight antenna ports, it may be considered that codebooks as illustrated in Table 6 to Table 13 are used. Eight CSI-RS antenna ports may be expressed as antenna port indexes 15 to 22. Each of Tables 6, 7, 8, 9, 10, 11, 12 and 13 illustrates an example of a codebook for 1-layer, 2-layer, 3-layer, 4-layer, 5-layer, 6-layer, 7-layer, and 8-layer CSI reports based on the antenna ports 15 to 22.

[0172] In Table 6 to Table 13, ϕ_n and v_m may be given by the following Equation 13.

$$\phi_n=e^{j\pi n/2} \qquad \text{[Equation 13]}$$

$$v_m=[1\ e^{j2\pi m/32}\ e^{j4\pi m/32}\ e^{j6\pi m/32}]^T$$

TABLE 4-continued

	Number of rank	
Codebook index	1	2
3	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	—

TABLE 6

	i_2							
i_1	0	1	2	3	4	5	6	7
0-15	$W_{2i_1,0}^{(1)}$	$W_{2i_1,1}^{(1)}$	$W_{2i_1,2}^{(1)}$	$W_{2i_1,3}^{(1)}$	$W_{2i_1+1,0}^{(1)}$	$W_{2i_1+1,1}^{(1)}$	$W_{2i_1+1,2}^{(1)}$	$W_{2i_1+1,3}^{(1)}$
	i_2							
i_1	8	9	10	11	12	13	14	15
0-15	$W_{2i_1+2,0}^{(1)}$	$W_{2i_1+2,1}^{(1)}$	$W_{2i_1+2,2}^{(1)}$	$W_{2i_1+2,3}^{(1)}$	$W_{2i_1+3,0}^{(1)}$	$W_{2i_1+3,1}^{(1)}$	$W_{2i_1+3,2}^{(1)}$	$W_{2i_1+3,3}^{(1)}$

where $W_{m,n}^{(1)} = \frac{1}{\sqrt{8}}\begin{bmatrix} v_m \\ \varphi_n v_m \end{bmatrix}$

TABLE 7

	i_2			
i_1	0	1	2	3
0-15	$W_{2i_1,2i_1,0}^{(2)}$	$W_{2i_1,2i_1,1}^{(2)}$	$W_{2i_1+1,2i_1+1,0}^{(2)}$	$W_{2i_1+1,2i_1+1,1}^{(2)}$
	i_2			
i_1	4	5	6	7
0-15	$W_{2i_1+2,2i_1+2,0}^{(2)}$	$W_{2i_1+2,2i_1+2,1}^{(2)}$	$W_{2i_1+3,2i_1+3,0}^{(2)}$	$W_{2i_1+3,2i_1+3,1}^{(2)}$

TABLE 7-continued

	i_2			
i_1	8	9	10	11
0-15	$W_{2i_1,2i_1+1,0}^{(2)}$	$W_{2i_1,2i_1+1,1}^{(2)}$	$W_{2i_1+1,2i_1+2,0}^{(2)}$	$W_{2i_1+1,2i_1+2,1}^{(2)}$
	i_2			
i_1	12	13	14	15
0-15	$W_{2i_1,2i_1+3,0}^{(2)}$	$W_{2i_1,2i_1+3,1}^{(2)}$	$W_{2i_1+1,2i_1+3,0}^{(2)}$	$W_{2i_1+1,2i_1+3,1}^{(2)}$

where $W_{m,m',n}^{(2)} = \frac{1}{4}\begin{bmatrix} v_m & v_{m'} \\ \varphi_n v_m & -\varphi_n v_{m'} \end{bmatrix}$

TABLE 8

	i_2			
i_1	0	1	2	3
0-3	$W_{8i_1,8i_1,8i_1+8}^{(3)}$	$W_{8i_1+8,8i_1,8i_1+8}^{(3)}$	$\tilde{W}_{8i_1,8i_1+8,8i_1+8}^{(3)}$	$\tilde{W}_{8i_1+8,8i_1,8i_1}^{(3)}$
	i_2			
i_1	4	5	6	7
0-3	$W_{8i_1+2,8i_1+2,4i_1+10}^{(3)}$	$W_{8i_1+10,8i_1+2,8i_1+10}^{(3)}$	$\tilde{W}_{8i_1+2,8i_1+10,8i_1+10}^{(3)}$	$\tilde{W}_{8i_1+10,8i_1+2,8i_1+2}^{(3)}$
	i_2			
i_1	8	9	10	11
0-3	$W_{8i_1+4,8i_1+4,8i_1+12}^{(3)}$	$W_{8i_1+12,8i_1+4,8i_1+12}^{(3)}$	$\tilde{W}_{8i_1+4,8i_1+12,8i_1+12}^{(3)}$	$\tilde{W}_{8i_1+12,8i_1+4,8i_1+4}^{(3)}$
	i_2			
i_1	12	13	14	15
0-3	$W_{8i_1+6,8i_1+6,8i_1+14}^{(3)}$	$W_{8i_1+14,8i_1+6,8i_1+14}^{(3)}$	$\tilde{W}_{8i_1+6,8i_1+14,8i_1+14}^{(3)}$	$\tilde{W}_{8i_1+14,8i_1+6,8i_1+6}^{(3)}$

where $W_{m,m',m''}^{(3)} = \frac{1}{\sqrt{24}}\begin{bmatrix} v_m & v_{m'} & v_{m''} \\ v_m & -v_{m'} & -v_{m''} \end{bmatrix}$, $\tilde{W}_{m,m',m''}^{(3)} = \frac{1}{\sqrt{24}}\begin{bmatrix} v_m & v_{m'} & v_{m''} \\ v_m & -v_{m'} & -v_{m''} \end{bmatrix}$

TABLE 9

	i_2			
i_1	0	1	2	3
0-3	$W_{8i_1,8i_1+8,0}^{(4)}$	$W_{8i_1,8i_1+8,1}^{(4)}$	$W_{8i_1+2,8i_1+10,0}^{(4)}$	$W_{8i_1+2,8i_1+10,1}^{(4)}$
	i_2			
i_1	4	5	6	7
0-3	$W_{8i_1+4,8i_1+12,0}^{(4)}$	$W_{8i_1+4,8i_1+12,1}^{(4)}$	$W_{8i_1+6,8i_1+14,0}^{(4)}$	$W_{8i_1+6,8i_1+14,1}^{(4)}$

where $W_{m,m',n}^{(4)} = \frac{1}{\sqrt{32}}\begin{bmatrix} v_m & v_{m'} & v_m & v_{m'} \\ \varphi_n v_m & \varphi_n v_{m'} & -\varphi_n v_m & -\varphi_n v_{m'} \end{bmatrix}$

TABLE 10

i_1	i_2 0
0-3	$W_{i_1}^{(5)} = \frac{1}{\sqrt{40}}\begin{bmatrix} v_{2i_1} & v_{2i_1} & v_{2i_1+8} & v_{2i_1+8} & v_{2i_1+16} \\ v_{2i_1} & -v_{2i_1} & v_{2i_1+8} & -v_{2i_1+8} & v_{2i_1+16} \end{bmatrix}$

TABLE 11

i_1	i_2 0
0-3	$W_{i_1}^{(6)} = \frac{1}{\sqrt{48}}\begin{bmatrix} v_{2i_1} & v_{2i_1} & v_{2i_1+8} & v_{2i_1+8} & v_{2i_1+16} & v_{2i_1+16} \\ v_{2i_1} & -v_{2i_1} & v_{2i_1+8} & -v_{2i_1+8} & v_{2i_1+16} & -v_{2i_1+16} \end{bmatrix}$

TABLE 12

i_1	i_2 0
0-3	$W_{i_1}^{(7)} = \frac{1}{\sqrt{56}}\begin{bmatrix} v_{2i_1} & v_{2i_1} & v_{2i_1+8} & v_{2i_1+8} & v_{2i_1+16} & v_{2i_1+16} & v_{2i_1+24} \\ v_{2i_1} & -v_{2i_1} & v_{2i_1+8} & -v_{2i_1+8} & v_{2i_1+16} & -v_{2i_1+16} & v_{2i_1+24} \end{bmatrix}$

TABLE 13

i_1	i_2 0
0	$W_{i_1}^{(8)} = \frac{1}{8}\begin{bmatrix} v_{2i_1} & v_{2i_1} & v_{2i_1+8} & v_{2i_1+8} & v_{2i_1+16} & v_{2i_1+16} & v_{2i_1+24} & v_{2i_1+24} \\ v_{2i_1} & -v_{2i_1} & v_{2i_1+8} & -v_{2i_1+8} & v_{2i_1+16} & -v_{2i_1+16} & v_{2i_1+24} & -v_{2i_1+24} \end{bmatrix}$

[0173] Multi-Antenna Array

[0174] FIG. **11** is a diagram illustrating examples constituting **8** transmitting antennas.

[0175] FIG. **11**(*a*) illustrates that N number of antennas configures mutual independent channels without grouping. Generally, this antenna configuration will be referred to as ULA (Uniform Linear Array).

[0176] FIG. **11**(*b*) illustrates ULA type antenna configuration of a pair of antennas (Paired ULA). In this case, the pair of antennas may have an associated channel therebetween and have an independent channel from another pair of antennas.

[0177] If a plurality of transmitting antennas should be installed in an insufficient space, ULA antenna configuration as illustrated in FIGS. **11**(*a*) and **11**(*b*) may not be appropriate. Accordingly, it may be considered that dual-pole (or cross-pole) antenna configuration as illustrated in FIG. **11**(*c*) is used. If the transmitting antennas are configured in this way, although a distance d between the antennas is relatively short, an independent channel may be configured by lowering antenna correlation, whereby data transmission of high throughput may be performed.

[0178] In the example of FIG. **11**(*c*), in array of a total of N_T number of transmitting antennas, a group 1 of indexes 1, 2, . . . , $N_T/2$ and a group 2 of indexes $N_T/2+1$, $N_T/2+2$, . . . , N_T may be configured to have polarizations orthogonal to each other. The antennas of the antenna group 1 may have the same polarization (for example, vertical polarization) and the antennas of the antenna group 2 may have another same polarization (for example, horizontal polarization). Also, the two antenna groups are co-located. For example, antenna 1 and $N_T/2+1$, antenna 2 and $N_T/2+2$, antenna 3 and $N_T/2+3$, . . . , antenna $N_T/2$ and N_T may be co-located. In other words, the antennas within one antenna group have the same polarization like ULA (Uniform Linear Array), and correlation between the antennas within one antenna group has linear phase increment property. Also, correlation between the antenna groups has phase rotation property.

[0179] 1-Dimensional Antenna Array and CSI Feedback

[0180] 1-dimensional antenna array may include ULA or cross-pole antenna array configuration as illustrated in FIG. **11**. If this 1-dimensional antenna array is used, the aforementioned reference signal transmission and CSI feedback method is used. In other words, in order to estimate the channel between the transmitter and the receiver (or base station and user equipment) in downlink transmission, the transmitter may transmit the reference signal (for example, CRS or CSI-RS) to the receiver, and the receiver may estimate the channel status based on the reference signal. The receiver may calculate rank, precoding weight value, and CQI based on the precoding weight value, which will be expected to be suitable for downlink data transmission, on the basis the channel information acquired through the reference signal.

[0181] For MIMO transmission such as precoded spatial multiplexing, precoding information may be required, wherein the precoding weight value may be configured in a type of codebook.

[0182] For example, in the MIMO system that uses four transmitting antennas (hereinafter, referred to as 4Tx), CSI feedback for precoded spatial multiplexing (SM) based on the CRS may be described as follows. When the base station having four transmitting antennas transmits the CRS, if it is assumed that indexes of antenna ports (AP) mapped into each RS are APO, 1, 2 and 3, the user equipment may estimate the channels from APO, 1, 2 and 3 by using the CRS.

[0183] In this case, if the matrix (or vector) that expresses the channel estimated by the user equipment is H, $H=[H_{11}\ H_{12}\ H_{13}\ H_{14}; H_{21}\ H_{22}\ H_{23}\ H_{24}; \ldots; H_{Nr1}\ H_{Nr2}\ H_{Nr3}\ H_{Nr4}]$ may be expressed. In other words, H may be expressed as Nr×Nt sized matrix (or vector). In this case, Nr is the number of receiving antennas, and Nt is the number of transmitting antennas.

[0184] Also, the user equipment may assume that the base station transmits data by using a precoding weight matrix (or vector) $W_m(k)$. In $W_m(k)$, m means a transmission rank, and k means index of the precoding weight matrix (or vector) defined for Rank-m. $W_m(k)$ may be expressed as $W_m(k)=[W_{11}\ W_{12}\ W_{13} \ldots W_{1m}; W_{21}\ W_{22}\ W_{23} \ldots W_{2m}; W_{31}\ W_{32}\ W_{33} \ldots W_{3m}; \ldots; W_{41}\ W_{42}\ W_{43} \ldots W_{4m}]$. That is, $W_m(k)$ may be expressed as Nt×m sized matrix (or vector).

[0185] Also, the user equipment may calculate an equivalent channel H_{eq}. The equivalent channel H_{eq} may be calculated by synthesis of the estimated channel H and the precoding weight value $W_m(k)$ (that is, $H_{eq}=HW_m(k)$), or may be calculated by synthesis of a Covariance Matrix R of the estimated channel and the precoding weight value $W_m(k)$ (that is, $H_{eq}=RW_m(k)$). The user equipment may select rank and precoding weight value, which are suitable for downlink transmission, on the basis of the equivalent channel H_{eq}. Also, the user equipment may calculate CQI expected when the selected rank and precoding weight value are used.

[0186] For another example, in the MIMO system that uses eight transmitting antennas (hereinafter, referred to as 8Tx), CSI feedback for precoded spatial multiplexing (SM) based on the CSI-RS may be described as follows. When the base station having eight transmitting antennas transmits the CSI-RS, if it is assumed that indexes of antenna ports (AP) mapped into each RS are AP15, 16, 17, 18, 19, 20, 21, 22, the user equipment may estimate the channels from AP15, 16, 17, 18, 19, 20, 21, 22 by using the CSI-RS.

[0187] In this case, if the matrix (or vector) that expresses the channel estimated by the user equipment is H, $H=[H_{11}\ H_{12}\ H_{13}\ H_{14}\ H_{15}\ H_{16}\ H_{17}\ H_{18}; H_{21}\ H_{22}\ H_{23}\ H_{24}\ H_{25}\ H_{26}\ H_{27}\ H_{28}; \ldots; H_{Nr1}\ H_{Nr2}\ H_{Nr3}\ H_{Nr4}\ H_{Nr5}\ H_{Nr6}\ H_{Nr7}\ H_{Nr8}]$ (wherein Nr is the number of receiving antennas) may be expressed.

[0188] Also, the user equipment may assume that the base station transmits data by using a precoding weight matrix (or vector) $W_m(k)$. $W_m(k)$ may be expressed as $W_m(k)=[W_{11}\ W_{12}\ W_{13} \ldots W_{1m}; W_{21}\ W_{22}\ W_{23} \ldots W_{2m}; W_{31}\ W_{32}\ W_{33} \ldots W_{3m}; \ldots; W_{81}\ W_{82}\ W_{83} \ldots W_{8m}]$.

[0189] Also, the user equipment may select rank and precoding weight value, which are suitable for downlink transmission, on the basis of the equivalent channel H_{eq} (wherein, the equivalent channel is calculated by $H_{eq}=HW_m(k)$ or $H_{eq}=RW_m(k)$), and may calculate CQI expected when the selected rank and precoding weight value are used.

[0190] Accordingly, in the MIMO system that supports Nt number of transmitting antennas, the user equipment may feed CSI (for example, RI, PMI, CQI), which is selected/calculated using the CRS or CSI-RS as described above, back to the base station. The base station may determine rank, precoding weight value, and modulation and coding scheme, which are suitable for downlink transmission, by considering the CSI reported by the user equipment.

[0191] 2-Dimensional Antenna Array and CSI Feedback

[0192] FIG. **12**(*a*) illustrates ULA which is an example of 1-dimensional antenna configuration, and FIG. **12**(*b*) illustrates URA (Uniform Rectangular Array) which is an example of 2-dimensional antenna configuration.

[0193] In the example of ULA of FIG. **12**(*a*), N number of antennas are arranged at an interval of d_r. A weave for ULA may be expressed as a vector k_p. ψ_p represents a direction of the vector k_p, and corresponds to an azimuth angle on a x-y plane.

[0194] A steering vector represents a set of phase delays suffered by the wave, wherein the set of phase delays is determined by antennas belonging to the antenna array. If the steering vector is a_r, the following Equation may be expressed.

$$\varphi_p = \frac{d_r}{\lambda}\cos(\psi_p) \qquad \text{[Equation 14]}$$

$$a_r(\varphi_p) = [\,1 \quad e^{-j2\pi\varphi_p} \quad e^{-j2\pi 2\varphi_p} \quad \ldots \quad e^{-j2\pi(N-1)\varphi_p}\,]^T$$

[0195] In the above Equation 14, λ represents a wavelength. The steering vector a_r is defined by N×1 sized complex vector, and each of N number of elements of a_r represents relative phase at each of the antennas of ULA.

[0196] In the example of URA of FIG. **12**(*b*), the antennas are arranged 2-dimensionally on a x-z plane. URA may be referred to as UPA (Uniform Planar Array). This 2-dimensional antenna structure is suggested as a method for arranging so many antennas, and may be used for massive MIMO for maximizing advantages of the existing MIMO technology.

[0197] URA of FIG. **12**(*b*) includes N×M number of antennas. The N×M number of antennas are arranged on an x axis at an interval of d_r, and on a z axis at an interval of d_c. A direction of a wave vector k_p of URA may be expressed by an azimuth angle ψ_p on a x-y plane and an elevation angle θ_p on a y-z plane. Also, a steering matrix for URA may be expressed by the following Equation.

$$\theta_p = \frac{d_c}{\lambda}\sin(\vartheta_p) \qquad \text{[Equation 15]}$$

$$\varphi_p = \frac{d_r}{\lambda}\cos(\psi_p)\cos(\vartheta_p)$$

$$a_c(\theta_p) = [\,1 \quad e^{-j2\pi\theta_p} \quad e^{-j2\pi 2\theta_p} \quad \ldots \quad e^{-j2\pi(M-1)\theta_p}\,]^T$$

$$a_r(\varphi_p) = [\,1 \quad e^{-j2\pi\varphi_p} \quad e^{-j2\pi 2\varphi_p} \quad \ldots \quad e^{-j2\pi(N-1)\varphi_p}\,]^T$$

$$A(\theta_p, \varphi_p) = a_c(\theta_p)\cdot a_r(\varphi_p)^T$$

[0198] In the above Equation 15, $A(\theta_p,\phi_p)$ represents a steering matrix. The) steering matrix $A(\theta_p,\phi_p$ is defined as N×M sized complex matrix, and each of N×M number of elements represents relative phase at each of the antennas of URA.

[0199] A beam formed by the 1-dimensional antenna structure like the existing ULA is specified by the azimuth angle (for example, horizontal domain) only and cannot be speci-

fied by the elevation angle (for example, vertical domain), whereby 2-dimensional beamforming is only supported. This 1-dimensional antenna structure (for example, ULA or cross-pole array configuration) may support adaptive beamforming or spatial multiplexing in a direction of the azimuth angle, and MIMO transmission and reception scheme for the 1-dimensional antenna structure is only designed in the existing wireless communication system (for example, system based on 3GPP LTE release-8, 9, 10 and 11).

[0200] In the meantime, if 2-dimensional antenna structure (for example, URA) based MIMO transmission and reception scheme, which is intended to improve system throughput, is supported, the beam formed by the 2-dimensional antenna structure may be specified in the direction of the azimuth angle and the direction of the elevation angle, whereby 3-dimensional beamforming may be performed.

[0201] FIG. **13** is a diagram illustrating examples of beamforming based on 2-dimensional antenna configuration.

[0202] FIG. **13**(*a*) illustrates examples of sector specific beamforming formed by restricting a certain range of the azimuth angle and a certain range of the elevation angle. FIG. **13**(*b*) illustrates examples of UE-specific beamforming formed by varying the elevation angle on the same azimuth angle.

[0203] According to the function of forming the beam by specifying the azimuth angle and the elevation angle as described above, sector specific elevation beamforming (for example, vertical pattern beamwidth and/or downtilt based adaptive control), improved sectorization in the vertical domain, and new beamforming such as user (or UE)-specific elevation beamforming may be supported.

[0204] Vertical sectorization may increase average system throughput through gain of a vertical sector pattern, and does not require support of additional standard technology.

[0205] UE-specific elevation beamforming may improve SINR to the corresponding UE by designating a vertical antenna pattern. On the other hand, unlike vertical sectorization or sector-specific vertical beamforming, UE-specific elevation beamforming requires support of additional standard technology. For example, in order to normally support 2-dimensional port structure, CSI measurement and feedback method of the UE for UE-specific elevation beamforming will be required.

[0206] In order to support UE-specific elevation beamforming, a downlink MIMO improvement method will be required. Examples of the downlink MIMO improvement method may include improvement (for example, new codebook design, method for supporting codebook selection/update/modification, minimization of CSI payload size increase, etc.) of CSI feedback method of the UE, change of CSI-RS configuration for UE-specific elevation beamforming, definition of additional antenna ports for UE-specific elevation beamforming, and improvement (for example, method for obtaining common channel coverage and/or RRM (Radio Resource Management) measurement reliability if the number of antenna ports is increased) of downlink control operation for supporting UE-specific elevation beamforming.

[0207] Also, in designing the improved downlink MIMO operation, various factors such as base station (eNB) antenna calibration error (error on phase and time), estimation error, downlink overhead, complexity, feedback overhead, backward compatibility, actual UE realization, reuse of the existing feedback framework, and subband to wideband feedback may be considered.

[0208] Method for Transmitting Reference Signal to Support 2-Dimensional Antenna Structure

[0209] The present invention suggests a method for transmitting a reference signal and a CSI feedback method to normally and efficiently support schemes such as UE-specific elevation beamforming and vertical sectorization, which may be performed by the 2-dimensional antenna structure.

[0210] In the existing system, a beam direction is fixed in a vertical direction (that is, vertical direction of beam cannot be selected/adjusted), and horizontal beamforming may be performed. The base station command the UE to perform CSI-RS configuration and transmit the CSI-RS based on the CSI-RS configuration to the UE, so that the UE may report CSI, which includes PMI, etc., to the base station, thereby determining the most appropriate horizontal beamforming. The command to perform the CSI-RS configuration means that one or more of information (for example, CSI-RS port, CSI-RS transmission timing, CSI-RS transmission RE position, etc.) included in the CSI-RS-Config IE of Table 2 is provided.

[0211] For 3-dimensional beamforming, vertical beamforming (or selection of vertical beam) is required additionally to the existing horizontal beamforming, and a detailed method for additional vertical beamforming has not been defined yet.

[0212] In order to describe the basic principle of the present invention, 2-dimensional URA (or UPA) may be assumed by combination of ULA of a first domain (for example, horizontal domain) and ULA of a second domain (for example, vertical domain). For example, 3-dimensional beam may be formed in such a manner that the azimuth angle is determined in the horizontal domain after the elevation angle is determined in the vertical domain, or the elevation angle is determined in the vertical domain after the azimuth angle is determined in the horizontal domain. In this 2-dimensional antenna structure, selection of ULA for any one of the first and second domains may be referred to as regional selection or domain selection.

[0213] Also, in 3-dimensional beamforming, one dimension may be determined by a static or long-term, and the other two dimensions may be determined by a dynamic or short-term. For example, a beam of a specific direction in the vertical domain may be determined and beamforming of the horizontal domain according to the existing beamforming technology may be performed for the corresponding vertical beam, whereby the 3-dimensional beam may be formed.

[0214] For example, it is assumed that N number of beamformings may be available vertically and M number of beamformings may be available horizontally in a planar array that includes K×L number of antennas. In this case, one dominant beam of the N number of vertical beam patterns may be determined, and one beam may be selected from the M number of horizontal beam patterns, whereby the 3-dimensional beam may be formed. At this time, if L number of antennas of the horizontal domain are equivalent to the number of antennas of the MIMO system which is conventionally designed (for example, L=2, 4, 8), the existing feedback codebook may be used for CSI feedback for horizontal beamforming.

[0215] As described above, in the 2-dimensional antenna structure, vertical beamforming (or elevation beamforming) may be performed together with horizontal beamforming (or azimuth beamforming). If vertical beamforming is added to the existing horizontal beamforming, a new method for CSI determination/calculation (that is, determination of rank and

precoding weight value (or precoding matrix) and CQI calculation) and a method for transmitting a reference signal will be required.

[0216] Also, the MIMO system having the 2-dimensional antenna structure may perform vertical sectorization and at the same time perform horizontal beamforming To this end, the method for transmitting a reference signal and a new method for CSI determination/calculation will be required.

[0217] In order to describe the method for transmitting a reference signal used to acquire channel status information in the MIMO system having the 2-dimensional antenna structure, the 2-dimensional antenna structure is assumed, in which Ntv number of antennas are arranged in the vertical domain and Nth number of antennas are arranged in the horizontal domain. In this 2-dimensional antenna structure, the base station has a total of Nt (Nt=Ntv×Nth) number of antennas. In order that the UE estimates the channel transmitted from the Nt number of antennas of the base station, the base station may allocate and transmit the reference signal to each of the Nt number of antennas.

[0218] FIGS. **14** and **15** are diagrams illustrating a method for allocating antenna port numbers in a 2-dimensional antenna structure.

[0219] FIG. **14** illustrates an example of a total of 16 antennas (that is, 2×8 antenna structure) that include 8 columns in a horizontal direction and 2 rows in a vertical direction.

[0220] FIG. **14**(*a*) illustrates an example of counting antenna port numbers in a horizontal first manner. In the example of FIG. **14**(*a*), for a total of 16 antennas (that is, 2×8 antenna structure) that include 8 columns in a horizontal direction and 2 rows in a vertical direction, antenna port numbers p, p+1, . . . p+7 are sequentially allocated to eight antennas in a horizontal direction of the first row, if there is no antenna to which antenna port number will be allocated in a horizontal direction, antenna port numbers p+8, p+9, . . . p+15 are sequentially allocated to eight antennas of the second row in a vertical direction.

[0221] FIG. **14**(*b*) illustrates an example of counting antenna port numbers in a vertical first manner. In the example of FIG. **14**(*b*), antenna port numbers p, p+1 are sequentially allocated to two antennas in a vertical direction of the first column, if there is no antenna to which antenna port number will be allocated in a vertical direction, antenna port numbers p+2, p+3 are sequentially allocated to two antennas of the second column in a vertical direction. In this way, the antenna port numbers are allocated to a total of 16 antennas in accordance with a vertical first manner.

[0222] FIG. **15** illustrates an example of a total of 16 antennas (that is, 4×4 antenna structure) that include 4 columns in a horizontal direction and 4 rows in a vertical direction. FIG. **15**(*a*) illustrates an example of counting antenna port numbers in a horizontal first manner. FIG. **15**(*b*) illustrates an example of counting antenna port numbers in a vertical first manner.

[0223] In the MIMO system to which the aforementioned 2-dimensional antenna structure is applied, in order that the receiver determines/calculates channel status information of the channel formed from the 2-dimensional antenna structure, the reference signal suitable for the 2-dimensional antenna structure should be transmitted from the transmitter. Hereinafter, examples of the present invention for reference signal configuration suitable for the 2-dimensional antenna structure will be described.

[0224] Method 1

[0225] According to the method 1 of the present invention, reference signal configuration for channel estimation of the 2-dimensional antenna structure may be defined by reuse or modification of the CSI-RS configuration defined in the 3GPP LTE release-10 or 11.

[0226] The above Table 2 illustrates configuration of the CSI-RS-Config IE defined in the 3GPP LTE release-10 or 11. For example, in the system according to the release-10, a CSI-RS pattern for supporting 1, 2, 4 or 8Tx antenna ports has been defined. As illustrated in FIG. **8**, on one resource block pair, one of 32 patterns may be used for 2Tx antenna port CSI-RS, one of 16 patterns may be used for 4Tx antenna port CSI-RS, and one of 8 patterns may be used for 8Tx antenna port CSI-RS.

[0227] Also, as illustrated in Table 1, for configuration for a subframe at which the CSI-RS is transmitted, one of 155 combinations of period and offset for which the CSI-RS is transmitted, may be used.

[0228] Also, the CSI-RS is power boosted in accordance with a p_C parameter value, wherein the same power boosting value is applied to each antenna port.

[0229] CSI-RS configuration of the existing 3GPP LTE release-10/11 may be used by being corrected to CSI-RS configuration for the 2-dimensional antenna structure as follows.

[0230] Method 1-1

[0231] If the 2-dimensional antenna structure has maximum 8 Tx antennas, CSI-RS configuration of the 3GPP LTE release-10/11 may be used by modification.

[0232] In other words, CSI-RS resource for the 2-dimensional antenna structure may be allocated using the CSI-RS configuration of the 3GPP LTE release-10/11. However, since the CSI-RS configuration of the 3GPP LTE release-10/11 has been designed for the 1-dimensional antenna structure, if the feedback codebook for the 1-dimensional antenna structure is used for the CSI-RS for the 2-dimensional antenna structure, maximization of throughput cannot be expected. Accordingly, the feedback codebook for the 2-dimensional antenna structure should newly be designed.

[0233] Also, if the CSI-RS configuration for the 1-dimensional antenna structure and the CSI-RS configuration for the 2-dimensional antenna structure are provided in the same IE type, it is required to identify the CSI-RS configuration for the 1-dimensional antenna structure and the CSI-RS configuration for the 1-dimensional antenna structure from each other. For example, if the transmission mode (or 3-dimensional beamforming transmission mode) based on the 2-dimensional antenna structure is defined as a new transmission mode (for example, TM11), it may be indicated explicitly or implicitly that the feedback codebook (or feedback codebook for 3-dimensional beamforming) for the 2-dimensional antenna structure should be used if TM11 is set.

[0234] The feedback codebook for the 2-dimensional antenna structure may be configured similarly to the existing 8Tx codebook (for example, Tables 6 to 13) of the 1-dimensional antenna structure. However, since precoding vectors/matrixes suitable for the property of the 2-dimensional antenna structure should be included in the codebook, the existing codebook cannot be used as it is.

[0235] First of all, factors constituting the existing 8Tx rank-1 codebook (Table 6) of the 1-dimensional antenna structure are defined to depend on the principle of a precoding vector W as expressed by the following Equation 16.

$$W = \begin{bmatrix} W1 \\ {}_{\alpha}W1 \end{bmatrix} \quad \text{[Equation 16]}$$

[0236] In the Equation 16, the factor W1 constituting the vector W1 is defined as expressed by the following Equation 17.

$$W1 = \frac{1}{\sqrt{N_T}} e^{j2\pi nk/N} \quad \text{[Equation 17]}$$

[0237] In the Equation 17, N_T is the number of transmitting antennas. N means the number of beams, n has a value of 0, 1, 2, . . . , N−1, and k has a value of 0, 1, 2, . . . , $N_T/2-1$. For example, the vector W1 of the Equation 16 may be a 4−1 sized vector corresponding to $(1/\sqrt{8})\times v_m$ of the Equation 13 and Table 6. In W, W1 is applied to antenna indexes 1, 2, . . . , $N_T/2$ (that is, //// pole antennas in FIG. **11**(*c*)) in a 1-dimensional cross pole antenna structure of FIG. **11** (*c*), a W1 is applied to antenna indexes $N_T/2+1$, $N_T/2+2$, . . . , N_T (that is, \\\\ pole antennas in FIG. **11**(*c*)), and phase difference/between pole antenna and \ pole antenna is compensated by a $\epsilon\{1,-1,j,-j\}$.

[0238] FIG. **16** is a diagram illustrating an example of 2-dimensional antenna array.

[0239] In design of the feedback codebook for 2-dimensional antenna array, the precoding vector W defined as expressed by the following Equation 18 may be used, wherein the Equation 18 is modified from the Equation 16 which is the basic Equation used for the 8Tx codebook design of the 1-dimensional antenna structure.

$$W = \begin{bmatrix} W1 \\ aW2 \end{bmatrix} \quad \text{[Equation 18]}$$

[0240] In case of 1-dimensional cross pole antenna array, the same precoding vector W1 is applied to a first antenna group (antenna indexes 1, 2, . . . , $N_T/2$) and a second antenna group (antenna indexes $N_T/2+1$, $N_T/2+2$, . . . , N_T). On the other hand, in case of 2-dimensional antenna array, W1 is applied to a first antenna group (antenna indexes 1, 2, . . . , $N_T/2$), whereas W2 different from W1 is applied to a second antenna group (antenna indexes $N_T/2+1$, $N_T/2+2$, . . . , N_T). In 2-dimensional antenna array, as the precoding vector applied to the first antenna group, a value which is not the same as, but similar to, the precoding vector applied to the second antenna group may be used. In more detail, the values of the vectors applied to the first antenna group and the second antenna group may be modified due to elevational beamforming. For example, W1 and W2 may be defined as expressed by the following Equation 19.

$$W1 = \frac{1}{\sqrt{N_T}} e^{j2\pi nk/N} \quad \text{[Equation 19]}$$

$$W2 = \frac{1}{\sqrt{N_T}} e^{j2\pi bnk/N}$$

[0241] As expressed by the above Equation 19, W1 and W2 are different from each other in that whether a value of b has been used or not. Also, the value of b is defined by a value determined based on 'a' which is a combining value. For example, the value of b may be defined as expressed by the following Equation 20.

$$b=\sqrt{1-a^2} \quad \text{[Equation 20]}$$

[0242] The factors (that is, precoding vectors/matrixes) which will be included in the feedback codebook for supporting the 2-dimensional antenna structure may be configured on the basis of the precoding vector W which is defined as above. If the transmission mode for supporting the 2-dimensional antenna structure is set, the UE may use the precoding vectors/matrixes on the codebook newly defined as above when selecting/calculating CSI.

[0243] Method 1-2

[0244] Resource configuration resourceConfig for vertical antennas may be indicated explicitly while CSI-RS configuration is being indicated on the basis of horizontal antennas.

[0245] In more detail, it is defined that a value of antennaPortsCount parameter {an1,an2,an4,an8, . . . } indicated by the CSI-RS-Config IE indicates the number of antennas (for example, L in K×L antenna array) of the horizontal domain in the 2-dimensional antenna array. In case of the 2-dimensional antenna array, since the same number of antennas of the horizontal domain exist in each row, one antennaPortsCount parameter exists.

[0246] Next, the resourceConfig parameter indicated by the CSI-RS-Config IE is set to have one value of ranges (for example, in case of an2, 0 to 31) determined in accordance with the antennaPortsCount value. In this case, a plurality of resourceConfig parameters may be included in the 2-dimensional antenna array. For example, if two antennas exist in the vertical domain, index indicating a resource element position (that is, CSI-RS pattern) where antennaPortsCount number of antennas of the first row will be arranged may be indicated by resourceConfig A parameter, and index indicating a resource element position where antennaPortsCount number of antennas of the second row will be arranged may be indicated by resourceConfig B parameter.

[0247] As described above, the CSI-RS-Config IE for the 2-dimensional antenna array may be configured as illustrated in Table 14 below. Table 14 corresponds to a part of Table 2, and in Table 14, portions the same as Table 2 are omitted, and modified/added portions from Table 2 are marked with underlines.

TABLE 14

...	
antennaPortsCount-r**xx**	ENUMERATED {an1, an2, an4, an8},
resourceConfig-r**xx A**	INTEGER (0..31),
resourceConfig-rxxB	**INTEGER(0..31),**
subframeConfig-r**xx**	INTEGER (0..154),
p-C-r**xx**	INTEGER (−8..15)
...	

[0248] If four antennas exist in the vertical domain, four resourceConfig parameters may be included in the CSI-RS-Config IE. In this way, the resourceConfig parameters equivalent to the number of antennas in the vertical domain may be included in the CSI-RS-Config IE. For example, if Ntv number of antennas exist in the vertical domain, Ntv number of resourceConfig parameters may be included in the CSI-RS-Config IE. As a result, the user equipment UE may know that the corresponding CSI-RS configuration is for the 2-dimensional antenna array of Ntv×antennaPortsCount number of antennas.

[0249] Method 1-3

[0250] A parameter for vertical antennas may be indicated additionally while CSI-RS configuration is being indicated on the basis of horizontal antennas.

[0251] It is defined that a value of antennaPortsCount parameter {an1,an2,an4,an8, . . . } indicated by the CSI-RS-Config IE indicates the number of antennas (for example, Ntv

in Ntv×Nth antenna array) of the horizontal domain in the 2-dimensional antenna array. In case of the 2-dimensional antenna array, since the same number of antennas of the horizontal domain exist in each row, one antennaPortsCount parameter exists.

[0252] In order to indicate the number of antennas in the vertical domain, a VantennaPortsCount parameter is additionally defined. If the number of antennas in the vertical domain is indicated by the VantennaPortsCount parameter, resources equivalent to the number of antennas in the vertical domain should be allocated additionally.

[0253] The resources which are allocated additionally may be indicated implicitly by the resourceConfig parameter indicated by the CSI-RS-Config IE. For example, a predetermined offset value mapped into the value of the VantennaPortsCount parameter is added to the index value indicated by the resourceConfig parameter, whereby resources corresponding to a resultant value may be determined as the resources which are allocated additionally.

[0254] As described above, the CSI-RS-Config IE for the 2-dimensional antenna array may be configured as illustrated in Table 15 below. Table 15 corresponds to a part of Table 2, and in Table 15, portions the same as Table 2 are omitted, and modified/added portions from Table 2 are marked with underlines.

TABLE 15

...	
antennaPortsCount-r**xx**	ENUMERATED {an1, an2, an4, an8},
resourceConfig-r**xx**	INTEGER (0..31),
VantennaPortsCount-rxx	**ENUMERATED {an1,an2,an4,an8},**
subframeConfig-r**xx**	INTEGER (0..154),
p-C-r**xx**	INTEGER (−8..15)
...	

[0255] According to the example of Table 15, for example, if the antennaPortsCount parameter indicates an4 and the resourceConfig parameter indicates a value of 0, a resource element position corresponding to index 0 is selected from CSI-RS resources defined for 4Tx. And, if the VantennaPortsCount parameter indicates an2, it may be determined that two antennas exist in the vertical domain (that is, 2×4 antenna array). It is assumed that an offset value mapped when the VantennaPortsCount parameter is an2 is Offset2. In this case, a resource element position (that is, CSI-RS pattern) corresponding to index (0+Offset2) may be selected in addition to the CSI-RS resource element position corresponding to index 0. For example, in case of Offset2=1, a CSI-RS resource element position corresponding to index 1 may be selected additionally. Accordingly, a resource element pattern corresponding to index 0 may be determined for CSI-RS transmission for four horizontal domain antennas of the first row in the vertical domain, and a resource element pattern corresponding to index 1 may be determined for CSI-RS transmission for four horizontal domain antennas of the second row in the vertical domain.

[0256] Also, if the antennaPortsCount parameter indicates an4 and the VantennaPortsCount parameter indicates an2, the UE may recognize that the base station performs 8Tx antenna transmission, and may use a transmission method and/or channel measurement method, which is defined for 8Tx antenna transmission.

[0257] For example, if the antennaPortsCount parameter indicates an4 and the resourceConfig parameter indicates 0, a resource element position corresponding to index 0 is selected from the CSI-RS resources defined for 4Tx. If the VantennaPortsCount parameter indicates an4, it may be determined that four antennas exist in the vertical domain (that is, 4×4 antenna array). It is assumed that an offset value mapped when the VantennaPortsCount parameter is an24 is Offset4. In this case, a resource element position (that is, CSI-RS pattern) corresponding to index (0+Offset4) may be selected in addition to the CSI-RS resource element position corresponding to index 0. For example, the value of Offset4 may be 1, 2 and 3. Accordingly, a resource element pattern corresponding to index 0 may be determined for CSI-RS transmission for four horizontal domain antennas of the first row in the vertical domain, a resource element pattern corresponding to index 1 may be determined for CSI-RS transmission for four horizontal domain antennas of the second row in the vertical domain, a resource element pattern corresponding to index 2 may be determined for CSI-RS transmission for four horizontal domain antennas of the third row in the vertical domain, and a resource element pattern corresponding to index 4 may be determined for CSI-RS transmission for four horizontal domain antennas of the fourth row in the vertical domain.

[0258] Also, if the antennaPortsCount parameter indicates an4 and the VantennaPortsCount parameter indicates an4, the UE may recognize that the base station performs 16Tx antenna transmission, and may use a transmission method and/or channel measurement method, which is defined for 16Tx antenna transmission.

[0259] Method 2

[0260] For reference signal transmission for channel estimation in the 2-dimensional antenna structure, CSI-RS configuration for the horizontal domain and CSI-RS configuration for the vertical domain may be indicated. That is, CSI-RS configuration may be configured in accordance with a target or usage of the CSI-RS.

[0261] The following Table 16 illustrates an example of configuration information on the CSI-RS for vertical domain antennas.

TABLE 16

...	
VantennaPortsCount-rxx	**ENUMERATED {an1,an2,an4,an8},**
VresourceConfig-rxx	**INTEGER (0..31),**
VsubframeConfig-rxx	**INTEGER (0..154),**
p-C-rxx	**INTEGER (−8..15)**
...	

[0262] The base station may configure CSI-RS configuration for antennas of the vertical domain as illustrated in Table 16 and notify the UE of the CSI-RS configuration. Accordingly, the UE may receive the CSI-RS based on the notified CSI-RS configuration and perform channel estimation by using the received CSI-RS. The channel estimated by the UE is the channel for antennas of the vertical domain. The UE may select a precoding vector preferred for the estimated channel and report the selected precoding vector to the base station. The base station may perform vertical beamforming for the corresponding UE by considering the reported precoding vector.

[0263] Also, configuration information on the CSI-RS for horizontal domain antennas may be configured as illustrated in Table 17 below.

TABLE 17

...	
HantennaPortsCount-rxx	ENUMERATED{an1,an2,an4,an8},
HresourceConfig-rxx	INTEGER(0..31),
HsubframeConfig-rxx	INTEGER(0..154),
p-C-rxx	INTEGER (−8..15)
...	

[0264] The base station may configure CSI-RS configuration for antennas of the horizontal domain as illustrated in Table 17 and notify the UE of the CSI-RS configuration. Accordingly, the UE may receive the CSI-RS based on the notified CSI-RS configuration and perform channel estimation by using the received CSI-RS. The channel estimated by the UE is the channel for antennas of the horizontal domain. The UE may select a precoding vector preferred for the estimated channel and report the selected precoding vector to the base station. The base station may perform horizontal beamforming for the corresponding UE by considering the reported precoding vector.

[0265] In this case, if the UE receives the CSI-RS for antennas of the vertical domain and reports CSI for vertical beamforming to the base station and the base station determines vertical beamforming based on the reported CSI, the base station may notify the UE of CSI-RS configuration for antennas of the horizontal domain by assuming the status based on the determined vertical beamforming. In other words, The base station determines optimized horizontal beamforming based on vertical beamforming without determining horizontal beamforming regardless of a direction of vertical beamforming. That is, the base station may notify the UE of CSI-RS configuration in the horizontal domain based on vertical beamforming and finally determine horizontal beamforming by considering CSI feedback reported from the UE. Accordingly, the base station may determine final 3-dimensional beamforming considering both vertical beamforming and horizontal beamforming.

[0266] Also, determination of horizontal beamforming based on vertical beamforming may be applied favorably when CSI-RS configuration and/or transmission for antennas in the vertical domain is performed by a static or long-term and CSI-RS configuration and/or transmission for antennas in the horizontal domain is performed by a dynamic or short-term. That is, CSI-RS configuration for antennas in the vertical domain may be changed or provided less frequently than CSI-RS configuration for antennas in the horizontal domain. Also, the CSI-RS for antennas in the vertical domain may be transmitted less frequently than the CSI-RS for antennas in the horizontal domain. In this case, a value of CSI-RS subframe period determined by the VsubframConfig parameter of Table 16 may be set to a value greater than that of CSI-RS subframe period determined by the HsubframConfig parameter of Table 17.

[0267] Method 3

[0268] For reference signal transmission for channel estimation in the 2-dimensional antenna structure, multiple CSI-RS configurations may be configured.

[0269] Multiple CSI-RS configurations means that beamforming of any one of the horizontal and vertical domains is determined by the precoding vector previously determined by the base station (that is, beamforming is not determined based on CSI feedback of UE), and beamforming of the other one domain is determined based on the precoding vector selected and reported by the UE in accordance with CSI-RS configuration and transmission from the base station. In other words, multiple CSI-RS configurations for determining beamforming of the second domain may be configured in a state that beamforming of the first domain is previously determined.

[0270] For example, in case of vertical domain sectorization, multiple CSI-RS configurations may be configured for one azimuth angle. In this case, the base station may notify the UE of a plurality of CSI-RS configurations for vertical beamforming after determining one azimuth angle (that is, beamforming of horizontal domain is applied in accordance with a previously determined requirement). The UE may determine CSI-RS reception, channel estimation, and precoding vector in accordance with each of the plurality of CSI-RS configurations. As a result, a plurality of precoding vectors corresponding to the plurality of CSI-RS configurations may be determined, and the UE may select a preferred one of the plurality of precoding vectors and report the selected precoding vector to the base station. The base station may perform vertical beamforming for the plurality of CSI-RS configurations by considering the precoding vector reported by the UE.

[0271] For example, the precoding vector for multiple CSI-RS configurations for one azimuth angle may include eight elements as illustrated in Table 18 below. In Table 18, H means a channel value of each of eight antenna ports, and h means a channel value for a antenna port set (that is, one antenna port sent includes four antenna ports) obtained by synthesis of two of eight antenna ports. For example, h11, h12, h13 and h14 represent channel values for the first antenna port set that includes four antenna ports. Also, h21, h22, h23 and h24 represent channel values for the second antenna port set that includes another four antenna ports. Channel properties as illustrated in the example of Table 18 may be generated when different vertical beams are applied to the first and second antenna port sets. The UE may select a preferred one of eight elements and report the selected element to the base station.

TABLE 18

h11 = (H1 + H5)	h12 = (H2 + H6)	h13 = (H3 + H7)
h14 = (H4 + H8)	h21 = (H1 − H5)	h22 = (H2 − H6)
h23 = (H3 − H7)	h24 = (H4 − H8)	

[0272] Alternatively, multiple CSI-RS configurations may be configured for one elevation angle. In this case, the base station may notify the UE of a plurality of CSI-RS configurations for horizontal beamforming after determining one elevation angle (that is, beamforming of vertical domain is applied in accordance with a previously determined requirement). The UE may determine CSI-RS reception, channel estimation, CSI selection/calculation and CSI report in accordance with each of the plurality of CSI-RS configurations. As a result, the base station may select a proper one of a plurality of CSIs (or a plurality of precoding vectors) reported by the UE for a plurality of CSI-RS configurations and perform horizontal beamforming by using the selected CSI.

[0273] FIG. **17** is a flow chart illustrating CSI-RS related operation for a 2-dimensional antenna structure according to the present invention.

[0274] At step **S1710**, the base station may configure CSI-RS configuration information for the 2-dimensional antenna structure and provide the configured CSI-RS configuration information to the base station. The CSI-RS configuration

information may be configured by one or combination of at least two of the details described in the various embodiments of the present invention.

[0275] At step S**1720**, the base station may transmit the CSI-RS for the 2-dimensional antenna structure to the user equipment. The user equipment may receive the CSI-RS for the 2-dimensional antenna structure on the basis of the CSI-RS configuration information provided from the base station at step S**1710**.

[0276] At step S**1730**, the user equipment may estimate the channel by using the received CSI-RS and generate CSI for the channel formed by the 2-dimensional antenna structure of the base station. The operation of generating CSI for the 2-dimensional antenna structure of the base station may be configured by one or combination of at least two of the details described in the various embodiments of the present invention.

[0277] At step S**1740**, the user equipment may report the generated CSI to the base station.

[0278] FIG. **18** is a diagram illustrating a base station and a user equipment according the preferred embodiment of the present invention.

[0279] Referring to FIG. **18**, a base station **10** according to the present invention may include a transmitter **11**, a receiver **12**, a processor **13**, a memory **14**, and a plurality of antennas **15**. The transmitter **11** may transmit various signals, data and information to an external device (for example, user equipment). The receiver **10** may receive various signals, data and information from the external device (for example, user equipment). The processor **13** may control the overall operation of the base station **10**. The plurality of antennas **15** may be configured in accordance with the 2-dimensional antenna structure.

[0280] The processor **13** of the base station **10** according to the embodiment of the present invention may be configured to configure CSI-RS configuration information, which will be provided to the user equipment, in accordance with the embodiments suggested in the present invention, transmit CSI-RS on the basis of the CSI-RS configuration information, and receive CSI generated by the user equipment. In addition, the processor **13** of the base station **10** performs a function of operation-processing information received by the base station **10** and information to be transmitted to the external device. The memory **14** may store the operation-processed information for a predetermined time, and may be replaced with a buffer (not shown).

[0281] Referring to FIG. **18**, a user equipment **20** according to the present invention may include a transmitter **21**, a receiver **22**, a processor **23**, a memory **24**, and a plurality of antennas **25**. The plurality of antennas **25** mean user equipments that support MIMO transmission and reception. The transmitter **21** may transmit various signals, data and information to an external device (for example, base station). The receiver **20** may receive various signals, data and information from the external device (for example, base station). The processor **23** may control the overall operation of the user equipment **20**.

[0282] The processor **23** of the user equipment **20** according to the embodiment of the present invention may be configured to receive CSI-RS on the basis of CSI-RS configuration information provided from the base station in accordance with the embodiments suggested in the present invention, and generate and report CSI for the 2-dimensional antenna structure of the base station by using the received CSI-RS. In addition, the processor **23** of the user equipment **20** performs a function of operation-processing information received by the user equipment **20** and information to be transmitted to the external device. The memory **24** may store the operation-processed information for a predetermined time, and may be replaced with a buffer (not shown).

[0283] The details of the aforementioned user equipment **20** may be configured in such a manner that the aforementioned various embodiments of the present invention may independently be applied thereto, or two or more embodiments may simultaneously be applied thereto. The repeated description of the details of the user equipment **20** will be omitted for clarification.

[0284] Also, in the description of the various embodiments of the present invention, the base station has been described as a downlink transmission entity or uplink reception entity, and the user equipment has been described as a downlink reception entity or uplink transmission entity. However, the scope of the present invention is not limited to the above example. For example, the description of the base station may equally be applied to a case where a cell, an antenna port, an antenna port group, RRH, a transmission point, a reception point, an access point or a relay becomes a downlink transmission entity to the user equipment or an uplink reception entity from the user equipment. Also, the principle of the present invention described through the various embodiments of the present invention may equally be applied to even a case where the relay becomes a downlink transmission entity to the user equipment or an uplink reception entity from the user equipment, or a case where the relay becomes an uplink transmission entity to the base station or a downlink reception entity from the base station.

[0285] The aforementioned embodiments according to the present invention may be implemented by various means, for example, hardware, firmware, software, or their combination.

[0286] If the embodiments according to the present invention are implemented by hardware, the embodiments of the present invention may be implemented by one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, microcontrollers, microprocessors, etc.

[0287] If the embodiments according to the present invention are implemented by firmware or software, the embodiments of the present invention may be implemented by a type of a module, a procedure, or a function, which performs functions or operations described as above. A software code may be stored in a memory unit and then may be driven by a processor. The memory unit may be located inside or outside the processor to transmit and receive data to and from the processor through various means which are well known.

[0288] It will be apparent to those skilled in the art that the present invention may be embodied in other specific forms without departing from the spirit and essential characteristics of the invention. Thus, the above embodiments are to be considered in all respects as illustrative and not restrictive. The scope of the invention should be determined by reasonable interpretation of the appended claims and all change which comes within the equivalent scope of the invention are included in the scope of the invention.

[0289] Those skilled in the art will appreciate that the present invention may be carried out in other specific ways than those set forth herein without departing from the spirit and essential characteristics of the present invention. The above embodiments are therefore to be construed in all aspects as illustrative and not restrictive. The scope of the invention should be determined by the appended claims and their legal equivalents, not by the above description, and all changes coming within the meaning and equivalency range of

the appended claims are intended to be embraced therein. It is also obvious to those skilled in the art that claims that are not explicitly cited in each other in the appended claims may be presented in combination as an embodiment of the present invention or included as a new claim by a subsequent amendment after the application is filed.

INDUSTRIAL APPLICABILITY

[0290] The aforementioned embodiments according to the present invention may be applied to various wireless communication systems.

1. A method for reporting channel status information (CSI) from a user equipment in a wireless communication system, the method comprising:

receiving from a base station a first channel status information-reference signal (CSI-RS) based on CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure, the CSI-RS configuration information for the first domain antenna group being provided from the base station;

reporting to the base station first CSI for the first domain antenna group, the first CSI being generated by using the first CSI-RS;

receiving from the base station a second CSI-RS based on CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure, the CSI-RS configuration information for the second domain antenna group being provided from the base station; and

reporting to the base station second CSI for the second domain antenna group, the second CSI is generated by using the second CSI-RS,

wherein the CSI-RS configuration information for the second domain antenna group is determined based on the first CSI.

2. The method according to claim **1**, wherein the first CSI includes a precoding vector preferred for the first domain, and beamforming in the first domain is determined by considering the precoding vector preferred for the first domain.

3. The method according to claim **1**, wherein the second CSI-RS configuration information is determined by assuming that beamforming in the first domain is applied based on the first CSI.

4. The method according to claim **1**, wherein the second CSI includes a precoding vector preferred for the second domain, beamforming in the second domain is determined by considering the precoding vector preferred for the second domain, and the precoding vector preferred for the second domain is determined by assuming that beamforming in the first domain is applied.

5. The method according to claim **1**, wherein three-dimensional beamforming for the two-dimensional antenna structure is determined by combination of beamforming in the first domain and beamforming in the second domain, the beamforming in the first domain and the beamforming in the second domain being determined considering the first CSI and the second CSI, respectively.

6. The method according to claim **1**, wherein the CSI-RS configuration information for the first domain antenna group is provided statically, and the CSI-RS configuration information for the second domain antenna group is provided dynamically.

7. The method according to claim **1**, wherein a transmission period of the first CSI-RS is greater than a transmission period of the second CSI-RS.

8. The method according to claim **1**, wherein the CSI-RS configuration information for the first domain antenna group includes a first antenna port count parameter, a first resource configuration parameter, a first subframe configuration parameter, and a first transmission power rate parameter.

9. The method according to claim **1**, wherein the CSI-RS configuration information for the second domain antenna group includes a second antenna port count parameter, a second resource configuration parameter, a second subframe configuration parameter, and a second transmission power rate parameter.

10. The method according to claim **1**, wherein the two-dimensional antenna structure is configured by a number of antennas of the second domain antenna group×a number of antennas of the first domain antenna group.

11. The method according to claim **1**, wherein the first domain is a horizontal domain, and the second domain is a vertical domain.

12. The method according to claim **1**, wherein the first domain is a vertical domain, and the second domain is a horizontal domain.

13. A user equipment for reporting channel status information (CSI) in a wireless communication system, the user equipment comprising:

a receiver;

a transmitter; and

a processor,

wherein the processor is configured to receive from a base station a first channel status information-reference signal (CSI-RS) by using the receiver on the basis of CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure, the CSI-RS configuration information for the first domain antenna group being provided from the base station, report to the base station first CSI for the first domain antenna group, the first CSI being generated by using the first CSI-RS, by using the transmitter, receive from the base station a second CSI-RS by using the receiver based on CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure, the CSI-RS configuration information for the second domain antenna group being provided from the base station, and report to the base station second CSI for the second domain antenna group, the second CSI being generated by using the second CSI-RS, by using the transmitter, and

the CSI-RS configuration information for the second domain antenna group is determined based on the first CSI.

14. A method for receiving channel status information (CSI) in a base station of a wireless communication system, the method comprising:

providing a user equipment with CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure of the base station and transmitting a first channel status information-reference signal (CSI-RS) to the user equipment based on CSI-RS configuration information for the first domain antenna group;

receiving from the user equipment first CSI for the first domain antenna group, the first CSI being generated in the user equipment by using the first CSI-RS;

providing the user equipment with CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure and transmitting a

second CSI-RS to the user equipment based on the CSI-RS configuration information for the second domain antenna group; and

receiving from the user equipment the second CSI-RS for the second domain antenna group, the second CSI being generated in the user equipment by using the second CSI-RS, wherein the CSI-RS configuration information for the second domain antenna group is determined based on the first CSI.

15. A base station for receiving channel status information (CSI) in a wireless communication system, the base station comprising:

a receiver;

a transmitter; and

a processor,

wherein the processor is configured to provide a user equipment with CSI-RS configuration information for a first domain antenna group of a two-dimensional antenna structure of the base station and transmit a first channel status information-reference signal (CSI-RS) to the user equipment based on CSI-RS configuration information for the first domain antenna group, receive from the user equipment first CSI for the first domain antenna group, the first CSI being generated in the user equipment by using the first CSI-RS, provide the user equipment with CSI-RS configuration information for a second domain antenna group of the two-dimensional antenna structure and transmit a second CSI-RS to the user equipment based on the CSI-RS configuration information for the second domain antenna group, and receive from the user equipment the second CSI-RS for the second domain antenna group, the second CSI being generated in the user equipment by using the second CSI-RS, wherein the CSI-RS configuration information for the second domain antenna group is determined based on the first CSI.

* * * * *

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Office Action Summary	Application No. 15/972,167	Applicant(s) ZHANG, Xiaobo	
	Examiner MANDISH RANDHAWA	Art Unit 2477	AIA (FITF) Status Yes

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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.
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Status

1)☑ Responsive to communication(s) filed on 5/6/18.

☐ 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) 1-18 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) 1-18 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 _____ 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.

Claim Rejections - 35 USC § 102

2. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.

4. Claims 1-18 are rejected under 35 U.S.C. 102(a)(2) as being anticipated by Guo et al. (US 2018/0083680 A1, hereinafter "Guo").

Regarding claims 1 and 11, Guo teaches a method in a User Equipment (UE) (**figs. 16**) for wireless communication, comprising: receiving a first radio signal (**17A-17C, ¶ [0275], control channel 1710 and data channel 1720. The control channel 1710 can include three OFDM symbols 1731, 1732 and 1733**); wherein the first radio signal is transmitted within a first time unit (**¶ [0275], subframe**), a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols (**figs. 17A-17C, ¶ [0272], a control region comprises an N number of OFDM**

symbols); as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving (**¶ [0275], receiving beam**) for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer (**figs. 17A-17C, ¶ [0272], ¶ [0273], ¶ [0277], The control channel 1710 can include three OFDM symbols 1731, 1732 and 1733. The UE is configured to use the same Rx beam within each slot/subframe cycle the Rx beams over subframes/slots. There are control channel 1710 and data channel 1720 in each subframe/slot, ¶ [0280], ¶ [0281], The UE is configured with 4 Rx beams 1691, 1692, 1693, and 1694 for cycling. Assume the UE begin the Rx beam cycling from subframe 1701. The UE is configured to apply Rx beam 1691 on OFDM symbol 1731 in subframe 1701, apply Rx beam 1692 on OFDM symbol 1732 in subframe 1701, apply Rx beam 1693 on OFDM symbol 1733 in subframe 1701, then apply Rx beam 1694 on OFDM symbol 1734 in subframe 1702, then the UE cycle back to beam 1691 and apply Rx beam 1691 on OFDM symbol 1735 in subframe 1702. and ¶ [0285]. And pages 16-22 of provisional application 62/421039**).

Regarding claims 2 and 12, Guo teaches the method according to claim 1, comprising: receiving a second radio signal; wherein the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols (**¶ [0226] A gNB can indicate UE to use an Rx mode for DL signal reception (PDSCH and PDSCH DMRS) via RRC, MAC-CE or DCI signaling. ¶ [0235] A DL assignment DCI may indicate reference QCL resource(s) to be used for demodulation of a PDSCH assigned by the**

DCI. ¶ [0270], A UE can be indicated to use Rx beam cycling to receive control channels via RRC, MAC CE or DCI signaling. UE can be indicated to use Rx beam cycling to receive data channels via RRC, MAC CE or DCI signaling. ¶ [0271] and ¶ [0272]. And pages 16-22 of provisional application 62/421039).

Regarding claims 3 and 13, Guo teaches the method according to claim 2, wherein if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal (**figs. 17A-17C, ¶ [0272], a control region comprises an N number of OFDM symbols. The UE is further configured to apply N different Rx beams on the N number of OFDM symbols. The UE can be indicated with N Rx beam IDs for the Rx beam cycling across OFDM symbols via RRC, DCI or MAC CE signaling, ¶ [0273], a UE is configured to keep using the indicated set of N Rx beams across OFDM symbols for control signal reception in subsequent slots/subframes, until another set of N Rx beam indication is received. ¶ [0277], ¶ [0280] and ¶ [0285]. And pages 16-22 of provisional application 62/421039**).

Regarding claims 4 and 14, Guo teaches the method according to claims 1, comprising: receiving first information, wherein the first information is used for determining the first time point; or, receiving third information, wherein the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols (**figs. 17A-17C, ¶ [0270]- [0272], The UE can be indicated with N Rx beam IDs for the Rx beam cycling across OFDM**

symbols via RRC, DCI or MAC CE signaling, ¶ [0277] In some embodiments, a control region comprises an N number of OFDM symbols. The UE is further configured to a same Rx beam on the N number of OFDM symbols. The UE can be indicated with Pc Rx beam IDs for the Rx beam cycling across subframes/slots via RRC, DCI or MAC CE signaling).

Regarding claim 5, Guo teaches the method according to claims 1 comprising: transmitting second information; wherein the second information is used for determining the first time point (**figs. 17A-17C, ¶ [0270]- [0272], The UE can be indicated with N Rx beam IDs for the Rx beam cycling across OFDM symbols via RRC, DCI or MAC CE signaling, ¶ [0277] In some embodiments, a control region comprises an N number of OFDM symbols. The UE is further configured to a same Rx beam on the N number of OFDM symbols. The UE can be indicated with Pc Rx beam IDs for the Rx beam cycling across subframes/slots via RRC, DCI or MAC CE signaling**).

Regarding claims 6 and 15, Guo teaches a method in a base station device (**figs. 16**) for wireless communication, comprising: transmitting a first radio signal (**17A-17C, ¶ [0275], control channel 1710 and data channel 1720. The control channel 1710 can include three OFDM symbols 1731, 1732 and 1733**); wherein the first radio signal is transmitted within a first time unit (**¶ [0275], subframe**),, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols (**figs. 17A-17C, ¶ [0272], a control region comprises an N number of OFDM symbols**); as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving(**¶ [0275], receiving beam**) for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the

first time point is one time point within the first time unit; and G is a positive integer (**figs. 17A-17C, ¶ [0272], ¶ [0273], ¶ [0277], The control channel 1710 can include three OFDM symbols 1731, 1732 and 1733. The UE is configured to use the same Rx beam within each slot/subframe cycle the Rx beams over subframes/slots. There are control channel 1710 and data channel 1720 in each subframe/slot, ¶ [0280], ¶ [0281], The UE is configured with 4 Rx beams 1691, 1692, 1693, and 1694 for cycling. Assume the UE begin the Rx beam cycling from subframe 1701. The UE is configured to apply Rx beam 1691 on OFDM symbol 1731 in subframe 1701, apply Rx beam 1692 on OFDM symbol 1732 in subframe 1701, apply Rx beam 1693 on OFDM symbol 1733 in subframe 1701, then apply Rx beam 1694 on OFDM symbol 1734 in subframe 1702, then the UE cycle back to beam 1691 and apply Rx beam 1691 on OFDM symbol 1735 in subframe 1702. and ¶ [0285]. And pages 16-22 of provisional application 62/421039**).

Regarding claims 7 and 16, Guo teaches the method according to claim 6, comprising: transmitting a second radio signal; wherein the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols (**¶ [0226] A gNB can indicate UE to use an Rx mode for DL signal reception (PDSCH and PDSCH DMRS) via RRC, MAC-CE or DCI signaling. ¶ [0235] A DL assignment DCI may indicate reference QCL resource(s) to be used for demodulation of a PDSCH assigned by the DCI. ¶ [0270], A UE can be indicated to use Rx beam cycling to receive control channels via RRC, MAC CE or DCI signaling. UE can be indicated to use Rx beam cycling to receive data channels via RRC, MAC CE or DCI signaling. ¶ [0271] and ¶ [0272]. And pages 16-22 of provisional application 62/421039**).

Regarding claims 8 and 17, Guo teaches the method according to claim 7, wherein if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal (**figs. 17A-17C, ¶ [0272], a control region comprises an N number of OFDM symbols. The UE is further configured to apply N different Rx beams on the N number of OFDM symbols. The UE can be indicated with N Rx beam IDs for the Rx beam cycling across OFDM symbols via RRC, DCI or MAC CE signaling, ¶ [0273], a UE is configured to keep using the indicated set of N Rx beams across OFDM symbols for control signal reception in subsequent slots/subframes, until another set of N Rx beam indication is received. ¶ [0277], ¶ [0280] and ¶ [0285]. And pages 16-22 of provisional application 62/421039**).

Regarding claims 9 and 18, Guo teaches the method according to claims 6, comprising: transmitting first information, wherein the first information is used for determining the first time point; or, transmitting third information, wherein the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols (**figs. 17A-17C, ¶ [0270]- [0272], The UE can be indicated with N Rx beam IDs for the Rx beam cycling across OFDM symbols via RRC, DCI or MAC CE signaling, ¶ [0277] In some embodiments, a control region comprises an N number of OFDM symbols. The UE is further configured to a same Rx beam on the N number of OFDM symbols. The UE can be indicated with Pc**

Rx beam IDs for the Rx beam cycling across subframes/slots via RRC, DCI or MAC CE signaling).

Regarding claim 10, Guo teaches the method according to claims 6, comprising: receiving second information; wherein the second information is used for determining the first time point (**figs. 17A-17C, ¶ [0270]- [0272], The UE can be indicated with N Rx beam IDs for the Rx beam cycling across OFDM symbols via RRC, DCI or MAC CE signaling, ¶ [0277] In some embodiments, a control region comprises an N number of OFDM symbols. The UE is further configured to a same Rx beam on the N number of OFDM symbols. The UE can be indicated with Pc Rx beam IDs for the Rx beam cycling across subframes/slots via RRC, DCI or MAC CE signaling**).

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MANDISH RANDHAWA whose telephone number is (571)270-5650. The examiner can normally be reached on Monday-Thursday (7 AM-4 PM).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ayaz Sheikh can be reached on (571) 272-3795. 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.

/MANDISH K RANDHAWA/
Examiner, Art Unit 2477

Notice of References Cited	Application/Control No. 15/972,167	Applicant(s)/Patent Under Reexamination ZHANG, Xiaobo	
	Examiner MANDISH RANDHAWA	Art Unit 2477	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-20180083680-A1	03-2018	Guo; Li	H04B7/0626	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/972,167	ZHANG, Xiaobo
	Examiner	**Art Unit**
	MANDISH RANDHAWA	2477

✓	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	03/19/2020								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/972,167	ZHANG, Xiaobo
	Examiner	Art Unit
	MANDISH RANDHAWA	2477

CPC - Searched*		
Symbol	Date	Examiner

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
Performed Inventor/Double Patenting search	03/09/2020	MR
Performed NPL and East text search	03/09/2020	MR

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

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	"15972167"	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:18
S2	1537	(multi$carrier symbols)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:20
S3	300	("g" or "n" or "m" or multiple or plurality or two or several) near2 (multi$carrier symbols)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:20
S4	20	(multi$carrier symbols) same beam$5	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:23
S5	0	(multi$carrier symbols) same P$DCCH near3 resource	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:50
S6	8	(multi$carrier symbols) same P$dsch same p$dcch	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:52
S7	1	(multi$carrier symbols) and symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:55
S8	171	symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:55
S9	38	(multi$carrier) and symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:56
S10	1	(multi$carrier) same symbol same P$dsch same p$dcch same beam$4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 13:56
S11	5	(multi$carrier near4 symbol) same (antenna) near2 (direction or position)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:01

EAST Search History (Prior Art)

S12	57	(multi$carrier symbols) same (beam$2 or beam$form$4 or beam adj form$4)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:08
S13	37	S12 not S4	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:08
S14	26	(wide$3 near3 beam$3) with p$dcch same narrow$4 near3 beam$3 with p$dsch	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 14:21
S15	102	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) symbol same (first or wid$3) near3 beam$5 same (second or narrow$3) beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 18:08
S16	1	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) symbol same (first or wid$3) near3 beam$5 same (second or narrow$3) beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 18:13
S17	133	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) near2 symbol same beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/07 18:47
S18	123	(mult4carrier or ofdm or filter bank multiple carrier or fbmc) near2 symbol same (chang$4 or adjust$4) near2 beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:04
S19	2	(cross$2 symbol) same beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:35
S20	145	(symbol) with beam same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:35
S21	10	(symbol) with (chang$4 beam) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:36
S22	21	(symbol) with ((chang$4 or different or mode or wide$4 or narrow$4) beam) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 14:36
S23	34	(symbol) with ((chang$4 or different or mode or wide$4 or narrow$4 or swap$4 or switch$4) near2 beam) same ($3dsch or data channel) same ($3dcch or control channel)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 16:10

EAST Search History (Prior Art)

S24	13	S23 not S22	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 16:11
S25	906	(time or symbol index) with (data channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:19
S26	6	(symbol index) with (data channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:19
S27	215	(index) with (data channel or $3dsch) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:22
S28	111	(index) with (data channel or $3dsch) same beam same (control channel or $3dcch)	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:23
S29	11	(index) with (data channel or $3dsch) same beam same (control channel or $3dcch) same symbol	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:24
S30	3	"20040110469"	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:40
S31	56	(cross$2 symbol) same beam	US-PGPUB; USPAT; EPO; DERWENT	NEAR	ON	2020/03/08 17:43

Bibliographic Data

Application No: 15/972,167

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /MANDISH RANDHAWA/ Examiner's Signature [ ] Initials

Title: METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
05/06/2018	370	2477	S3876.10011US01
RULE			

APPLICANTS

Shanghai Langbo Communication Technology Company Limited,

INVENTORS

Xiaobo ZHANG Shanghai, CHINA

CONTINUING DATA

FOREIGN APPLICATIONS /M.K.R/ 03/19/2020

CHINA 201710318202.4 05/08/2017

IF REQUIRED, FOREIGN LICENSE GRANTED**

05/29/2018

**** SMALL ENTITY ****

STATE OR COUNTRY

CHINA

ADDRESS

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

FILING FEE RECEIVED

$1,015

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
15/972,167	05/06/2018	Xiaobo ZHANG	S3876.10011US01

CONFIRMATION NO. 3699

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

POA ACCEPTANCE LETTER

OC000000105603184

Date Mailed: 02/05/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/31/2019.

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

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

/agizaw/

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	15/972,167		
Filing Date	May 6, 2018		
First Named Inventor	Xiaobo Zhang		
Title	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION		
Art Unit	2464		
Examiner Name	Ricky Quoc NGO		
Attorney Docket Number	S3876.10011US01		
SIGNATURE of Applicant or Patent Practitioner			
Signature	/R. Burns Israelsen/	**Date**	January 31, 2019
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:

- [X] 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*.

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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：201710318202.4

申　请　类　型：发明专利

发明 创造 名称：一种基站、用户设备中的用于无线通信的方法和装置

申　　请　　日：2017 年 05 月 08 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

2018 年 06 月 18 日

权 利 要 求 书

1. 一种被用于无线通信的用户设备中的方法，包括：

- 接收第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号；对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关；所述第一时间点是所述第一时间单元内的一个时间点；所述 G 是正整数。

2. 根据权利要求 1 所述的方法，其中包括：

- 接收第二无线信号；

所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被用于确定所述 G 个多载波符号所占用的时域资源。

3. 根据权利要求 2 所述的方法，其中，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收；或者所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

4. 根据权利要求 1-3 中任一权利要求所述的方法，其中，所述多天线相关的接收是指相应的用于接收的波束赋型向量；或者所述多天线相关的接收是指相应的用于发送的天线端口。

5. 根据权利要求 1-4 中的任一权利要求所述的方法，其中包括：

- 接收第一信息；

所述第一信息被用于确定所述第一时间点。

6. 根据权利要求 1-5 中的任一权利要求所述的方法，其中包括：

-发送第二信息；

所述第二信息被用于确定所述第一时间点。

7. 根据权利要求 1-6 中的任一权利要求所述的方法，其中包括：

- 接收第三信息；

所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

8. 一种被用于无线通信的基站设备中的方法，包括：

- 发送第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号；对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关；所述第一时间点是所述第一时间单元内的一个时间点；所述 G 是正整数。

9. 根据权利要求 8 所述的方法，其中包括：

- 发送第二无线信号；

所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被用于确定所述 G 个多载波符号所占用的时域资源。

10. 根据权利要求 9 所述的方法，其中，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收；或者所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

11. 根据权利要求 8-10 中任一权利要求所述的方法，其中，所述多天线相关的接收是指相应的用于接收的波束赋型向量；或者所述多天线相关的接收是指相应的用于发送的天线端口。

12. 根据权利要求 8-11 中的任一权利要求所述的方法，其中包括：

- 发送第一信息；

所述第一信息被用于确定所述第一时间点。

13. 根据权利要求 8-12 中的任一权利要求所述的方法，其中包括：

-接收第二信息；

所述第二信息被用于确定所述第一时间点。

14. 根据权利要求 8-13 中的任一权利要求所述的方法，其中包括：

- 发送第三信息；

所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

15. 一种被用于无线通信的用户设备，包括：

- 第一模块，接收第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

16. 一种被用于无线通信的基站设备，包括：

- 第二模块，发送第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号；对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关；所述第一时间点是所述第一时间单元内的一个时间点；所述 G 是正整数。

2017103182024

说 明 书

一种基站、用户设备中的用于无线通信的方法和装置

技术领域

本申请涉及无线通信系统中的无线信号的传输方案，特别是涉及多天线传输的方法和装置。

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，形成多用户 MIMO（MU-MIMO），以提高大规模 MIMO 系统的吞吐量，降低传输时延。

在 3GPP 新空口讨论中，有公司提出用较宽的波束传输 PDCCH（Physical Downlink Control Channel，物理下行控制信道）以增加传输的鲁棒性，用较窄的波束传输 PDSCH（Physical Downlink Shared Channel，物理下行共享信道）以提高 SNR（Signal-to-Noise Ratio，信噪比）；也有公司提出使用 PDCCH 对 PDSCH 的传输波束做跨时隙指示，以解决 UE（User Equipment，用户设备）从 PDCCH 中获得 PDSCH 的传输波束和使用 PDCCH 指示的波束信息进行 PDSCH 接收之间的延迟问题。

发明内容

作为一个实施例，发明人通过研究发现，跨时隙波束指示会导致波束信息动态性降低，控制信令开销增加，调度动态性降低等问题；处理能力强的 UE 可以在短时间内对 PDCCH 进行解码得到用于接收 PDCCH 所在时隙的 PDSCH 的波束信息，调整接收波束对 PDSCH 所在的多载波符号进行接收，但用于解码 PDCCH 所导致的 PDSCH 传输的延迟会导致系统资源的不充分利用。

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，本申请的实施例和实施例中的特征可以任意相互组合。例如，

本申请的基站中的实施例和实施例中的特征可以应用到用户设备中，反之亦然。

本申请公开了一种被用于无线通信的用户设备中的方法，包括：

- 接收第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

作为一个实施例，上述方法的好处在于，根据多天线相关的接收延迟要求灵活的配置被用于所述第一无线信号的多天线相关的接收。

作为一个实施例，所述第一无线信号是一个 PDSCH。

作为一个实施例，所述第一无线信号是一个在时域上连续的数据传输块。

作为一个实施例，所述第一无线信号是在时域上连续的所述 G 个多载波符号。。

作为一个实施例，所述第一时间单元是一个子帧。

作为一个实施例，所述子帧包括了 14 个 OFDM（Orthogonal Frequency Division Multiplexing）符号。

作为一个实施例，所述第一时间单元是一个时隙。

作为一个实施例，所述时隙包括了 7 个 OFDM（Orthogonal Frequency Division Multiplexing）符号。

作为一个实施例，所述第一时间单元是一个 TTI（Transmission Time Interval，传输时间间隔）。

作为一个实施例，所述第一时间单元只包括一个用于指示下行资源分配（Downlink Assignment）的 DCI（Downlink Control Information）。

作为一个实施例，所述第一比特块中的所有比特被用于生成所述第一无线信号。

作为一个实施例，所述第一比特块中的部分比特被用于生成所述第一

无线信号。

作为一个实施例，所述第一比特块是一个传输块。

作为一个实施例，所述第一比特块经过加 CRC（Circular Redundancy Check，循环冗余检验）、分段、信道编码、速率匹配、加扰、调制、天线映射的步骤形成所述第一无线信号。

作为一个实施例，所述第一比特块是一个传输块中的子块。

作为一个实施例，所述第一比特块是一个传输块加了 CRC、并分段后形成的多个子比特块中的一个子比特块。

作为一个实施例，所述第一比特块经过信道编码、速率匹配、加扰、调制、天线映射的步骤形成所述第一无线信号。

作为一个实施例，多个比特块与所述第一无线信号中的多层信号一一对应，所述第一比特块是所述多个比特块中的一个比特块。

作为一个实施例，所述多载波符号是 OFDM 符号。

作为一个实施例，所述多载波符号是 FBMC(Filter Bank Multiple Carrier，滤波器组多载波)符号。

作为一个实施例，所述多天线相关的接收是指模拟接收波束。

作为一个实施例，所述多天线相关的接收是指所述用户设备假设的发送天线端口。

作为一个实施例，所述 G 个多载波符号是连续的 G 个多载波符号。

作为一个实施例，所述第一无线信号由所述 G 个多载波符号组成。

作为一个实施例，所述第一无线信号包括不在所述 G 个多载波符号中的多载波符号。

作为一个实施例，如果所述给定多载波符号在时域上在所述第一时间点之前，则第一多天线接收方式被用于所述给定多载波符号的多天线相关的接收；如果所述给定多载波符号在时域上在所述第一时间点之后，则第二多天线接收方式被用于所述给定多载波符号的多天线相关的接收。所述第一多天线接收方式和所述第二多天线接收方式不同。

作为一个实施例，所述第一多天线接收方式和所述第二多天线接收方式分别对应使用不同的模拟波束接收。

作为一个实施例，所述第一多天线接收方式和所述第二多天线接收方式分别对应假设不同的发送天线端口发送。

作为一个实施例，所述第二多天线接收方式对应的天线接收增益比所述第一天线接收方式对应的天线接收增益更大。

作为一个实施例，所述第一多天线接收方式对应的传输可靠性比所述第二天线接收方式对应的传输可靠性更大。

作为一个实施例，所述第二多天线接收方式是指使用比所述第一多天线接收方式更窄的波束。

作为一个实施例，所述 G 个多载波符号在时域上都在所述第一时间点之前，针对所述 G 个多载波符号的多天线相关的接收相同。

作为一个实施例，所述 G 个多载波符号在时域上都在所述第一时间点之后，针对所述 G 个多载波符号的多天线相关的接收相同。

作为一个实施例，所述 G 个多载波符号中的 G1 个多载波符号在时域上所述第一时间点之前，所述 G 个多载波符号中的 G2 个多载波符号在时域上所述第一时间点之后，针对所述 G1 个多载波符号的多天线相关的接收相同，针对所述 G2 个多载波符号的多天线相关的接收相同，针对所述 G1 个多载波符号的多天线相关的接收与针对所述 G2 个多载波符号的多天线相关的接收不同。所述 G1 和所述 G2 是正整数。

作为一个实施例，所述第一时间点是一个多载波符号在所述第一时间单元内的检索值。

根据本申请的一个方面，其中包括：

- 接收第二无线信号；

所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被用于确定所述 G 个多载波符号所占用的时域资源。

作为一个实施例，上述方法的好处在于灵活的配置所述 G 个多载波符号所占用的时域资源。

作为一个实施例，所述第二无线信号是 PDCCH。

作为一个实施例，所述第二无线信号是 ePDCCH(Enhanced PDCCH，增强物理层从控制信道)。

作为一个实施例，所述所述第二无线信号显式的指示所述 G 个多载波符号所占用的时域资源。

作为一个实施例，所述所述第二无线信号隐式的指示所述 G 个多载波符号所占用的时域资源。

作为一个实施例，所述第二无线信号是携带下行传输资源分配（Downlink Assignment）信息的DCI（Downlink Control Information）。

作为一个实施例，所述第一时间单元由所述第二无线信号所在的 N1 个多载波符号和 N2 个多载波符号组成，所述 N2 不小于所述 G。所述第二无线信号被用于确定所述 N 个多载波符号中的所述 G 个多载波符号。所述 N1 和所述 N2 是正整数。

作为一个实施例，所述第一时间单元由所述第二无线信号所在的 N1 个多载波符号和 G 个多载波符号组成，所述 N1 个多载波符号被用于确定所述 G 个多载波符号。所述 N1 是正整数。

根据本申请的一个方面，其中，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收；或者所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

作为一个实施例，上述方法的好处是，增加多天线相关的接收的动态性。

作为一个实施例，上述方法的好处是，避免了由于对所述第二无线信号的解码延迟造成的所述第一无线信号的接收延迟。

作为一个实施例，上述方的好处是，PDSCH 在所述第一时间点之前使用与用于接收 PDCCH 相同的波束接收所述 PDSCH 在所述第一时间点之前的多载波符号，避免了由于 PDCCH 解码延迟造成的 PDSCH 传输延迟的问题。

作为一个实施例，如果所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收；如果所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

作为一个实施例，所述第二无线信号显式的指示所述针对所述给定多载波符号的多天线相关的接收。

作为一个实施例，所述第二无线信号隐式的指示所述针对所述给定多载波符号的多天线相关的接收。

作为一个实施例，所述针对所述给定多载波符号的接收波束与针对所

述第二无线信号的接收波束相同。

作为一个实施例，所述针对所述给定多载波符号的接收假设的发送天线端口与针对所述第二无线信号假设的发送天线端口相同。

根据本申请的一个方面，其中，所述多天线相关的接收是指相应的用于接收的波束赋型向量；或者所述多天线相关的接收是指相应的用于发送的天线端口。

作为一个实施例，上述方法的好处在于，对数据传输所使用的波束进行灵活的调整，提高天线阵列增益。

作为一个实施例，接收波束的索引值被用于指示用于接收的波束赋型向量。

作为一个实施例，第一波束对的索引值被用于指示用于接收的波束赋型向量，所述第一波束对由一个发送向量和一个接收向量组成。

作为一个实施例，所述波束赋型向量是模拟波束赋型向量。

作为一个实施例，所述波束赋型向量是由模拟波束赋型向量和数字波束赋型向量组成的波束赋型向量。

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，第一参考信号通过所述用于发送的天线端口发送，所述第一参考信号所经历的小尺度信道参数被用于确定所述第一无线信号所经历的小尺度信道参数，所述第一参考信号被指示与第二参考信号关联，所述第二参考信号所经历的大尺度信道参数被用于确定所述第一无线信号所经历的大尺度信道参数。

作为上述实施例的一个子实施例，所述第一参考信号被指示与所述第二参考信号 QCL（Quasi Co-Located，类共站）。

根据本申请的一个方面，其中包括：

- 接收第一信息；

所述第一信息被用于确定所述第一时间点。

作为一个实施例，上述方法的好处是，根据 UE 能力和系统状况灵活地配置所述第一时间点。

作为一个实施例，所述第一信息显式的指示所述第一时间点。

作为一个实施例，所述第一信息隐式的指示所述第一时间点。

作为一个实施例，所述第一时间点是一个多载波符号在所述第一时间单元内的索引。

作为一个实施例，所述第一信息是高层信令。

作为一个实施例，所述第一信息是 RRC（Radio Resource Control）信令。

根据本申请的一个方面，其中包括：

-发送第二信息；

所述第二信息被用于确定所述第一时间点。

作为一个实施例，上述方法的好处在于，UE 可以通过指示基站 UE 的处理能力来辅助基站确定所述第一时间点，从而优化系统的性能。

作为一个实施例，所述第二信息显式的指示所述第一时间点。

作为一个实施例，所述第二信息隐式的指示所述第一时间点。

作为一个实施例，所述第二信息是 RRC 信令。

作为一个实施例，所述第二信息在随机接入（Random Access）过程中的 Message 3（第三条消息）中发送。

根据本申请的一个方面，其中包括：

- 接收第三信息；

所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

作为一个实施例，上述方法的好处在于，灵活的配置所述 G 个多载波符号对应的多天线相关的接收的候选方案。

作为一个实施例，所述第三信息显式的指示所述 G 个多载波符号对应的多天线相关的接收的候选方案。

作为一个实施例，所述第三信息隐式的指示所述 G 个多载波符号对应的多天线相关的接收的候选方案。

作为一个实施例，所述所述 G 个多载波符号对应的多天线相关的接收的候选方案包括第一多天线接收方式和第二多天线接收方式。所述第一多天线接收方式和所述第二多天线接收方式不同。如果所述给定多载波符号在时域上在所述第一时间点之前，则第一多天线接收方式被用于所述给定多载波符号的多天线相关的接收；如果所述给定多载波符号在时域上在所

述第一时间点之后，则第二多天线接收方式被用于所述给定多载波符号的多天线相关的接收。

作为一个实施例，所述所述 G 个多载波符号对应的多天线相关的接收的候选方案包括多个候选用于接收的波束。

作为一个实施例，所述所述 G 个多载波符号对应的多天线相关的接收的候选方案包括多个候选用于接收的波束赋型向量。

作为一个实施例，所述第三信息是 DCI。

作为一个实施例，所述第三信息在 PDCCH 上发送。

作为一个实施例，所述第三信息由所述第二无线信号承载。

作为一个实施例，所述所述 G 个多载波符号对应的多天线相关的接收的候选方案中的一个候选方案由所述第二无线信号承载。

作为一个实施例，所述第三信息是高层信令。

作为一个实施例，所述第三信息是 RRC 信令。

作为一个实施例，所述第三信息被用于确定所述第二无线信号对应的多天相关的接收。

作为一个实施例，所述第三信息显式的指示所述第二无线信号对应的多天相关的接收。

作为一个实施例，所述第三信息隐式的指示所述第二无线信号对应的多天相关的接收。

本申请公开了一种被用于无线通信的基站设备中的方法，包括：

- 发送第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

根据本申请的一个方面，其中包括：

- 发送第二无线信号；

所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被

用于确定所述 G 个多载波符号所占用的时域资源。

根据本申请的一个方面，其中，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收；或者所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

根据本申请的一个方面，其中，所述多天线相关的接收是指相应的用于接收的波束赋型向量；或者所述多天线相关的接收是指相应的用于发送的天线端口。

根据本申请的一个方面，其中包括：

- 发送第一信息；

所述第一信息被用于确定所述第一时间点。

根据本申请的一个方面，其中包括：

-接收第二信息；

所述第二信息被用于确定所述第一时间点。

根据本申请的一个方面，其中包括：

- 发送第三信息；

所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

本申请公开了一种被用于无线通信的用户设备，包括：

- 第一模块，接收第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

作为一个实施例，上述用户设备的特征在于，其中，所述第一模块还被用于接收第二无线信号；所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被用于确定所述 G 个多载波符号所占用的时域资源。

作为一个实施例，上述用户设备的特征在于，其中，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收；或者所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

作为一个实施例，上述用户设备的特征在于，其中，所述多天线相关的接收是指相应的用于接收的波束赋型向量；或者所述多天线相关的接收是指相应的用于发送的天线端口。

作为一个实施例，上述用户设备的特征在于，其中，所述第一模块还被用于接收第一信息；所述第一信息被用于确定所述第一时间点。

作为一个实施例，上述用户设备的特征在于，其中，所述第一模块还被用于发送第二信息；所述第二信息被用于确定所述第一时间点。

作为一个实施例，上述用户设备的特征在于，其中，所述第一模块还被用于接收第三信息；所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

本申请公开了一种被用于无线通信的基站设备，包括：

- 第二模块，发送第一无线信号；

其中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

作为一个实施例，上述基站设备的特征在于，其中，所述第二模块还被用于发送第二无线信号；所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被用于确定所述 G 个多载波符号所占用的时域资源。

作为一个实施例，上述基站设备的特征在于，其中，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收；或者所述所

述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

作为一个实施例，上述基站设备的特征在于，其中，所述多天线相关的接收是指相应的用于接收的波束赋型向量；或者所述多天线相关的接收是指相应的用于发送的天线端口。

作为一个实施例，上述基站设备的特征在于，其中，所述第二模块还被用于发送第一信息；所述第一信息被用于确定所述第一时间点。

作为一个实施例，上述基站设备的特征在于，其中，所述第二模块还被用于接收第二信息；所述第二信息被用于确定所述第一时间点。

作为一个实施例，上述基站设备的特征在于，其中，所述第二模块还被用于发送第三信息；所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

作为一个实施例，和传统方案相比，本申请具备如下优势：

- 增加多天线相关接收的动态性；
- 节约控制信令开销；
- 增加调度动态性；
- 提高传输增益。

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第一无线信号的示意图；

图 3 示出了根据本申请的一个实施例的第二无线信号和第一无线信号的示意图；

图 4 示出了根据本申请的一个实施例的第一信息和第二信息的示意图；

图 5 示出了根据本申请的一个实施例的用于用户设备中的处理装置的结构框图；

图 6 示出了根据本申请的一个实施例的用于基站设备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。在附图 1 中，基站 N1 是 UE U2 的服务小区维持基站。附图 1 中，方框 F1、方框 F2、方框 F3 和方框 F4 中的步骤是分别可选的。

对于 N1，在步骤 S11 中接收第二信息；在步骤 S12 中发送第一信息；在步骤 S13 中发送第三信息；在步骤 S14 中发送第二无线信号；在步骤 S15 中发送第一无线信号。

对于 U2，在步骤 S21 中发送第二信息；在步骤 S22 中接收第一信息；在步骤 S23 中接收第三信息；在步骤 S24 中接收第二无线信号；在步骤 S25 中接收第一无线信号。

在实施例 1 中， N1 在第一时间单元内发送所述第一无线信号，第一比特块被 N1 用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，U2 针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

作为实施例 1 的子实施例 1，方框 F4 中的步骤存在，N1 在所述第一时间单元内发送所述第二无线信号，所述第二无线信号被 U2 用于确定所述 G 个多载波符号所占用的时域资源。

作为实施例 1 的子实施例 2，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被 U2 用于确定所述针对所述给定多载波符号的多天线相关的接收。

作为实施例 1 的子实施例 3，所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，U2 所述针对所述给定多载波符号的多天线相关的接收和针对所述第二无线信号的所述多天线相关的接收有关。

作为实施例 1 的子实施例 4，所述多天线相关的接收是指 U2 相应的用于接收的波束赋型向量。

作为实施例 1 的子实施例 5，所述多天线相关的接收是指 N1 相应的

用于发送的天线端口。

作为实施例 1 的子实施例 6，方框 F2 中的步骤存在，所述第一信息被 U2 用于确定所述第一时间点。

作为实施例 1 的子实施例 7，方框 F1 中的步骤存在，所述第二信息被 N1 用于确定所述第一时间点。

作为实施例 1 的子实施例 8，方框 F3 中的步骤存在，所述第三信息被 U2 用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

不冲突的情况下，上述子实施例 1-8 能够任意组合。

实施例 2

实施例 2 示例了第一无线信号，如附图 2 所示。在附图 2 中，斜线填充的长方格表示第一时间点之前的第一无线信号中的多载波符号，交叉填充的长方格表示第一时间点之后的第一无线信号中的多载波符号，空白填充的长方格表示不在第一无线信号内的多载波符号，斜线填充的较宽椭圆表示第一接收波束，交叉填充的较窄椭圆表示第二接收波束。

在实施例 2 中，第一无线信号由 G 个多载波符号组成，第一时间单元包括了所述 G 个多载波符号，第一时间点是所述第一时间单元上的一个时间点，所述第一无线信号和所述第一时间点在时域上的相对位置包括如附图 2 所示的三种情况。

在实施例 2 的第一种情况中，所述第一时间点是所述 G 个多载波符号所在的时域上的一个时间点。第一接收波束被用于接收在所述第一时间点之前的所述第一无线信号中的多载波符号。第二接收波束被用于接收在所述第一时间点之后的所述第一无线信号中的多载波符号。

在实施例 2 的第二种情况中，所述第一时间点在所述 G 个多载波符号之后，所述第一接收波束被用于接收在所述 G 个多载波符号。

在实施例 2 的第三种情况中，所述第一时间点在所述 G 个多载波符号前，所述第二接收波束被用于接收在所述 G 个多载波符号。

作为实施例 2 的子实施例 1，所述时间单元是子帧。

作为实施例 2 的子实施例 2，所述时间单元子时隙。

作为实施例 2 的子实施例 3，所述第二无线信号是一个 PDSCH 所在的多载波符号。

作为实施例 2 的子实施例 4，不同的波束赋型向量被用于形成所述第一接收波束和所述第二接收波束。

作为实施例 2 的子实施例 5，所述第一接收波束的波束宽度大于所述第二接收波束的波束宽度。

实施例 3

实施例 3 示例了第二无线信号和第一无线信号，如附图 3 所示。灰色填充的长方格表示第二无线信号中的多载波符号，斜线填充的长方格表示第一时间点之前的第一无线信号中的多载波符号，交叉填充的长方格表示第一时间点之后的第一无线信号中的多载波符号，空白填充的长方格表示不在第一无线信号内的多载波符号，斜线填充的较宽椭圆表示第一接收波束，交叉填充的较窄椭圆表示第二接收波束。

在实施例 3 中，第一无线信号和第二无线信号都在第一时间单元内，所述第二无线信号所占的多载波符号在时域上在所述第一无线信号所占的多载波符号之前，所述第一接收波束被用于接收所述第二无线信号，所述第二无线信号指示所述第一无线信号在所述第一时间单元内的起始时间点，所述起始时间点被用于确定所述第一无线信号在所述第一时间单元内所占用的时域资源。第一时间点是所述第一时间单元内在所述第二无线信号所占的多载波符号之后的一个时间点。

在实施例 3 中，第一接收波束被用于接收所述第二无线信号以及所述第一无线信号中在所述第一时间点之前的多载波符号，第二接收波束被用于接收所述第一无线信号中在所述第一时间点之后的多载波符号。

作为实施例 3 的子实施例 1，所述第二无线信号是 PDCCH，所述第一无线信号是 PDSCH。

作为实施例 3 的子实施例 2，所述第二无线信号是用于指示下行资源分配（downlink assignment）的 DCI，所述第一无线信号是在所述第二无线信号指示的下行资源上传输的 PDSCH。

作为实施例 3 的子实施例 3，所述第二无线信号指示所述第二接收波束。

作为实施例 3 的子实施例 4，在所述第一时间单元之前的信令被用于指示所述第一接收波束。

实施例 4

实施例 4 示例了第一信息和第二信息，如附图 4 所示。

在实施例 4 中，UE 根据自身的处理能力向基站发送第二信息用于推荐第一时间点的候选项，基站根据 UE 的处理能力及系统状况向 UE 发送第一信息指定所述第一时间点。所述第一时间点是第一时间单元内的一个时间点。所述第一时间点在时域上不早于所述推荐的第一时间点的候选项。所述第一时间点被用于确定在所述第一时间单元内的第一无线信号对应的多天线相关的接收。所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。

实施例 5

实施例 5 示例了用于用户设备中处理装置的结构框图，如附图 5 所示。UE 装置 200 主要由第一模块 201 组成。

在实施例 5 中，第一模块 201 接收第一无线信号。

在实施例 5 中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

作为实施例 5 的子实施例 1，所述第一模块 201 还被用于接收第二无线信号；所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被用于确定所述 G 个多载波符号所占用的时域资源。

作为实施例 5 的子实施例 2，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收。

作为实施例 5 的子实施例 3，所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关

的接收和针对所述第二无线信号的所述多天线相关的接收有关。

作为实施例 5 的子实施例 4，所述多天线相关的接收是指相应的用于接收的波束赋型向量。

作为实施例 5 的子实施例 5，所述多天线相关的接收是指相应的用于发送的天线端口。

作为实施例 5 的子实施例 6，所述第一模块 201 还被用于接收第一信息；所述第一信息被用于确定所述第一时间点。

作为实施例 5 的子实施例 7，所述第一模块 201 还被用于发送第二信息；所述第二信息被用于确定所述第一时间点。

作为实施例 5 的子实施例 8，所述第一模块 201 还被用于接收第三信息；所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

实施例 6

实施例 6 示例了用于基站设备中的处理装置的结构框图，如附图 6 所示。基站装置 300 主要由第二模块 301 组成。

在实施例 6 中，第二模块 301 发送第一无线信号。

在实施例 6 中，所述第一无线信号在第一时间单元内发送，第一比特块被用于生成所述第一无线信号，所述第一无线信号包括 G 个多载波符号。对于所述 G 个多载波符号中的任一给定多载波符号，针对所述给定多载波符号的多天线相关的接收与所述给定多载波符号所占用的时域资源和第一时间点在时域上的相对位置有关。所述第一时间点是所述第一时间单元内的一个时间点。所述 G 是正整数。

作为实施例 6 的子实施例 1，所述第二模块 301 还被用于发送第二无线信号；所述第二无线信号在所述第一时间单元内发送，所述第二无线信号被用于确定所述 G 个多载波符号所占用的时域资源。

作为实施例 6 的子实施例 2，所述所述给定多载波符号所占用的时域资源在所述第一时间点之后，所述第二无线信号被用于确定所述针对所述给定多载波符号的多天线相关的接收。

作为实施例 6 的子实施例 3，所述所述给定多载波符号所占用的时域资源在所述第一时间点之前，所述针对所述给定多载波符号的多天线相关

的接收和针对所述第二无线信号的所述多天线相关的接收有关。

作为实施例 6 的子实施例 4，所述多天线相关的接收是指相应的用于接收的波束赋型向量。

作为实施例 6 的子实施例 5，所述多天线相关的接收是指相应的用于发送的天线端口。

作为实施例 6 的子实施例 6，所述第二模块 301 还被用于发送第一信息；所述第一信息被用于确定所述第一时间点。

作为实施例 6 的子实施例 7，所述第二模块 301 还被用于接收第二信息；所述第二信息被用于确定所述第一时间点。

作为实施例 6 的子实施例 8，所述第二模块 301 还被用于发送第三信息；所述第三信息被用于确定所述 G 个多载波符号对应的多天线相关的接收的候选方案。

本领域普通技术人员可以理解上述方法中的全部或部分步骤可以通过程序来指令相关硬件完成，所述程序可以存储于计算机可读存储介质中，如只读存储器，硬盘或者光盘等。可选的，上述实施例的全部或部分步骤也可以使用一个或者多个集成电路来实现。相应的，上述实施例中的各模块单元，可以采用硬件形式实现，也可以由软件功能模块的形式实现，本申请不限于任何特定形式的软件和硬件的结合。本发明中的 UE 或者终端包括但不限于手机，平板电脑，笔记本，上网卡，NB-IOT 终端，eMTC 终端等无线通信设备。本发明中的基站或者系统设备包括但不限于宏蜂窝基站，微蜂窝基站，家庭基站，中继基站等无线通信设备。

以上所述，仅为本发明的较佳实施例而已，并非用于限定本发明的保护范围。凡在本发明的精神和原则之内，所做的任何修改，等同替换，改进等，均应包含在本发明的保护范围之内。

说 明 书 附 图

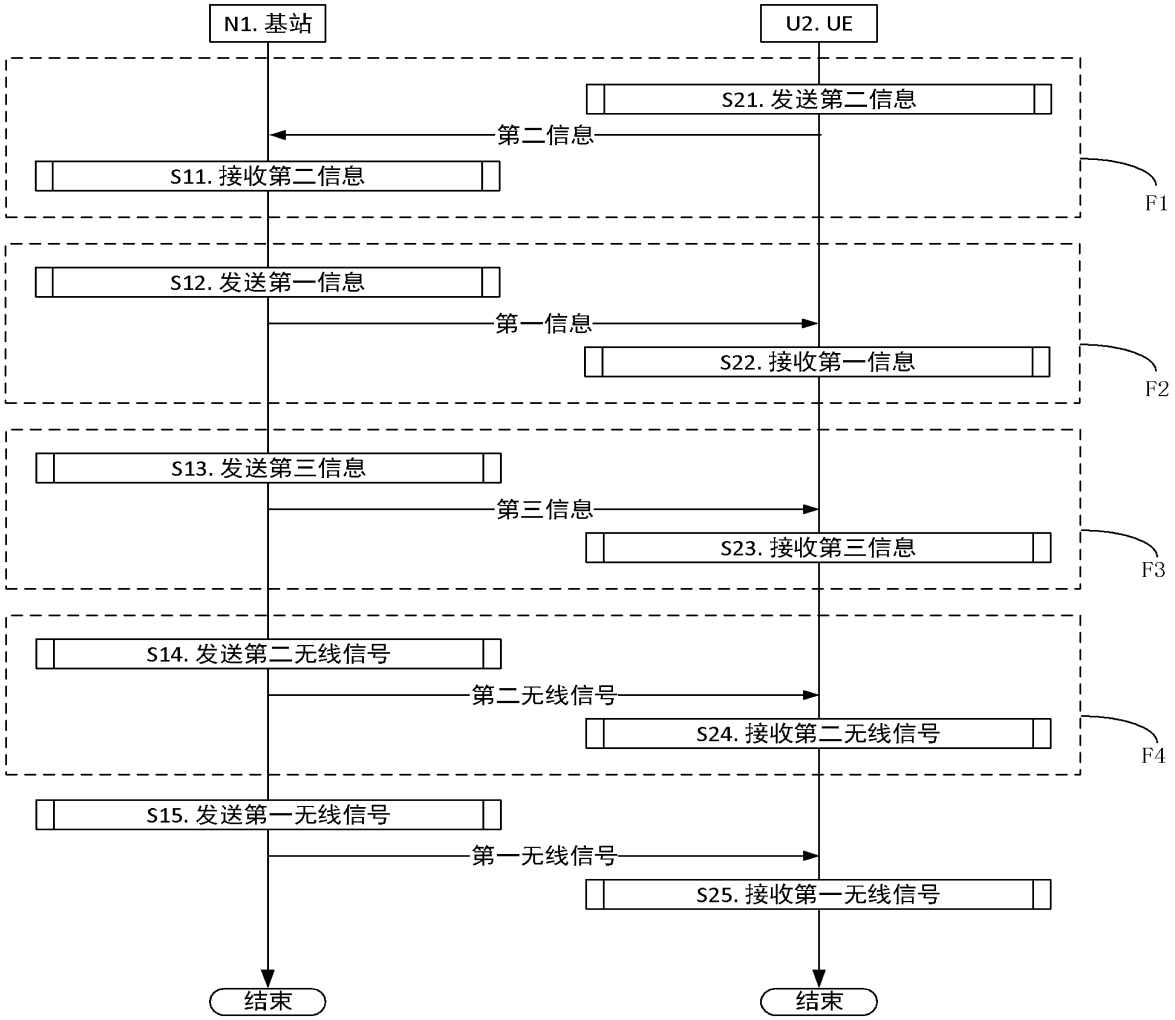

N1. 基站
U2. UE
S21. 发送第二信息
第二信息
S11. 接收第二信息
F1
S12. 发送第一信息
第一信息
S22. 接收第一信息
F2
S13. 发送第三信息
第三信息
S23. 接收第三信息
F3
S14. 发送第二无线信号
第二无线信号
S24. 接收第二无线信号
F4
S15. 发送第一无线信号
第一无线信号
S25. 接收第一无线信号
结束
结束

图 1

说 明 书 附 图

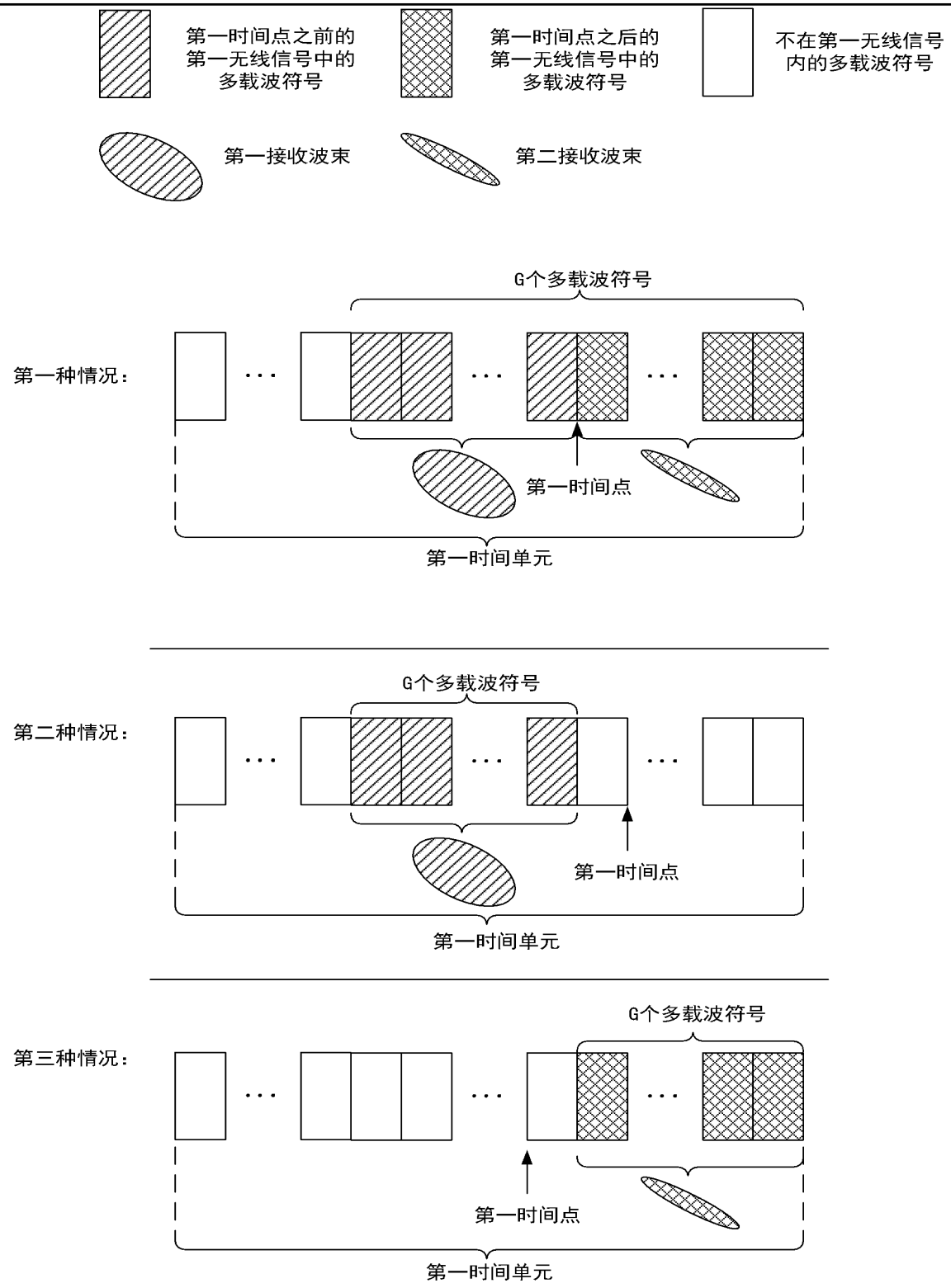

第一时间点之前的
第一无线信号中的
多载波符号
第一时间点之后的
第一无线信号中的
多载波符号
不在第一无线信号
内的多载波符号
第一接收波束
第二接收波束
第一种情况：
G个多载波符号
第一时间点
第一时间单元
第二种情况：
G个多载波符号
第一时间点
第一时间单元
第三种情况：
G个多载波符号
第一时间点
第一时间单元

图 2

说 明 书 附 图

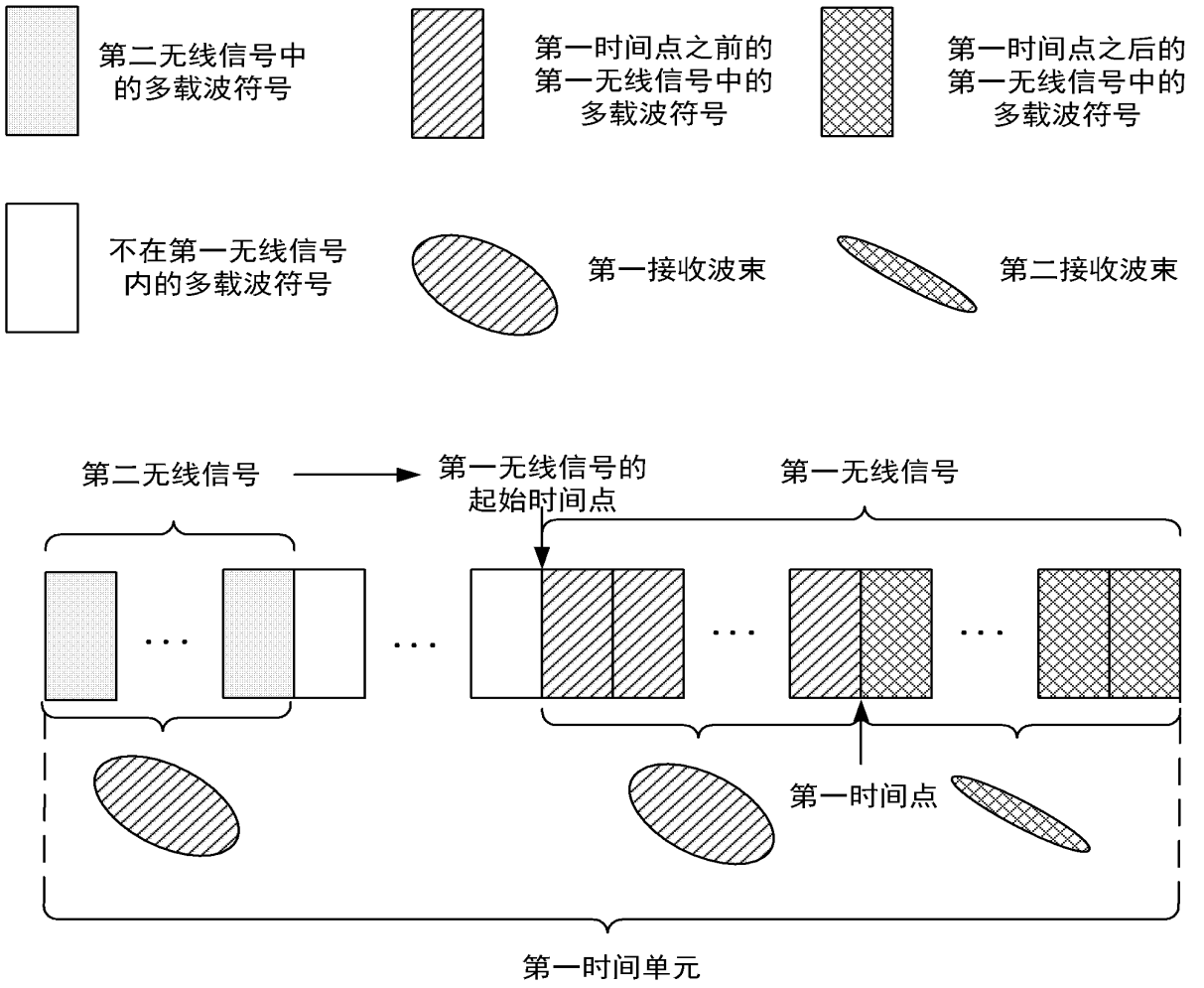

第二无线信号中的多载波符号
第一时间点之前的第一无线信号中的多载波符号
第一时间点之后的第一无线信号中的多载波符号
不在第一无线信号内的多载波符号
第一接收波束
第二接收波束
第二无线信号
第一无线信号的起始时间点
第一无线信号
第一时间点
第一时间单元

图 3

说 明 书 附 图

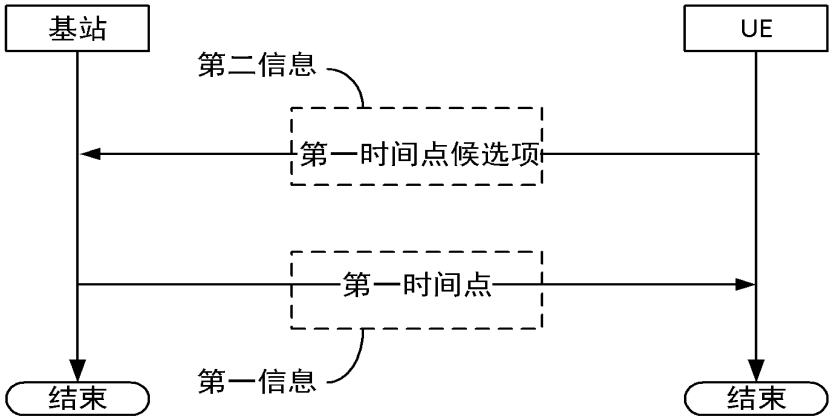


图 4

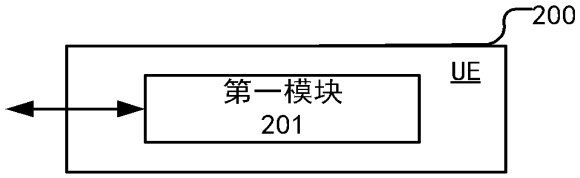


图 5



图 6

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United States Patent and Trademark Office
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/972,167	05/06/2018	2631	1015	126099-8013.US00	18	4

CONFIRMATION NO. 3699

FILING RECEIPT

70416
Perkins Coie LLP - SHA General
Patent - SHA
P.O. Box 1247
Seattle, WA 98111-1247



Date Mailed: 05/31/2018

Receipt is acknowledged of this non-provisional 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 APPLICANT, 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 Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections 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**

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Assignment For Published Patent Application

Shanghai Langbo Communication Technology Company Limited, Shanghai, CHINA

Power of Attorney: None

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

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 201710318202.4 05/08/2017

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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If Required, Foreign Filing License Granted: 05/29/2018
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/972,167**
Projected Publication Date: 11/08/2018
Non-Publication Request: No
Early Publication Request: No
**** SMALL ENTITY ****
Title

METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION

Preliminary Class

375

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

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/972,167

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))	18 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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION 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 — Remove

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:

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City	Shanghai — **State/Province**
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	70416
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Application Information:

Title of the Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION		
Attorney Docket Number	126099-8013.US00	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	

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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	70416		

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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)

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	126099-8013.US00
	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	

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)[i] 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).

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Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
201710318202.4	CN	2017-05-08	

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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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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.

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

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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).

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☐ 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.

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	Application Number	
Title of Invention	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION	

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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 Remove

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 E3, 8th Floor, JunYao Building		
Address 2	No.789, ZhaoJiaBang Road, 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. Add

Assignee Information including Non-Applicant Assignee Information:

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Assignee 1

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Organization Name	Shanghai Langbo Communication Technology Company Limited

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	Room E3, 8th Floor, JunYao Building		
Address 2	No.789, ZhaoJiaBang Road, XuHui District		
City	Shanghai	**State/Province**	
Country i	CN	Postal Code	200032
Phone Number		Fax Number	
Email Address			

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Signature:

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

Signature	/Aaron Wininger, Reg. No. 45,229/			Date (YYYY-MM-DD)	2018-05-06
First Name	Aaron	Last Name	Wininger	Registration Number	45229

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION

BACKGROUND

Cross Reference to Related Disclosure

This disclosure claims the priority benefit of Chinese Patent Application 201710318202.4, filed on May 8, 2017, all of which is incorporated herein by reference.

TECHNICAL FIELD

[0001] The present disclosure relates to transmission schemes of radio signals in wireless communication systems, and in particular to a method and a device for multi-antenna transmission.

RELATED ART

[0002] Massive Multi-Input Multi-Output (MIMO) becomes one research hotspot of next-generation mobile communications. In the massive MIMO, multiple antennas experience beamforming to form a relatively narrow beam which points to a particular direction to improve the quality of communication. The massive MIMO can also form different directions through multiple antennas to serve multiple users simultaneously, thereby forming Multi-User MIMO (MU-MIMO), and thus improving the throughput of the massive MIMO system and reducing the delay of transmission.

[0003] In 3GPP New Radio discussion, there is some company proposing to increase the robustness of transmission using a relatively wide beam transmitting Physical Downlink Control Channel (PDCCH) and to increase the Signal-to-Noise Ratio (SNR) using a relatively narrow beam transmitting Physical Downlink Shared Channel (PDSCH). There is also some company proposing to use the PDCCH to cross-slot indicate the transmission beam of the PDSCH, so as to solve the problem of delay between a User Equipment (UE) acquiring the transmission beam of the PDSCH from the PDCCH and conducting PDSCH receiving using the beam information indicated by the PDCCH.

SUMMARY

[0004] In one embodiment, the inventor finds through research that cross-slot beam indication would result in reduction of dynamic of beam information, increase of overhead of control

signaling, reduction of dynamic of scheduling, and other problems. A UE with high processing capacity can decode the PDCCH in a short time to obtain beam information that is used for receiving the PDSCH that is in the time slot of the PDCCH, and adjust a receiving beam to receive a multicarrier symbol in which the PDSCH is located. However, the delay in PDSCH transmission caused by decoding PDCCH would result in underutilization of system resources.

[0005] In view of the above problems, the present disclosure provides a solution. It should be noted that the embodiments of the present disclosure and the characteristics in the embodiments may be mutually combined if there is no conflict. For example, the embodiments of the base station of the present disclosure and the characteristics in the embodiments may be applied to the UE, and vice versa.

[0006] The present disclosure discloses a method in a UE used for wireless communication. The method includes the following steps:

[0007] receiving a first radio signal.

[0008] Herein, the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[0009] In one embodiment, the above method is advantageous in that the multi-antenna related receiving for the first radio signal is configured flexibly according to the delay requirements of multi-antenna related receiving.

[0010] In one embodiment, the first radio signal is a PDSCH.

[0011] In one embodiment, the first radio signal is a consecutive data transmission block in time domain.

[0012] In one embodiment, the first radio signal is G consecutive multicarrier symbols in time domain.

[0013] In one embodiment, the first time unit is a subframe.

[0014] In one embodiment, the subframe includes 14 Orthogonal Frequency Division

Multiplexing (OFDM) symbols.

[0015] In one embodiment, the first time unit is a time slot.

[0016] In one embodiment, the time slot includes 7 OFDM symbols.

[0017] In one embodiment, the first time unit is a Transmission Time Interval (TTI).

[0018] In one embodiment, the first time unit only includes a Downlink Control Information (DCI) that is used for indicating downlink assignment.

[0019] In one embodiment, all bits in the first bit block are used for generating the first radio signal.

[0020] In one embodiment, partial bits in the first bit block are used for generating the first radio signal.

[0021] In one embodiment, the first bit block is a transmission block.

[0022] In one embodiment, the first bit block is subjected to steps of Circular Redundancy Check (CRC) addition, segmentation, channel coding, rate matching, scrambling, modulation, antenna mapping to form the first radio signal.

[0023] In one embodiment, the first bit block is a subblock in a transmission block.

[0024] In one embodiment, the first bit block is one of the multiple bit subblocks that are formed after one transmission block is added with CRC and is segmented.

[0025] In one embodiment, the first bit block is subjected to steps of channel coding, rate matching, scrambling, modulation and antenna mapping to form the first radio signal.

[0026] In one embodiment, multiple bit blocks are one-to-one corresponding to multiple layers of signals in the first radio signal, and the first bit block is one of the multiple bit blocks.

[0027] In one embodiment, the multicarrier symbol is an OFDM symbol.

[0028] In one embodiment, the multicarrier symbol is a Filter Bank Multiple Carrier (FBMC) symbol.

[0029] In one embodiment, the multi-antenna related receiving refers to an analog receiving beam.

[0030] In one embodiment, the multi-antenna related receiving refers to a transmitting

antenna port assumed by the UE.

[0031] In one embodiment, the G multicarrier symbols are G consecutive multicarrier symbols.

[0032] In one embodiment, the first radio signal consists of G multicarrier symbols.

[0033] In one embodiment, the first radio signal includes a multicarrier symbol not in the G multicarrier symbols.

[0034] In one embodiment, if the given multicarrier symbol is before the first time point in time domain, a first multi-antenna receiving mode is employed for the multi-antenna related receiving of the given multicarrier symbol; if the given multicarrier symbol is behind the first time point in time domain, a second multi-antenna receiving mode is employed for the multi-antenna related receiving of the given multicarrier symbol. The first multi-antenna receiving mode differs from the second multi-antenna receiving mode.

[0035] In one embodiment, the first multi-antenna receiving mode and the second multi-antenna receiving mode use different analog beams to receive, respectively.

[0036] In one embodiment, the first multi-antenna receiving mode and the second multi-antenna receiving mode assume different transmitting antenna ports to transmit, respectively.

[0037] In one embodiment, the antenna receiving gain corresponding to the second multi-antenna receiving mode is greater than the antenna receiving gain corresponding to the first multi-antenna receiving mode.

[0038] In one embodiment, the transmission reliability corresponding to the first multi-antenna receiving mode is greater than the transmission reliability corresponding to the second multi-antenna receiving mode.

[0039] In one embodiment, the second multi-antenna receiving mode uses a beam narrower than that of the first multi-antenna receiving mode.

[0040] In one embodiment, the G multicarrier symbols are all before the first time point in time domain, and the multi-antenna related receiving for the G multicarrier symbols is the same.

[0041] In one embodiment, the G multicarrier symbols are all behind the first time point in time domain, and the multi-antenna related receiving for the G multicarrier symbols is the same.

[0042] In one embodiment, G1 multicarrier symbols of the G multicarrier symbols are before the first time point in time domain, G2 multicarrier symbols of the G multicarrier symbols are behind the first time point in time domain, the multi-antenna related receiving for the G1 multicarrier symbols is the same, the multi-antenna related receiving for the G2 multicarrier symbols is the same, the multi-antenna related receiving for the G1 multicarrier symbols and the multi-antenna related receiving for the G2 multicarrier symbols are different. G1 and G2 are positive integers.

[0043] In one embodiment, the first time point is an index value of one multicarrier symbol within the first time unit.

[0044] According to one aspect of the present disclosure, the method includes the following steps:

[0045] receiving a second radio signal.

[0046] The second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

[0047] In one embodiment, the above method is advantageous in that the time-domain resource occupied by the G multicarrier symbols is configured flexibly.

[0048] In one embodiment, the second radio signal is a PDCCH.

[0049] In one embodiment, the second radio signal is an Enhanced PDCCH (ePDCCH).

[0050] In one embodiment, the second radio signal indicates explicitly the time-domain resource occupied by the G multicarrier symbols

[0051] In one embodiment, the second radio signal indicates implicitly the time-domain resource occupied by the G multicarrier symbols

[0052] In one embodiment, the second radio signal is a DCI carrying downlink assignment.

[0053] In one embodiment, the first time unit is composed of N1 multicarrier symbols in which the second radio signal is located and N2 multicarrier symbols. N2 is not smaller than G The second radio signal is used for determining the G multicarrier symbols of the N multicarrier symbols. N1 and N2 are positive integers.

[0054] In one embodiment, the first time unit is composed of N1 multicarrier symbols in which the second radio signal is located and G multicarrier symbols. The N1 multicarrier

symbols are used for determining the G multicarrier symbols. N1 is a positive integer.

[0055] According to one aspect of the present disclosure, if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[0056] In one embodiment, the above method is advantageous in that the dynamic of the multi-antenna related receiving is increased.

[0057] In one embodiment, the above method is advantageous in that the delay in the receiving of the first radio signal resulted from the delay in the decoding of the second radio signal is avoided.

[0058] In one embodiment, the above method is advantageous in that, before the first time point, the PDSCH receives the multicarrier symbol of the PDSCH before the first time point using the same beam used for receiving the PDCCH, thereby avoiding the problem of the delay in PDSCH transmission resulted from the delay in PDCCH decoding.

[0059] In one embodiment, if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[0060] In one embodiment, the second radio signal indicates explicitly the multi-antenna related receiving for the given multicarrier symbol.

[0061] In one embodiment, the second radio signal indicates implicitly the multi-antenna related receiving for the given multicarrier symbol.

[0062] In one embodiment, the receiving beam for the given multicarrier symbol is the same as the receiving beam for the second radio signal.

[0063] In one embodiment, the assumed transmitting antenna port for the given multicarrier symbol is the same as the assumed transmitting antenna port for the second radio signal.

[0064] According to one aspect of the present disclosure, the multi-antenna related receiving refers to a corresponding beamforming vector used for receiving; or, the multi-antenna related receiving refers to a corresponding antenna port used for transmitting.

[0065] In one embodiment, the above method is advantageous in that the beam used for transmitting data is adjusted flexibly to improve the antenna array gain.

[0066] In one embodiment, the index value of the receiving beam is used for indicating the beamforming vector used for receiving.

[0067] In one embodiment, the index value of a first beam pair is used for indicating the beamforming vector used for receiving, and the first beam consists of a transmitting vector and a receiving vector.

[0068] In one embodiment, the beamforming vector is an analog beamforming vector.

[0069] In one embodiment, the beamforming vector is one beamforming vector consisting of an analog beamforming vector and a digital beamforming vector.

[0070] In one embodiment, the antenna port is formed by multiple physical antennas through antenna virtualization overlay. Mapping coefficients of the antenna port to the multiple physical antennas compose a beamforming vector, which is used for the antenna virtualization to form a beam.

[0071] In one embodiment, a first reference signal is transmitted through the antenna port used for transmitting, a small-scale channel parameter experienced by the first reference signal is used for determining the small-scale channel parameter experienced by the first radio signal, the first reference signal is indicated associated with a second reference signal, a big-scale channel parameter experienced by the second reference signal is used for determining the big-scale channel parameter experienced by the first radio signal.

[0072] In one subembodiment, the first reference signal is indicated Quasi Co-Located (QCL) with the second reference signal.

[0073] According to one aspect of the present disclosure, the method includes the following steps:

[0074] receiving first information.

[0075] The first information is used for determining the first time point.

[0076] In one embodiment, the above method is advantageous in that the first time point is configured flexibly according to the UE capability and system situations.

[0077] In one embodiment, the first information indicates explicitly the first time point.

[0078] In one embodiment, the first information indicates implicitly the first time point.

[0079] In one embodiment, the first time point is an index of one multicarrier symbol in the first time unit.

[0080] In one embodiment, the first information is a high-layer signaling.

[0081] In one embodiment, the first information is a Radio Resource Control (RRC) signaling.

[0082] According to one aspect of the present disclosure, the method includes the following steps:

[0083] transmitting second information.

[0084] The second information is used for determining the first time point.

[0085] In one embodiment, the above method is advantageous in that the UE can assist the base station to determine the first time point by indicating the processing capability of the UE to the base station, thereby optimizing the performance of the system.

[0086] In one embodiment, the second information indicates explicitly the first time point.

[0087] In one embodiment, the second information indicates implicitly the first time point.

[0088] In one embodiment, the second information is an RRC signaling.

[0089] In one embodiment, the second information is transmitted in a Message 3 in the random access process.

[0090] According to one aspect of the present disclosure, the method includes the following steps:

[0091] receiving third information.

[0092] The third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[0093] In one embodiment, the above method is advantageous in that the candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols is configured flexibly.

[0094] In one embodiment, the third information indicates explicitly the candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[0095] In one embodiment, the third information indicates implicitly the candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[0096] In one embodiment, the candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols includes a first multi-antenna receiving mode and a second multi-antenna receiving mode. The first multi-antenna receiving mode differs from the second multi-antenna receiving mode. If the given multicarrier symbol is before the first time point in time domain, the first multi-antenna receiving mode is employed for the multi-antenna related receiving of the given multicarrier symbol; if the given multicarrier symbol is behind the first time point in time domain, the second multi-antenna receiving mode is employed for the multi-antenna related receiving of the given multicarrier symbol.

[0097] In one embodiment, the candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols includes multiple candidate beams used for receiving.

[0098] In one embodiment, the candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols includes multiple candidate beamforming vectors used for receiving.

[0099] In one embodiment, the third information is a DCI.

[00100] In one embodiment, the third information is transmitted on the PDCCH.

[00101] In one embodiment, the third information is carried in the second radio signal.

[00102] In one embodiment, one of the candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols is carried by the second radio signal.

[00103] In one embodiment, the third information is a high-layer signaling.

[00104] In one embodiment, the third information is an RRC signaling.

[00105] In one embodiment, the third information is used for determining the

multi-antenna related receiving corresponding to the second radio signal.

[00106] In one embodiment, the third information indicates explicitly the multi-antenna related receiving corresponding to the second radio signal.

[00107] In one embodiment, the third information indicates implicitly the multi-antenna related receiving corresponding to the second radio signal.

[00108] The present disclosure discloses a method in a base station device used for wireless communication. The method includes the following steps:

[00109] transmitting a first radio signal.

[00110] Herein, the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[00111] According to one aspect of the present disclosure, the method includes the following steps:

[00112] transmitting a second radio signal.

[00113] The second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

[00114] According to one aspect of the present disclosure, if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[00115] According to one aspect of the present disclosure, the multi-antenna related receiving refers to a corresponding beamforming vector used for receiving; or, the multi-antenna related receiving refers to a corresponding antenna port used for transmitting.

[00116] According to one aspect of the present disclosure, the method includes the following steps:

[00117] transmitting first information.

[00118] The first information is used for determining the first time point.

[00119] According to one aspect of the present disclosure, the method includes the following steps:

[00120] receiving second information.

[00121] The second information is used for determining the first time point.

[00122] According to one aspect of the present disclosure, the method includes the following steps:

[00123] transmitting third information.

[00124] The third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[00125] The present disclosure discloses a UE used for wireless communication. The UE includes:

[00126] a first transceiver module, to receive a first radio signal.

[00127] Herein, the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[00128] In one embodiment, the above UE is characterized in that the first transceiver module is further configured to receive a second radio signal, the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

[00129] In one embodiment, the above UE is characterized in that if the time-domain

resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[00130] In one embodiment, the above UE is characterized in that the multi-antenna related receiving refers to a corresponding beamforming vector used for receiving; or, the multi-antenna related receiving refers to a corresponding antenna port used for transmitting.

[00131] In one embodiment, the above UE is characterized in that the first transceiver module is further configured to receive first information, the first information being used for determining the first time point.

[00132] In one embodiment, the above UE is characterized in that the first transceiver module is further configured to transmit second information, the second information being used for determining the first time point.

[00133] In one embodiment, the above UE is characterized in that the first transceiver module is further configured to receive third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[00134] The present disclosure discloses a base station device used for wireless communication. The base station device includes:

[00135] a second transceiver module, to transmit a first radio signal.

[00136] Herein, the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[00137] In one embodiment, the above base station device is characterized in that the second transceiver module is further configured to transmit a second radio signal, the second radio signal is transmitted within the first time unit, and the second radio signal is used for

determining a time-domain resource occupied by the G multicarrier symbols.

[00138] In one embodiment, the above base station device is characterized in that if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[00139] In one embodiment, the above base station device is characterized in that the multi-antenna related receiving refers to a corresponding beamforming vector used for receiving; or, the multi-antenna related receiving refers to a corresponding antenna port used for transmitting.

[00140] In one embodiment, the above base station device is characterized in that the second transceiver module is further configured to transmit first information, the first information being used for determining the first time point.

[00141] In one embodiment, the above base station device is characterized in that the second transceiver module is further configured to receive second information, the second information being used for determining the first time point.

[00142] In one embodiment, the above base station device is characterized in that the second transceiver module is further configured to transmit third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[00143] In one embodiment, compared with traditional schemes, the present disclosure has the following advantages:

[00144] the dynamic of the multi-antenna related receiving is increased;

[00145] the overhead of control signaling is saved;

[00146] the dynamic of scheduling is increased; and

[00147] the gain of transmission is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[00148] Other features, purposes and advantages of the present disclosure will become more apparent from the detailed description of non-restrictive embodiments taken in conjunction with the following drawings.

[00149] FIG. 1 is a flowchart illustrating a first radio signal according to one embodiment of the present disclosure.

[00150] FIG. 2 is a diagram illustrating a network architecture according to one embodiment of the present disclosure.

[00151] FIG. 3 is a diagram illustrating an embodiment of a radio protocol architecture of a user plane and a control plane according to one embodiment of the present disclosure.

[00152] FIG. 4 is a diagram illustrating an evolved node B and a UE according to one embodiment of the present disclosure.

[00153] FIG. 5 is a flowchart illustrating wireless transmission according to one embodiment of the present disclosure.

[00154] FIG. 6 is a diagram illustrating a first radio signal according to one embodiment of the present disclosure.

[00155] FIG. 7 is a diagram illustrating a second radio signal and a first radio signal according to one embodiment of the present disclosure.

[00156] FIG. 8 is a diagram illustrating first information and second information according to one embodiment of the present disclosure.

[00157] FIG. 9 is a structure block diagram illustrating a processing device used in a UE according to one embodiment of the present disclosure.

[00158] FIG. 10 is a structure block diagram illustrating a processing device used in a base station according to one embodiment of the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

[00159] Embodiment 1

[00160] Embodiment 1 illustrates an example of a flowchart of a first radio signal, as shown in FIG. 1.

[00161] In Embodiment 1, the UE in the present disclosure receives a first radio signal; the

first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[00162] In one embodiment, the UE receives a second radio signal; the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

[00163] In one embodiment, if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[00164] In one embodiment, the UE receives first information, and the first information is used for determining the first time point.

[00165] In one embodiment, the UE transmits second information, and the second information is used for determining the first time point.

[00166] In one embodiment, the UE receives third information, and the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[00167] Embodiment 2

[00168] Embodiment 2 illustrates an example of a diagram for a network architecture, as shown in FIG. 2.

[00169] Embodiment 2 illustrates an example of a diagram for a network architecture according to the present disclosure, as shown in FIG. 2. FIG. 2 is a diagram illustrating a system network architecture 200 of NR 5G, LTE and Long-Term Evolution Advanced (LTE-A). The NR 5G or LTE network architecture 200 may be called an Evolved Packet System (EPS) 200 or other appropriate terms. The EPS 200 may include one or more UEs 201, a Next Generation-Radio Access Network (NG-RAN) 202, a 5G-Core Network /Evolved Packet Core

(5G-CN/EPC) 210, a Home Subscriber Server (HSS) 220 and an Internet Service 230. The EPS may be interconnected with other access networks. For simple description, the entities/interfaces are not shown. As shown in FIG. 2, the EPS provides packet switching services. Those skilled in the art are easy to understand that various concepts presented throughout the present disclosure can be extended to networks providing circuit switching services or other cellular networks. The NG-RAN includes an NR node B (gNB) 203 and other gNBs 204. The gNB 203 provides UE 201 oriented user plane and control plane protocol terminations. The gNB 203 may be connected to other gNBs 204 via an Xn interface (for example, backhaul). The gNB 203 may be called 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 TRP or other appropriate terms. The gNB 203 provides an access point of the 5G-CN/EPC 210 for the UE 201. Examples of UE 201 include cellular phones, 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 (GPSs), multimedia devices, video devices, digital audio player (for example, MP3 players), cameras, games consoles, unmanned aerial vehicles, air vehicles, narrow-band physical network equipment, machine-type communication equipment, land vehicles, automobiles, wearable equipment, or any other devices having similar functions. Those skilled in the art also can call the UE 201 a mobile station, a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a radio communication device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client or other appropriate terms. The gNB 203 is connected to the 5G-CN/EPC 210 via an S1/NG interface. The 5G-CN/EPC 210 includes a Mobility Management Entity/Authentication Management Field/User Plane Function (MME/AMF/UPF) 211, other MMEs/AMFs/UPFs 214, a Service Gateway (S-GW) 212 and a Packet Data Network Gateway (P-GW) 213. The MME/AMF/UPF 211 is a control node for processing a signaling between the UE 201 and the 5G-CN/EPC 210. Generally, the MME/AMF/UPF 211 provides bearer and connection management. All user Internet Protocol (IP) packets are transmitted through the S-GW 212. The S-GW 212 itself is connected to the P-GW 213. The P-GW 213 provides UE IP address allocation and other functions. The P-GW 213 is connected to the internet service 230. The internet service 230 includes IP services corresponding to operators, specifically including internet, intranet, IP Multimedia Subsystems (IP IMSs) and PS Streaming Services (PSSs).

[00170] In one embodiment, the UE 201 corresponds to the UE in the present disclosure.

[00171] In one embodiment, the UE 201 corresponds to the terminal in the present disclosure.

[00172] In one embodiment, the gNB 203 corresponds to the base station in the present disclosure.

[00173] In one embodiment, the UE 201 supports conducting wireless communication of data transmission on an unauthorized spectrum.

[00174] In one embodiment, the gNB 203 supports conducting wireless communication of data transmission on an unauthorized spectrum.

[00175] In one embodiment, the UE 201 supports Non-Orthogonal Multiple Access (NOMA) based wireless communication.

[00176] In one embodiment, the gNB 203 supports Non-Orthogonal Multiple Access (NOMA) based wireless communication.

[00177] In one embodiment, the UE 201 supports Gran-Free uplink transmission.

[00178] In one embodiment, the gNB 203 supports Gran-Free uplink transmission.

[00179] In one embodiment, the UE 201 supports competition based uplink transmission.

[00180] In one embodiment, the gNB 203 supports competition based uplink transmission.

[00181] In one embodiment, the UE 201 supports beamforming based uplink transmission.

[00182] In one embodiment, the gNB 203 supports beamforming based uplink transmission.

[00183] In one embodiment, the UE 201 supports Massive-MIMO based uplink transmission.

[00184] In one embodiment, the gNB 203 supports Massive-MIMO based uplink transmission.

[00185] Embodiment 3

[00186] Embodiment 3 is a diagram illustrating an embodiment of a radio protocol architecture of a user plane and a control plane according to the present disclosure, as shown in FIG. 3.

[00187] FIG. 3 is a diagram illustrating an embodiment of a radio protocol architecture of a user plane and a control plane. In FIG. 3, the radio protocol architecture of a UE and a base station device (gNB or eNB) is presented by three layers, which are a layer 1, a layer 2 and a layer 3 respectively. The layer 1 (L1) 301 is the lowest layer and performs signal processing functions of each PHY layer. Layers above the layer 1 belong to higher layers. The layer 1 is called PHY 301 in this paper. The layer 2 (L2) 305 is above the PHY 301, and is in charge of the link between the UE and the gNB via the PHY 301. In the user plane, the L2 305 includes a Medium Access Control (MAC) sublayer 302, a Radio Link Control (RLC) sublayer 303, and a Packet Data Convergence Protocol (PDCP) sublayer 304. All the three sublayers end at the gNB of the network side. Although not described in FIG.3, the UE may include several higher layers above the L2 305, such as a network layer (i.e. IP layer) ending at a P-GW of the network side and an disclosure layer ending at the other side of the connection (i.e. a peer UE, a server, etc.). The PDCP sublayer 304 provides multiplexing among variable radio bearers and logical channels. The PDCP sublayer 304 also provides a header compression for a higher layer packet so as to reduce a radio transmission overhead. The PDCP sublayer 304 provides security by encrypting a packet and provides support for UE handover between gNBs. The RLC sublayer 303 provides segmentation and reassembling of a higher layer packet, retransmission of a lost packet, and reordering of a lost packet to as to compensate the disordered receiving caused by Hybrid Automatic Repeat Request (HARQ). The MAC sublayer 302 provides multiplexing between logical channels and transport channels. The MAC sublayer 302 is also responsible for allocating between UEs various radio resources (i.e., resource block) in a cell. The MAC sublayer 302 is also in charge of HARQ operation. In the control plane, the radio protocol architecture of the UE and the gNB is almost the same as the radio protocol architecture in the user plane on the PHY 301 and the L2 305, but there is no header compression for the control plane. The control plane also includes a Radio Resource Control (RRC) sublayer 306 in the layer 3 (L3). The RRC sublayer 306 is responsible for acquiring radio resources (i.e. radio bearer) and configuring the lower layers using a RRC signaling between the gNB and the UE.

[00188] In one embodiment, the radio protocol architecture shown in FIG. 3 is applicable to the UE in the present disclosure.

[00189] In one embodiment, the radio protocol architecture shown in FIG. 3 is applicable to the base station in the present disclosure.

[00190] In one embodiment, the first radio signal in the present disclosure is generated by the PDCP sublayer 304.

[00191] In one embodiment, the second radio signal in the present disclosure is generated by the PHY 301.

[00192] In one embodiment, the first information in the present disclosure is generated by the PDCP PHY 301.

[00193] In one embodiment, the second information in the present disclosure is generated by the RRC sublayer 306.

[00194] In one embodiment, the third information in the present disclosure is generated by the RRC sublayer 306.

[00195] Embodiment 4

[00196] Embodiment 4 illustrates a diagram of a base station device and a UE according to the present disclosure, as shown in FIG. 4. FIG. 4 is a block diagram of a gNB 410 in communication with a UE 450 in an access network.

[00197] The base station device 410 includes a controller/processor 440, a memory 430, a receiving processor 412, a transmitting processor 415, a transmitter/receiver 416 and an antenna 420.

[00198] The UE 450 includes a controller/processor 490, a memory 480, a data source 467, a transmitting processor 455, a receiving processor 452, a transmitter/receiver 456 and an antenna 460.

[00199] In uplink transmission, processes relevant to the base station device 410 include the following.

[00200] The receiver 416 receives a radio-frequency signal through the corresponding antenna 420, converts the received radio-frequency signal into a baseband signal, and provides the baseband signal to the receiving processor 412.

[00201] The receiving processor 412 performs signal receiving processing functions of an L1 layer (that is, PHY), such as multi-antenna receiving, demodulation, descrambling, despreading, de-interleaving, channel decoding, extraction of physical layer control signal, etc.

[00202] The controller/processor 440 performs operations of an L2 layer, and is connected to the memory 43 that stores program code and data.

[00203] The controller/processor 440 provides multiplexing between a transport channel

and a logical channel, packet reassembling, decryption, header decompression, and control signaling processing so as to recover a higher-layer packet coming from the UE 450. The higher-layer packet from the controller/processor 440 is then provided to a core network.

[00204] The controller/processor 440 determines a target aerial resource probably occupied by a target uplink radio signal, and sends the result to the receiving processor 412; and determines through blind detection whether the target uplink radio signal occupies the target aerial resource.

[00205] In UL transmission, processes relevant to the UE 450 include the following.

[00206] The data source 467 provides a higher-layer packet to the controller/processor 490. The data source 467 expresses all protocol layers above the L2 layer.

[00207] The transmitter 456 transmits a radio-frequency signal through the corresponding antenna 460, converts a baseband signal into a radio-frequency signal and provides the radio-frequency signal to the corresponding antenna 460.

[00208] The transmitting processor 455 performs signal receiving processing functions of the L1 layer (that is, PHY), including encoding, scrambling, code division multiplexing, interleaving, modulation, multi-antenna transmitting, etc.

[00209] The controller/processor 490 performs header compression, encryption, packet segmentation and reordering, and multiplexing between a logical channel and a transport channel based on the radio resource allocation of the gNB 410, and performs functions of the layer 2 of the user plane and the control plane.

[00210] The controller/processor 490 is also in charge of HARQ operation, retransmission of a lost packet, and the signaling to the eNB 410.

[00211] The controller/processor 490 determines itself the radio resource occupied by the radio signal and sends the result to the transmitting processor 455.

[00212] In Downlink (DL) transmission, processes relevant to the base station device 410 include the following.

[00213] A packet from a higher layer is provided to the controller/processor 440. The controller/processor 440 provides header compression, encryption, packet segmentation and reordering, multiplexing and de-multiplexing between a logical channel and a transport channel, to implement the L2 protocol used for the user plane and the control plane. The packet from a

higher layer may include data or control information, for example, Downlink Shared Channel (DL-SCH).

[00214] The controller/processor 440 is connected to a memory 430 that stores program code and data. The memory 430 is computer readable.

[00215] The controller/processor 440 includes a scheduling unit used for transmission requirements. The scheduling unit is configured to schedule aerial resources corresponding to transmission requirements.

[00216] The controller/processor 440 determines downlink signaling/data to be transmitted, and sends the result to the transmitting processor 415.

[00217] The transmitting processor 415 receives a bit stream output from the controller/processor 440, and performs signal transmitting processing functions of an L1 layer (that is, PHY), including encoding, interleaving, scrambling, modulation, precoding, power control/allocation, generation of physical layer control signaling (including PBCH, PDCCH, PHICH, PCFICH, reference signal), etc.

[00218] The transmitter 416 is configured to convert the baseband signal provided by the transmitting processor 415 into a radio-frequency signal and transmit the radio-frequency signal via the antenna 420. Each transmitter 416 performs sampling processing on respective input symbol streams to obtain respective sampled signal streams. Each transmitter 416 performs further processing (for example, digital-to-analogue conversion, amplification, filtering, up conversion, etc.) on respective sampled streams to obtain a downlink signal.

[00219] In DL transmission, processes relevant to the UE 450 include the following.

[00220] The receiver 456 is configured to convert a radio-frequency signal received via the antenna 460 into a baseband signal and provide the baseband signal to the receiving processor 452.

[00221] The receiving processor 452 performs signal receiving processing functions of an L1 layer (that is, PHY), including multi-antenna receiving, demodulation, descrambling, de-interleaving, decoding, extraction of physical layer control signaling, etc.

[00222] The controller/processor 490 receives a bit stream output from the receiving processor 452, and provides header decompression, decryption, packet segmentation and reordering, multiplexing and de-multiplexing between a logical channel and a transport channel,

to implement the L2 protocol used for the user plane and the control plane.

[00223] The controller/processor 490 is connected to a memory 480 that stores program code and data. The memory 480 is computer readable.

[00224] In one embodiment, the UE 450 device includes at least one processor and at least one memory. The at least one memory includes computer program codes. The at least one memory and the computer program codes are configured to be used in collaboration with the at least one processor. The UE 450 device at least receives a first radio signal, wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

[00225] In one embodiment, the UE 450 includes a memory that stores a computer readable instruction program. The computer readable instruction program generates an action when executed by at least one processor. The action includes receiving a first radio signal, wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

[00226] In one embodiment, the gNB 410 device includes at least one processor and at least one memory. The at least one memory includes computer program codes. The at least one memory and the computer program codes are configured to be used in collaboration with the at least one processor. The gNB 410 device at least transmits a first radio signal, wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

[00227] In one embodiment, the gNB 410 includes a memory that stores a computer readable instruction program. The computer readable instruction program generates an action when executed by at least one processor. The action includes transmitting a first radio signal, wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

[00228] In one embodiment, the UE 450 corresponds to the UE in the present disclosure.

[00229] In one embodiment, the gNB 410 corresponds to the base station in the present disclosure.

[00230] In one embodiment, at least the former two of the antenna 460, the receiver 456, the receiving processor 452, and the controller/processor 490 are configured to receive the first radio signal in the present disclosure.

[00231] In one embodiment, at least the former two of the antenna 460, the receiver 456, the receiving processor 452, and the controller/processor 490 are configured to receive the second radio signal in the present disclosure.

[00232] In one embodiment, at least the former two of the antenna 460, the receiver 456, the receiving processor 452, and the controller/processor 490 are configured to receive the first information in the present disclosure.

[00233] In one embodiment, at least the former two of the antenna 460, the receiver 456, the receiving processor 452, and the controller/processor 490 are configured to transmit the second information in the present disclosure.

[00234] In one embodiment, at least the former two of the antenna 460, the receiver 456, the receiving processor 452, and the controller/processor 490 are configured to receive the third information in the present disclosure.

[00235] In one subembodiment, at least the former two of the antenna 420, the transmitter 416, the transmitting processor 415, and the controller/processor 440 are configured to transmit the first radio signal in the present disclosure.

[00236] In one subembodiment, at least the former two of the antenna 420, the transmitter 416, the transmitting processor 415, and the controller/processor 440 are configured to transmit the second radio signal in the present disclosure.

[00237] In one subembodiment, at least the former two of the antenna 420, the transmitter 416, the transmitting processor 415, and the controller/processor 440 are configured to transmit the first information in the present disclosure.

[00238] In one subembodiment, at least the former two of the antenna 420, the transmitter 416, the transmitting processor 415, and the controller/processor 440 are configured to receive second first information in the present disclosure.

[00239] In one subembodiment, at least the former two of the antenna 420, the transmitter 416, the transmitting processor 415, and the controller/processor 440 are configured to transmit the third information in the present disclosure.

[00240] Embodiment 5

[00241] Embodiment 5 illustrates an example of a flowchart of wireless transmission, as shown in FIG. 5. In FIG. 5, the base station N1 is a maintenance base station for a serving cell of the UE U2. In FIG. 5, steps in box F1, box F2, box F3 and box F4 are optional respectively.

[00242] The N1 receives second information in S11, transmits first information in S12, transmits third information in S13, transmits a second radio signal in S14, and transmits a first radio signal in S15.

[00243] The U2 transmits the second information in S21, receives the first information in S22, receives the third information in S23, receives the second radio signal in S24, and receives the first radio signal in S25.

[00244] In embodiment 5, the N1 transmits the first radio signal in a first time unit, a first bit block is used by the N1 to generate the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol by the U2 is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[00245] In one subembodiment, the step in the box F4 exists, the N1 transmits the second

radio signal in the first time unit, and the second radio signal is used by the U2 to determine a time-domain resource occupied by the G multicarrier symbols.

[00246] In one subembodiment, if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used by the U2 to determine the multi-antenna related receiving for the given multicarrier symbol.

[00247] In one subembodiment, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol by the U2 is related to the multi-antenna related receiving for the second radio signal.

[00248] In one subembodiment, the multi-antenna related receiving refers to a beamforming vector used for receiving corresponding to the U2.

[00249] In one subembodiment, the multi-antenna related receiving refers to an antenna port used for transmitting corresponding to N1.

[00250] In one subembodiment, the step in the box F2 exists, the first information is used by the U2 to determine the first time point.

[00251] In one subembodiment, the step in the box F1 exists, the second information is used by the N1 to determine the first time point.

[00252] In one subembodiment, the step in the box F3 exists, the third information is used by the U2 to determine a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[00253] If there is no conflict, the above subembodiments can be arbitrarily combined.

[00254] Embodiment 6

[00255] Embodiment 6 illustrates an example of a first radio signal, as shown in FIG. 6. In FIG. 6, rectangles filled by oblique lines represent multicarrier symbols in the first radio signal before the first time point, rectangles filled by cross lines represent multicarrier symbols in the first radio signal behind the first time point, blank rectangles represent multicarrier symbols not in the first radio signal, a wide oval filled by oblique lines represents a first receiving beam, and a narrow oval filled by cross lines represents a second receiving beam.

[00256] In Embodiment 6, the first radio signal consists of G multicarrier symbols, the first

time unit includes the G multicarrier symbols, the first time point is one time point within the first time unit, and the relative position of the first radio signal with respect to the first time point in time domain includes the three cases shown in FIG. 6.

[00257] In the first case of Embodiment 6, the first time point is one time point in the time domain in which the G multicarrier symbols are located. The first receiving beam is used for receiving the multicarrier symbols in the first radio signal before the first time point. The second receiving beam is used for receiving the multicarrier symbols in the first radio signal behind the first time point.

[00258] In the second case of Embodiment 6, the first time point is behind the G multicarrier symbols, and the first receiving beam is used for receiving the G multicarrier symbols.

[00259] In the third case of Embodiment 6, the first time point is before the G multicarrier symbols, and the second receiving beam is used for receiving the G multicarrier symbols.

[00260] In one subembodiment, the time unit is a subframe.

[00261] In one subembodiment, the time unit is a time slot.

[00262] In one subembodiment, the second radio signal is a multicarrier symbol in which the PDSCH is located.

[00263] In one subembodiment, different beamforming vectors are used for forming the first receiving beam and the second receiving beam.

[00264] In one subembodiment, the first receiving beam has a beam width greater than that of the second receiving beam.

[00265] Embodiment 7

[00266] Embodiment 7 illustrates an example of a second radio signal and a first radio signal, as shown in FIG. 7. Grey rectangles represent multicarrier symbols in the second radio signal, rectangles filled by oblique lines represent multicarrier symbols in the first radio signal before the first time point, rectangles filled by cross lines represent multicarrier symbols in the first radio signal behind the first time point, blank rectangles represent multicarrier symbols not in the first radio signal, a wide oval filled by oblique lines represents a first receiving beam, and a narrow oval filled by cross lines represents a second receiving beam.

[00267] In Embodiment 7, both the first radio signal and the second radio signal are transmitted within the first time unit, the multicarrier symbols occupied by the second radio signal are before the multicarrier symbols occupied by the first radio signal in time domain, the first receiving beam is used for receiving the second radio signal, the second radio signal indicates the start time point of the first radio signal in the first time unit, and the start time point is used for determining the time domain resource occupied by the first radio signal in the first time unit. The first time point is one time point within the first time unit behind the multicarrier symbols occupied by the second radio signal.

[00268] In Embodiment 7, the first receiving beam is used for receiving the second radio signal and the multicarrier symbols of the first radio signal before the first time point, and the second receiving beam is used for receiving the multicarrier symbols of the first radio signal behind the first time point.

[00269] In one subembodiment, the second radio signal is a PDCCH, and the first radio signal is a PDSCH.

[00270] In one subembodiment, the second radio signal is a DCI that is used for indicating downlink assignment, and the first radio signal is a PDSCH transmitted on the downlink resource indicated by the second radio signal.

[00271] In one subembodiment, the second radio signal indicates the second receiving beam.

[00272] In one subembodiment, the signaling before the first time unit is used for indicating the first receiving beam.

[00273] Embodiment 8

[00274] Embodiment 8 illustrates an example of first information and second information, as shown in FIG. 8.

[00275] In Embodiment 8, the UE transmits to the base station the second information to recommend a candidate for the first time point, according to the processing capacity of the UE; and the base station transmits to the UE the first information to indicate the first time point, according to the processing capacity of the UE and the system situation. The first time point is one time point within the first time unit. The first time point is not earlier than the recommended candidate for the first time point in time domain. The first time point is used for determining the multi-antenna related receiving corresponding to the first radio signal in the first time unit. The

first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of the time-domain resource occupied by the given multicarrier symbol with respect to the first time point in time domain.

[00276] Embodiment 9

[00277] Embodiment 9 illustrates an example of a structure block diagram for a processing device used in a UE, as shown in FIG. 9. The UE device 200 is mainly composed of a first transceiver module 201.

[00278] In Embodiment 9, the first transceiver module 201 receives a first radio signal.

[00279] In embodiment 9, the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[00280] In one embodiment, the first transceiver module 201 includes the receiver 456 and the receiving processor 452 mentioned in Embodiment 4.

[00281] In one embodiment, the first transceiver module 201 includes the transmitter 456 and the transmitting processor 455 mentioned in Embodiment 4.

[00282] In one embodiment, the first transceiver module 201 includes the antenna 460 mentioned in Embodiment 4.

[00283] In one embodiment, the first transceiver module 201 includes the controller/processor 490 mentioned in Embodiment 4.

[00284] In one embodiment, the first transceiver module 201 is further configured to receive a second radio signal; and the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

[00285] In one embodiment, if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for

determining the multi-antenna related receiving for the given multicarrier symbol.

[00286] In one embodiment, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[00287] In one embodiment, the multi-antenna related receiving refers to a corresponding beamforming vector used for receiving

[00288] In one embodiment, the multi-antenna related receiving refers to a corresponding antenna port used for transmitting.

[00289] In one embodiment, the first transceiver module 201 is further configured to receive first information; and the first information is used for determining the first time point.

[00290] In one embodiment, the first transceiver module 201 is further configured to transmit second information; and the second information is used for determining the first time point.

[00291] In one embodiment, the first transceiver module 201 is further configured to receive third information; and the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[00292] Embodiment 10

[00293] Embodiment 10 illustrates an example of a structure block diagram for a processing device used in a base station, as shown in FIG. 10. The base station device 300 is mainly composed of a second transceiver module 301.

[00294] In Embodiment 10, the second transceiver module 301 transmits a first radio signal.

[00295] In Embodiment 10, the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal includes G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. G is a positive integer.

[00296] In one embodiment, the second transceiver module 301 includes the transmitter 416 and the transmitting processor 415 mentioned in Embodiment 4.

[00297] In one embodiment, the second transceiver module 301 includes the receiver 416 and the receiving processor 412 mentioned in Embodiment 4.

[00298] In one embodiment, the second transceiver module 301 includes the receiver 416 and the transmitting processor 412 mentioned in Embodiment 4.

[00299] In one embodiment, the second transceiver module 301 includes the antenna 420 mentioned in Embodiment 4.

[00300] In one embodiment, the second transceiver module 301 is further configured to transmit a second radio signal; and the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

[00301] In one embodiment, if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol.

[00302] In one embodiment, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

[00303] In one embodiment, the multi-antenna related receiving refers to a corresponding beamforming vector used for receiving.

[00304] In one embodiment, the multi-antenna related receiving refers to a corresponding antenna port used for transmitting.

[00305] In one embodiment, the second transceiver module 301 is further configured to transmit first information, and the first information is used for determining the first time point.

[00306] In one embodiment, the second transceiver module 301 is further configured to receive second information, and the second information is used for determining the first time point.

[00307] In one embodiment, the second transceiver module 301 is further configured to

transmit third information, and the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

[00308] The ordinary skill in the art may understand that all or part 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 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 realized 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 or terminal in the present disclosure include but not limited to mobile phones, tablet computers, notebooks, network cards, NB-IOT terminals, eMTC terminal and other wireless communication equipment. The base station or system in the present disclosure includes but not limited to macro-cellular base stations, micro-cellular base stations, home base stations, relay base station and other wireless communication equipment.

[00309] 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 in a User Equipment (UE) for wireless communication, comprising:

receiving a first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

2. The method according to claim 1, comprising:

receiving a second radio signal;

wherein the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

3. The method according to claim 2, wherein if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

4. The method according to claims 1, comprising:

receiving first information, wherein the first information is used for determining the first time point;

or,

receiving third information, wherein the third information is used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

5. The method according to claims 1 comprising:

transmitting second information;

wherein the second information is used for determining the first time point.

6. A method in a base station device for wireless communication, comprising:

transmitting a first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

7. The method according to claim 6, comprising:

transmitting a second radio signal;

wherein the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

8. The method according to claim 7, wherein if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

9. The method according to claims 6, comprising:

transmitting first information, wherein the first information is used for determining the first time point;

or,

transmitting third information, wherein the third information is used for

determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

10. The method according to claims 6, comprising:

receiving second information;

wherein the second information is used for determining the first time point.

11. A UE for wireless communication, comprising:

a first transceiver module, to receive a first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

12. The UE according to claim 11, wherein the first transceiver module receives a second radio signal, the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

13. The UE according to claim 12, wherein if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

14. The UE according to claim 11, wherein the first transceiver module receives first information, the first information being used for determining the first time point; or, the first transceiver module transmits second information, the second information being used for determining the first time point; or, the first transceiver module receives third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G

multicarrier symbols.

15. A base station device for wireless communication, comprising:

a second transceiver module, to transmit a first radio signal;

wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols; as for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain; the first time point is one time point within the first time unit; and G is a positive integer.

16. The base station device according to claim 15, wherein the second transceiver module transmits a second radio signal, the second radio signal is transmitted within the first time unit, and the second radio signal is used for determining a time-domain resource occupied by the G multicarrier symbols.

17. The base station device according to claim 16, wherein if the time-domain resource occupied by the given multicarrier symbol is behind the first time point, the second radio signal is used for determining the multi-antenna related receiving for the given multicarrier symbol; or, if the time-domain resource occupied by the given multicarrier symbol is before the first time point, the multi-antenna related receiving for the given multicarrier symbol is related to the multi-antenna related receiving for the second radio signal.

18. The base station device according to claim 15, wherein the second transceiver module transmits first information, the first information being used for determining the first time point; or, the second transceiver module receives second information, the second information being used for determining the first time point; or, the second transceiver module transmits third information, the third information being used for determining a candidate scheme for the multi-antenna related receiving corresponding to the G multicarrier symbols.

ABSTRACT

The present disclosure provides a method and a device used for wireless communication in a base station and a User Equipment (UE). The UE receives a first radio signal, wherein the first radio signal is transmitted within a first time unit, a first bit block is used for generating the first radio signal, and the first radio signal comprises G multicarrier symbols. As for any one given multicarrier symbol of the G multicarrier symbols, the multi-antenna related receiving for the given multicarrier symbol is related to the relative position of a time-domain resource occupied by the given multicarrier symbol with respect to a first time point in time domain. The first time point is one time point within the first time unit. The present disclosure increases the dynamic of the multi-antenna related receiving.

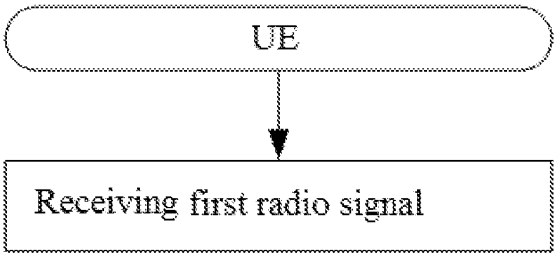

UE
Receiving first radio signal

FIG. 1

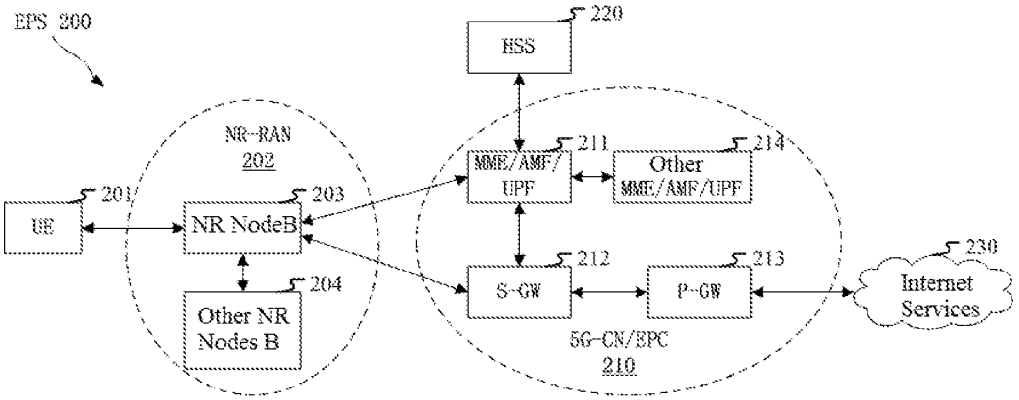

EPS 200
220
HSS
NR-RAN
202
211
MME/AMF/
UPF
214
Other
MME/AMF/UPF
201
UE
203
NR NodeB
212
213
230
S-GW
P-GW
Internet
Services
204
Other NR
Nodes B
5G-CN/EPC
210

FIG. 2

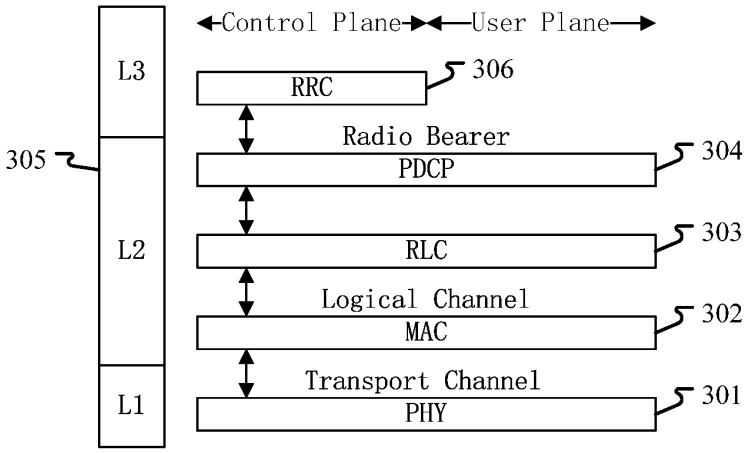

Control Plane
User Plane
L3
L2
L1
305
RRC
306
Radio Bearer
PDCP
304
RLC
303
Logical Channel
MAC
302
Transport Channel
PHY
301

FIG. 3

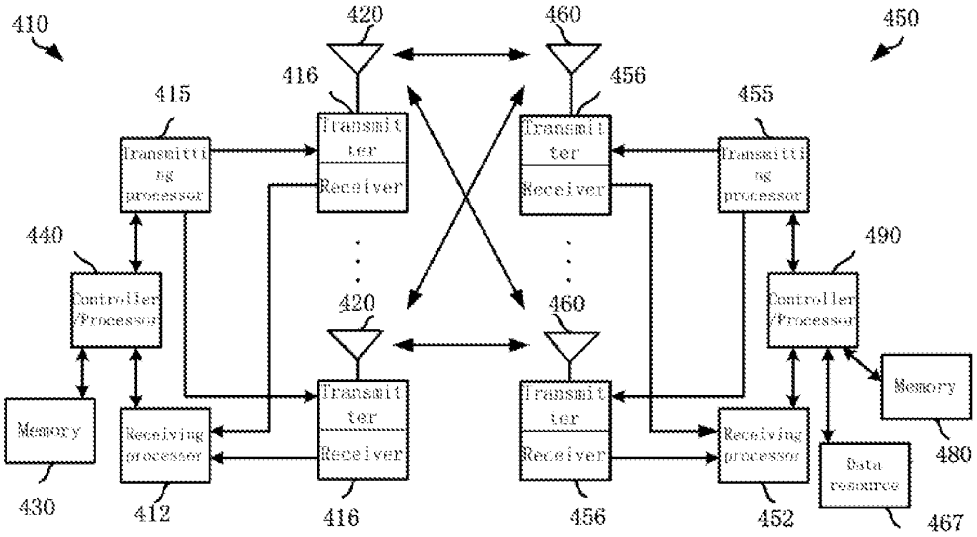

410
420
460
450
416
456
415
455
Transmitting processor
Transmitter
Receiver
440
490
Controller/Processor
Memory
Receiving processor
Data resource
480
430
412
452
467

FIG. 4

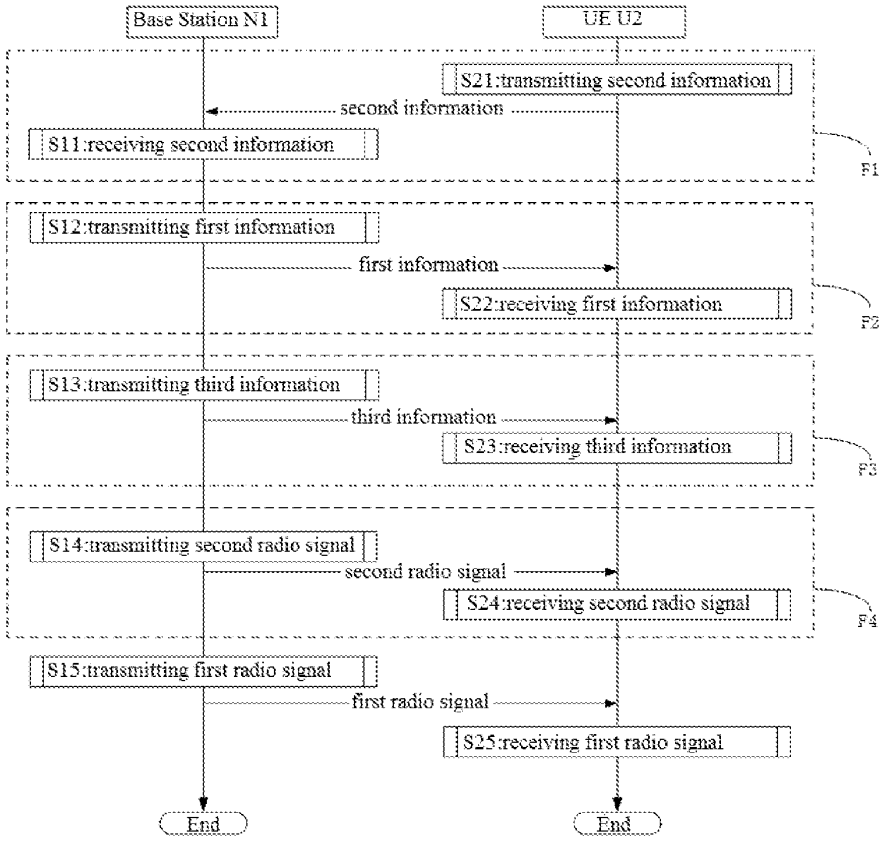

Base Station N1
UE U2
S21:transmitting second information
second information
S11:receiving second information
F1
S12:transmitting first information
first information
S22:receiving first information
F2
S13:transmitting third information
third information
S23:receiving third information
F3
S14:transmitting second radio signal
second radio signal
S24:receiving second radio signal
F4
S15:transmitting first radio signal
first radio signal
S25:receiving first radio signal
End
End

FIG. 5

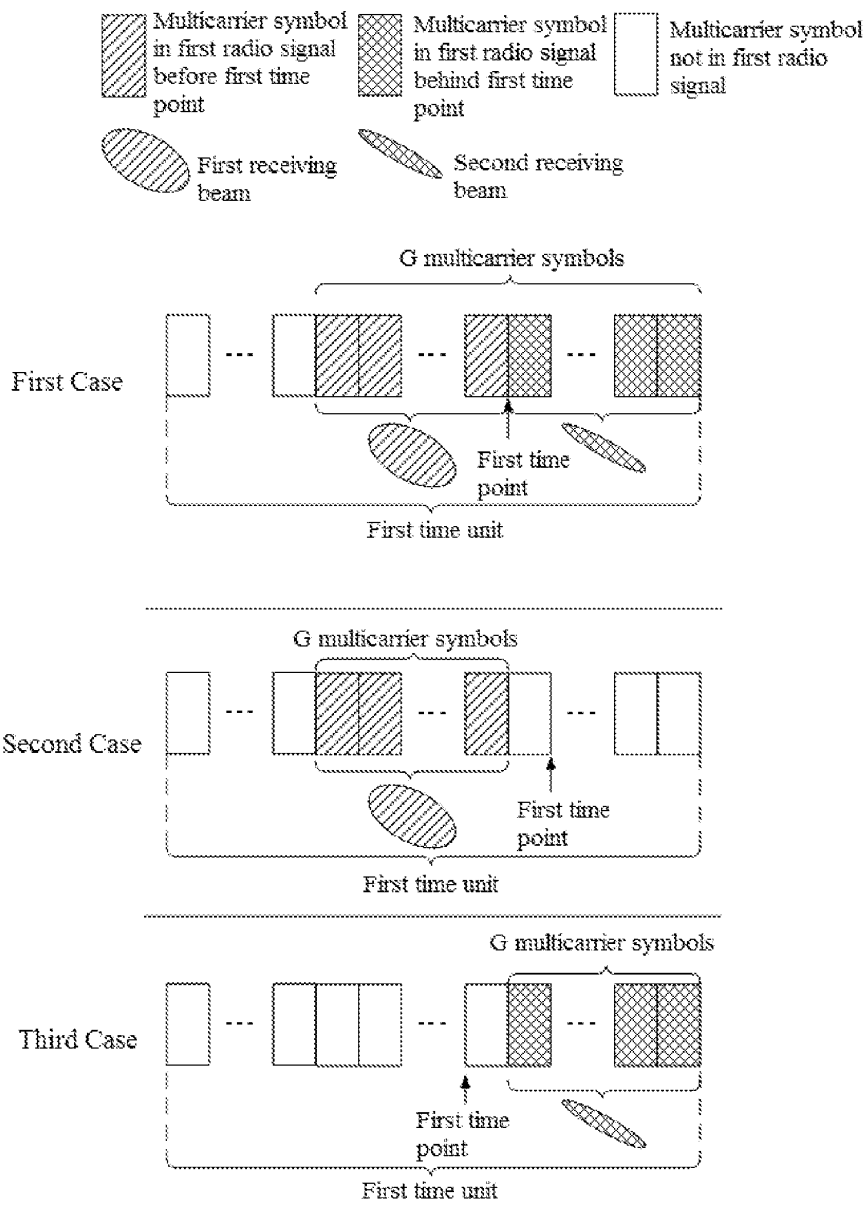

Multicarrier symbol in first radio signal before first time point
Multicarrier symbol in first radio signal behind first time point
Multicarrier symbol not in first radio signal
First receiving beam
Second receiving beam
G multicarrier symbols
First Case
First time point
First time unit
G multicarrier symbols
Second Case
First time point
First time unit
G multicarrier symbols
Third Case
First time point
First time unit

FIG. 6

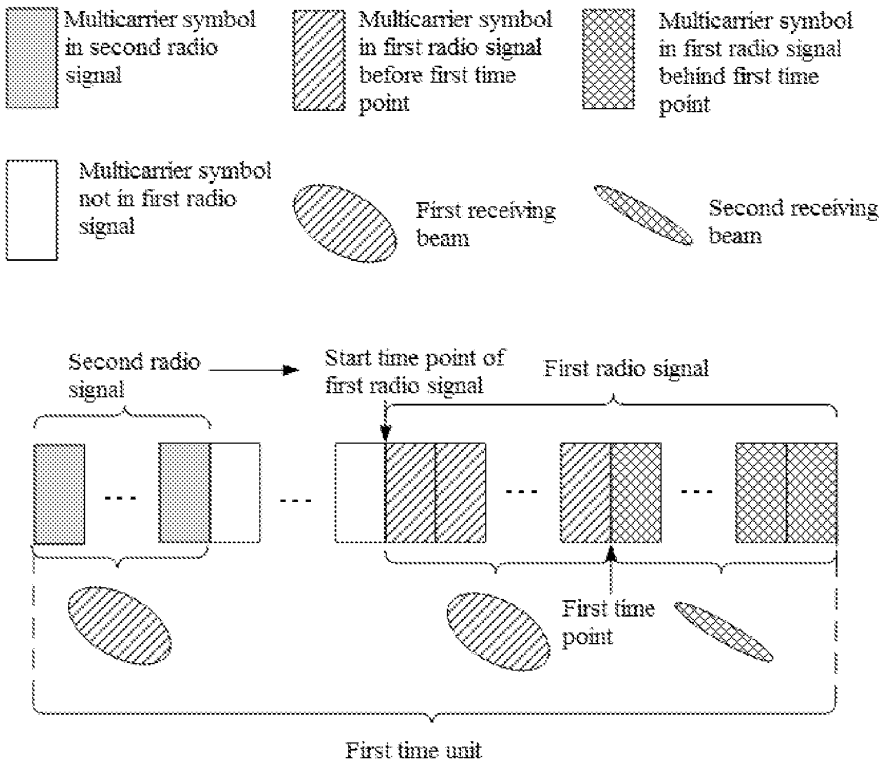

Multicarrier symbol in second radio signal
Multicarrier symbol in first radio signal before first time point
Multicarrier symbol in first radio signal behind first time point
Multicarrier symbol not in first radio signal
First receiving beam
Second receiving beam
Second radio signal
Start time point of first radio signal
First radio signal
First time point
First time unit

FIG. 7

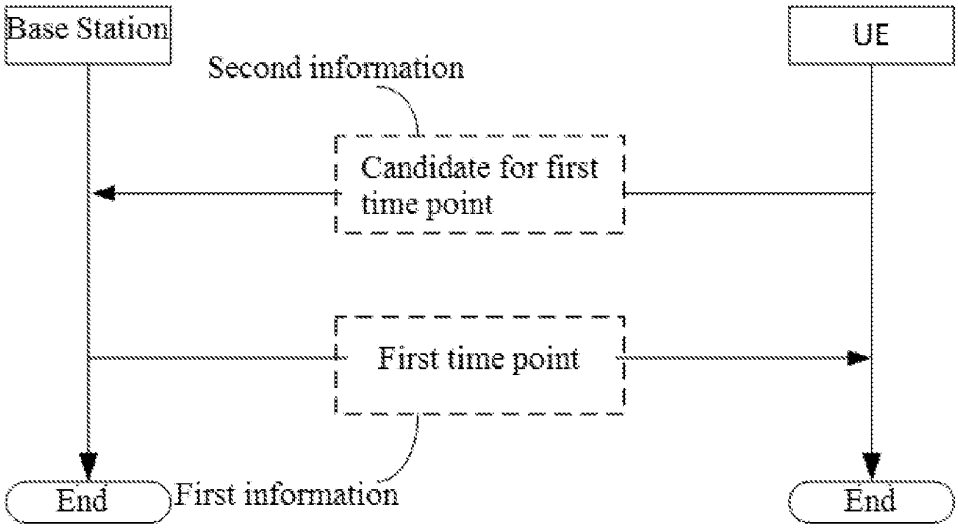


FIG. 8

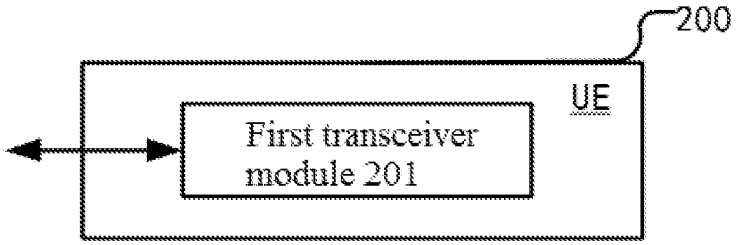


FIG. 9

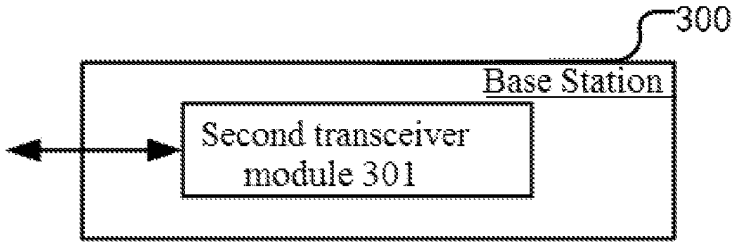


FIG. 10

PTO/AIA/01 (06-12)
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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 USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION

As the below named inventor, I hereby declare that:

This declaration is directed to:

[X] The attached application, or

[ ] United States application or PCT international application number _____

filed on _____.

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

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

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

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LEGAL NAME OF INVENTOR

Inventor: XiaoBo ZHANG Date (Optional): May.04 2018

Signature: XiaoBo ZHANG

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

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

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION
First Named Inventor/Applicant Name:	Xiaobo Zhang
Filer:	Aaron Richard Wininger
Attorney Docket Number:	126099-8013.US00

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:	32542147
Application Number:	15972167
International Application Number:	
Confirmation Number:	3699
Title of Invention:	METHOD AND DEVICE USD FOR WIRELESS COMMUNICATION IN UE AND BASE STATION
First Named Inventor/Applicant Name:	Xiaobo Zhang
Customer Number:	70416
Filer:	Aaron Richard Wininger
Filer Authorized By:	
Attorney Docket Number:	126099-8013.US00
Receipt Date:	06-MAY-2018
Filing Date:	
Time Stamp:	14:07:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1015
RAM confirmation Number	050718INTEFSW14083200
Deposit Account	500665
Authorized User	Aaron Wininger
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1	Application Data Sheet	1260998013US00ADS.pdf	1823086 99c751dfc1c8a4843e0d458a9cd6caa18b7eb85a	no	8
Warnings:					
Information:					
2		Spec.pdf	328217 8886749e3d89021e921715cbe9fdf1e50390280a	yes	36

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	Document Description	**Start**	**End**
	Specification	1	31
	Claims	32	35
	Abstract	36	36

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3	Drawings-only black and white line drawings	Drawings.pdf	214191 45c72e800b37117427dab4c0ea70735235e5c0b8	no	6
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4	Oath or Declaration filed	Default.pdf	90393 110a179919d7659c573b1a5187508194164 0a4b5	no	1
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