

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 10,148,402 B2
APPLICATION NO. : 15/863267
DATED : December 4, 2018
INVENTOR(S) : Ko-Chiang Lin et al.

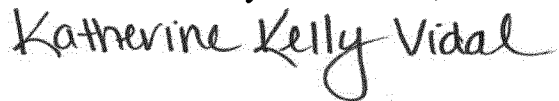
Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Under Column 14, Line 15, please delete “now abandoned”.

Signed and Sealed this
Seventeenth Day of October, 2023



Katherine Kelly Vidal
Director of the United States Patent and Trademark Office

IN THE U.S. PATENT AND TRADEMARK OFFICE

First Named Inventors: Ko-Chiang Lin and Richard Lee-Chee Kuo
Patent No.: 10,148,402
Issue Date: December 4, 2018
For: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A
WIRELESS COMMUNICATION SYSTEM

ATTENTION: CERTIFICATE OF CORRECTIONS BRANCH

REQUEST FOR CERTIFICATE OF CORRECTION
UNDER 35 U.S.C. § 255 and 37 C.F.R. § 1.323

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
Attn: Certificate of Correction Branch

Dear Commissioner:

Attached hereto is a Certificate of Correction (Form PTO-1050) in connection with the above-identified patent.

It is to be noted that the attached Certificate is being filed in order to correct an error that was clearly made in the printing of the Letters Patent. Therefore, the issuance of a Certificate of Correction under 35 U.S.C. § 254 without charge to the patentee is respectfully requested.

It is believed that no fee is required. Applicants invites the corrections branch to contact the undersigned with any questions.

Respectfully submitted,
BLUE CAPITAL LAW FIRM, P.C.
(Customer No.: 106622)

/Sang N. Dang/

Date: September 18, 2023

Sang N. Dang (Reg. 51,186)
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626
Tel: (714) 839-3800
Fax: (714) 795-2995

Attachments: Certificate of Correction

**UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION**

Page _____ of _____

PATENT NO. : 10,148,401

APPLICATION NO.: 15/863,267

ISSUE DATE : December 4, 2018

INVENTOR(S) : Ko-Chiang Lin et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On page 21, under column 14, line 15, please delete "now abandoned"

MAILING ADDRESS OF SENDER (Please do not use Customer Number below):

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995, unless the information collection has a currently valid OMB Control Number. The OMB Control Number for this information collection is 0651-0033. Public burden for this form is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Chief Administrative Officer, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 or email InformationCollection@uspto.gov. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. If filing this completed form by mail, 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.

Petitioners' Exhibit 1002, p. 3
AT&T et al v. Asustek Technology & Celerity
IPR2024-01121

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Ko-Chiang Lin and Richard Lee-Chee Kuo
Title: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A
WIRELESS COMMUNICATION SYSTEM
Serial No.: 15/863,267 Filed: January 5, 2018
Examiner: Min Jung Group Art Unit: 2472
Attorney Docket No.: 1426-188.101 (1060022-US)

**CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8**

I hereby certify that the enclosed 1 Page Request for Certificate of Correction; and 1
Page Certificate of Correction are being transmitted to the United States Patent and Trademark
Office via EFS-Web on September 18, 2023.

Date: September 18, 2023

/Sandy Kim/

Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)

650 Town Center Drive, Suite 1530

Costa Mesa, California 92626

Tel: 714-839-3800

Fax: 714-795-2995

Electronic Acknowledgement Receipt	
EFS ID:	48603580
Application Number:	15863267
International Application Number:	
Confirmation Number:	5504
Title of Invention:	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-188.101
Receipt Date:	18-SEP-2023
Filing Date:	05-JAN-2018
Time Stamp:	18:40:30
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		1426-188-101-- RequestforCertifofCorr09182023.pdf	167955	yes	3
			b40cad65f133ef09e767479c27147dd142edbc5b		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Request for Certificate of Correction	1	1
	Request for Certificate of Correction	2	2
	Miscellaneous Incoming Letter	3	3
Warnings:			
Information:			
Total Files Size (in bytes):		167955	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.			



UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/863,267	12/04/2018	10148402	1426-188.101	5504

106622 7590 11/14/2018
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

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

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

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

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

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

Ko-Chiang Lin, Taipei City, TAIWAN;
ASUSTek Computer Inc., Taipei City, TAIWAN;
Richard Lee-Chee Kuo, Taipei City, TAIWAN;

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Ko-Chiang Lin and Richard Lee-Chee Kuo
Title: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A
WIRELESS COMMUNICATION SYSTEM
Serial No.: 15/863,267 Filed: January 5, 2018
Examiner: Min Jung Group Art Unit: 2472
Attorney Docket No.: 1426-188.101 (1060022-US)

**CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8**

I hereby certify that the enclosed 1 Page Issue Fee Transmittal; and Payment by
electronic payment via EFS-Web are being transmitted to the United States Patent and
Trademark Office via EFS-Web on October 26, 2018.

Date: October 26, 2018

/Sandy Kim/

Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)

650 Town Center Drive, Suite 1530

Costa Mesa, California 92626

Tel: 714-839-3800

Fax: 714-795-2995

PART B – FEE(S) TRANSMITTAL

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

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

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

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

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

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

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	FILED DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO	CONFIRMATION NO
15/863,267	01-05-2018	Ko-Chiang Lin	1426-188.101	5504

TITLE OF INVENTION: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0	\$0	\$1000	12/26/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
JUNG, MIN	2472	370-328000

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. Blue Capital Law Firm, P.C.

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

ASUSTek Computer Inc.

(B) RESIDENCE: (CITY and STATE or COUNTRY)

Taipei City, Taiwan

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government4a. Fees Submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

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

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

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

☐ Applicant certifying micro entity status. See 37 CFR 1.29.

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

☐ Applicant asserting small entity status. See 37 CFR 1.27.

NOTE: If the application was previously under micro entity status, checking this box will be taken as a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken as a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature /Sang N. Dang/

Date October 26, 2018

Typed or printed name Sang N. Dang

Registration No. 51,186

Electronic Patent Application Fee Transmittal				
Application Number:		15863267		
Filing Date:		05-Jan-2018		
Title of Invention:		METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM		
First Named Inventor/Applicant Name:		Ko-Chiang Lin		
Filer:		Sang N. Dang/Sandy Kim		
Attorney Docket Number:		1426-188.101		
Filed as Large 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	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1000

Electronic Acknowledgement Receipt

EFS ID:	34127433
Application Number:	15863267
International Application Number:	
Confirmation Number:	5504
Title of Invention:	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-188.101
Receipt Date:	26-OCT-2018
Filing Date:	05-JAN-2018
Time Stamp:	13:34:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 1000
RAM confirmation Number	102618INTEFSW13353400
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		1426-188-101-- IssueFeeTransmittal.pdf	172556	yes	2
			fa273688e1e719be43f5cf33643d88b748463072		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Miscellaneous Incoming Letter		2	2	
	Issue Fee Payment (PTO-85B)		1	1	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30355	no	2
			9a4c75fdd3b50d62e6f60c314175341aab70d7ef		
Warnings:					
Information:					
Total Files Size (in bytes):			202911		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					



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

106622 7590 09/26/2018
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER

JUNG, MIN

ART UNIT

PAPER NUMBER

2472

DATE MAILED: 09/26/2018

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/863,267	01/05/2018	Ko-Chiang Lin	1426-188.101	5504

TITLE OF INVENTION: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	12/26/2018

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: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or **Fax** **(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)

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.

106622 7590 09/26/2018
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

_____ (Depositor's name)
_____ (Signature)
_____ (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/863,267	01/05/2018	Ko-Chiang Lin	1426-188.101	5504

TITLE OF INVENTION: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	12/26/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
JUNG, MIN	2472	370-328000

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 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

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

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

1 _____

2 _____

3 _____

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

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. 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. The following fee(s) are submitted:

☐ Issue Fee

☐ Publication Fee (No small entity discount permitted)

☐ Advance Order - # of Copies _____

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

☐ A check is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

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.
15/863,267	01/05/2018	Ko-Chiang Lin	1426-188.101	5504
106622	7590	09/26/2018	EXAMINER	
Blue Capital Law Firm, P.C. 650 Town Center Drive, Suite 1530 Costa Mesa, CA 92626			JUNG, MIN	
			ART UNIT	PAPER NUMBER
			2472	
DATE MAILED: 09/26/2018				

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 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, 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 a patent.
9. A record from this system of records may be disclosed, as a routine use, to the U.S. Patent and Trademark Office, or its enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/863,267	Applicant(s) Lin et al.	
	Examiner MIN JUNG	Art Unit 2472	AIA 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 Amendment filed 8-14-18.
☐ 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 1-3, 5, 7-13, 15-17 and 19 (renumbered as 1-15) . 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 areply 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)	5. ☐ Examiner's Amendment/Comment
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ____.	6. ☐ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material ____.	7. ☐ Other ____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date ____.	

/MIN JUNG/ Primary Examiner, Art Unit 2472	
---	--

Issue Classification 	Application/Control No. 15/863,267	Applicant(s)/Patent Under Reexamination Lin et al.
	Examiner MIN JUNG	Art Unit 2472

CPC						
Symbol					Type	Version
H04L	/	5	/	0048	F	2013-01-01
H04W	/	72	/	0406	I	2013-01-01
H04B	/	7	/	0617	I	2013-01-01
H04W	/	72	/	085	I	2013-01-01
H04B	/	7	/	0695	I	2013-01-01
H04W	/	88	/	08	A	2013-01-01
H04W	/	88	/	02	A	2013-01-01
H04L	/	5	/	00	A	2013-01-01

CPC Combination Sets				
Symbol		Type	Set	Version
/	/			

NONE	Total Claims Allowed:	
(Assistant Examiner)	(Date)	15
/MIN JUNG/ Primary Examiner, Art Unit 2472	17 September 2018	O.G. Print Claim(s)
(Primary Examiner)	(Date)	1

Issue Classification 	Application/Control No. 15/863,267	Applicant(s)/Patent Under Reexamination Lin et al.
	Examiner MIN JUNG	Art Unit 2472

INTERNATIONAL CLASSIFICATION			
CLAIMED			
H04L	/	5	/ 00
NON-CLAIMED			
	/		/

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/MIN JUNG/ Primary Examiner, Art Unit 2472 (Primary Examiner)	17 September 2018 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Issue Classification 	Application/Control No. 15/863,267	Applicant(s)/Patent Under Reexamination Lin et al.
	Examiner MIN JUNG	Art Unit 2472

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19										
	2		11		20										
	3		12												
	4		13												
	5		14												
	6		15												
	7		16												
	8		17												
	9		18												

NONE	Total Claims Allowed:					
(Assistant Examiner)	(Date)	15				
/MIN JUNG/ Primary Examiner, Art Unit 2472 (Primary Examiner)	17 September 2018 (Date)	<table><tr><td>O.G. Print Claim(s)</td><td>O.G. Print Figure</td></tr><tr><td>1</td><td>1</td></tr></table>	O.G. Print Claim(s)	O.G. Print Figure	1	1
O.G. Print Claim(s)	O.G. Print Figure					
1	1					

Information Disclosure Statement Transmittal

Docket Number

1426-188.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

In Re Application Of:

Ko-Chiang Lin

Application No.	15/863,267
Filing Date	January 5, 2018
Examiner	Min Jung
Art Unit	2472

Title of Invention

METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

BASIS FOR FILING (Select 1, 2 or 3 below.)

37 CFR 1.97(b)

- 1) ☐ The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53 (d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.

37 CFR 1.97(c)

- 2) ☒ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:

- a) ☒ the statement specified in 37 CFR 1.97(e);

OR

- b) ☐ the fee set forth in 37 CFR 1.17(p).

37 CFR 1.97(d)

- 3) ☐ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(c), and on or before payment of the issue fee, and is accompanied by the Statement as specified in 37 CFR 1.97(e) and the fee set forth in 37 CFR 1.17(p).

Information Disclosure Statement Transmittal

Docket Number

1426-188.101

STATEMENT UNDER 37 CFR 1.97(e) ACCOMPANYING INFORMATION DISCLOSURE STATEMENT

The Information Disclosure Statement submitted herewith is submitted under one of the following conditions, which satisfies the requirement under 37 CFR 1.97(e). (Select 4 or 5 below if applicable.)

- 4) ☒ 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; or
- 5) ☐ 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.

Remarks (Enter Remarks Below or Attach Document Containing Remarks)

Fee set forth in 37 CFR 1.17(p):

- ☒ No additional fee is required.
- ☐ A check in the amount of _____ is attached.
- ☐ The Director is hereby authorized to charge and credit Deposit Account No. _____ as described below.
- ☐ Charge the amount of _____
- ☐ Credit any overpayment.
- ☐ Charge any additional fee required.
- ☐ Payment by credit card. Form PTO-2038 is attached.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Information Disclosure Statement Transmittal

Docket Number

1426-188.101

Correspondence Address

Customer Number 106622

-OR-

Name

Address

City

State

Country

Postal Code

Phone Number

E-mail Address

Certificate of Mailing by Express Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Transmittal Letter, accompanying documents and fee authorization (if appropriate) is being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission)

(Name of Person Transmitting Correspondence)

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Transmittal Letter from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box

Sang N. Dang

Name

Sang N. Dang

Registration Number

51,186

Signatory Capacity

Attorney for Applicant(s)

E-mail Address

sdang@bluecapitallaw.com

eSign

/Sang N. Dang/

Date Signed

05-29-2018

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15863267
	Filing Date		2018-01-05
	First Named Inventor	LIN, KO-CHIANG	
	Art Unit	2472	
	Examiner Name	Min Jung	
	Attorney Docket Number	1426-188.101	

U.S.PATENTS						
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.

U.S.PATENT APPLICATION PUBLICATIONS						
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					

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

FOREIGN PATENT DOCUMENTS								
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	2015080648	WO		2015-06-04	Mattias FRENNE		☐

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

NON-PATENT LITERATURE DOCUMENTS			
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

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15863267
Filing Date	2018-01-05
First Named Inventor	LIN, KO-CHIANG
Art Unit	2472
Examiner Name	Min Jung
Attorney Docket Number	1426-188.101

1	SAMSUNG: "Discussion on DL beam management procedures P-2 and P-3", 3GPP DRAFT; R1-1612509, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Reno, USA; 20161114 - 20161118 13 November 2016 (2016-11-13), XP051176456, Retrieved from the Internet: URL: http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN/Docs/	☐
2	INTEL CORPORATION: "Reference Signal and Procedure for UE Beam Refinement (BMP-3)11, 3GPP DRAFT; R1-1609514 REFERENCE SIGNAL AND PROCEDURE FOR UE BEAM REFINEMENT R1, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLI, vol. RAN WG1, no. Lisbon, Portugal; 20161010 - 20161014 9 October 2016 (2016-10-09), XP051149553, Retrieved from the Internet:	☐
3	European Search Report from corresponding EP Application No. 18150416.8, dated May 22, 2018.	☐

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

EXAMINER SIGNATURE

Examiner Signature	/MIN JUNG/	Date Considered	09/17/2018
--------------------	------------	-----------------	------------

*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.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	0	15/863267	US-PGPUB; USPAT	OR	ON	2018/05/14 14:51
S2	13077	(beam near2 measur\$) same reference	US-PGPUB; USPAT	OR	ON	2018/05/14 14:52
S3	2433	S2.clm.	US-PGPUB; USPAT	OR	ON	2018/05/14 14:52
S4	512	beam adj id	US-PGPUB; USPAT	OR	ON	2018/05/14 14:53
S5	16	S3 and S4	US-PGPUB; USPAT	OR	ON	2018/05/14 14:53
S6	10979	H04L5/0048.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:34
S7	13096	(beam near2 measur\$) same reference	US-PGPUB; USPAT	OR	ON	2018/05/17 12:36
S8	2433	S7.clm.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:36
S9	21	S6 and S8	US-PGPUB; USPAT	OR	ON	2018/05/17 12:39
S10	7416	H04W72/0406.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:43
S11	1	S8 and S10	US-PGPUB; USPAT	OR	ON	2018/05/17 12:44
S12	6319	beam adj measurement	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S13	1432	S12.clm.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S14	1	S10 and S13	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S15	215312	reference adj signal	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S16	158	S12 same S15	US-PGPUB; USPAT	OR	ON	2018/05/17 12:46
S17	33	S16.clm.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:46
S18	30	S17 not S9	US-PGPUB; USPAT	OR	ON	2018/05/17 12:46
S19	5748	H04B7/0617.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:53
S20	21	S8 and S19	US-PGPUB; USPAT	OR	ON	2018/05/17 12:54
S21	13	S20 not S9	US-PGPUB; USPAT	OR	ON	2018/05/17 12:54
S22	12	S21 not S18	US-PGPUB; USPAT	OR	ON	2018/05/17 12:54

S23	5132	H04W72/085.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 13:50
S24	5	S8 and S23	US-PGPUB; USPAT	OR	ON	2018/05/17 13:51
S25	16287	H04W88/08.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 13:53
S26	4	S8 and S25	US-PGPUB; USPAT	OR	ON	2018/05/17 13:53
S27	17328	H04W88/02.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 13:53
S28	7	S8 and S27	US-PGPUB; USPAT	OR	ON	2018/05/17 13:54
S29	12	((("Lin") near3 ("Ko-Chiang"))).INV.	USPAT	OR	OFF	2018/05/17 14:11
S30	56	((("Lin") near3 ("Ko-Chiang"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/05/17 14:12
S31	1	("20170195998").PN.	US-PGPUB; USPAT	OR	OFF	2018/05/17 17:00
S32	12210	H04L5/0048.cpc.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:23
S33	8109	H04W72/0406.cpc.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:24
S34	6500	H04B7/0617.cpc.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:24
S35	5567	H04W72/085.cpc.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:24
S36	17667	H04W88/08.cpc.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:24
S37	18891	H04W88/02.cpc.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:25
S38	11115	(beam near2 (measure measurement measuring)) same reference	US-PGPUB; USPAT	OR	ON	2018/09/16 16:27
S39	2294	S38.clm.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:27
S40	25	S32 and S39	US-PGPUB; USPAT	OR	ON	2018/09/16 16:28
S41	1	15/863267	US-PGPUB; USPAT	OR	ON	2018/09/16 16:35
S42	2	S33 and S39	US-PGPUB; USPAT	OR	ON	2018/09/16 16:36
S43	73679	(reference adj signal).clm.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:37
S44	6522	beam adj measurement	US-PGPUB; USPAT	OR	ON	2018/09/16 16:37
S45	1461	S44.clm.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:37
S46	64	S43 and S45	US-PGPUB; USPAT	OR	ON	2018/09/16 16:37
S47	59	S46 not S40	US-PGPUB; USPAT	OR	ON	2018/09/16 16:38
S48	59	S44 same symbol	US-PGPUB; USPAT	OR	ON	2018/09/16 16:39

Petitioners' Exhibit 1002, p. 29

AT&T et al v. Asustek Technology & Celerity

IPR2024-01121

S49	1	S48.clm.	US-PGPUB; USPAT	OR	ON	2018/09/16 16:39
S50	19	S48 same (number plural plurality)	US-PGPUB; USPAT	OR	ON	2018/09/16 16:41
S51	7	S36 and S48	US-PGPUB; USPAT	OR	ON	2018/09/16 16:46
S52	7	S37 and S48	US-PGPUB; USPAT	OR	ON	2018/09/16 16:48
S53	2	S52 not S51	US-PGPUB; USPAT	OR	ON	2018/09/16 16:48
S54	1	15/863267	US-PGPUB; USPAT	OR	ON	2018/09/17 09:46

9/ 17/ 2018 11:07:57 AM
C:\ Users\ mjung\ Documents\ EAST\ Workspaces\ 15863267.wsp

Docket No. 1426-188.101 (1060022-US)
Appl. No. 15/863,267
Amdt. Dated August 14, 2018
Reply to Office Action of May 22, 2018

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 15/863,267
Confirmation No. : 5504
Applicant : Ko-Chiang Lin and Richard Lee-Chee Kuo
Filed : January 05, 2018
Title : METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A
WIRELESS COMMUNICATION SYSTEM
TC/A.U. : 2472
Examiner : Min Jung
Docket No. : 1426-188.101 (1060022-US)
Customer No. : 106622

Amendment to Office Action

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

Dear Sir:

In response to the non-final Office Action mailed on May 22, 2018, having a three-month period for filing a response to **August 22, 2018**, please amend the above-identified application as follows:

Claims begin on page 2.

Remarks begin on page 5.

Amendment Transmittal Letter

Docket Number

1426-188.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Title of Invention

METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

First Named Inventor Ko-Chiang Lin

Application No. 15/863,267

Filing Date January 5, 2018

Examiner Min Jung

Art Unit 2472

Transmitted herewith is an amendment in the above-identified application.

The fee has been calculated and is transmitted as shown below.

☐ Applicant claims Small Entity Status. See 37 CFR 1.27.

Fee Calculation

Claims as Amended

For	#Filed	#Previously Paid For	#Extra	Rate	Fee
Total Claims	15	- 20 =		x ☐ =	
Total Indep. Claims	3	- 3 =		x ☐ =	
Multiple Dependent Claims (check if applicable) ☐					
TOTAL					

Method of Payment

☐ Deposit Account ☐ Credit Card ☐ Check ☐ Money Order ☐ Other: _____

Deposit Account Number _____

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

- ☐ Charge the fee(s) set forth above
☐ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17
☐ Charge fee(s) indicated above, **except for the filing fee**
☐ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on form PTO-2038.

Amount Grand Total 0

Amendment Transmittal Letter

Docket Number

1426-188.101

Correspondence Address

Customer Number 106622

-OR-

Name

Address

City

State

Country

Postal Code

Phone Number

E-mail Address

Certificate of Mailing by Express Mail

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) authorization are being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission)

(Name of Person Transmitting Correspondence)

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Amendment from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box

Sang N. Dang

Name

Sang N. Dang

Registration Number

51,186

Signatory Capacity

Attorney for Applicant(s)

E-mail Address

sdang@bluecapitallaw.com

eSign

/Sang N. Dang/

Date Signed

08/14/2018

Electronic Acknowledgement Receipt

EFS ID:	33467504
Application Number:	15863267
International Application Number:	
Confirmation Number:	5504
Title of Invention:	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-188.101
Receipt Date:	14-AUG-2018
Filing Date:	05-JAN-2018
Time Stamp:	17:50:37
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		1426-188-101-- ROAof05222018asFiled081420 18.pdf	160757 6990b475fb85aeb76fd0fo2d59c17ab4e7ea db3a	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Miscellaneous Incoming Letter	11	11
	Applicant Arguments/Remarks Made in an Amendment	7	10
	Claims	4	6
	Amendment/Req. Reconsideration-After Non-Final Reject	3	3
	Transmittal Letter	1	2
Warnings:			
Information:			
Total Files Size (in bytes):		160757	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.			

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Ko-Chiang Lin and Richard Lee-Chee Kuo
Title: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A
WIRELESS COMMUNICATION SYSTEM
Serial No.: 15/863,267 Filed: January 5, 2018
Examiner: Min Jung Group Art Unit: 2472
Attorney Docket No.: 1426-188.101 (1060022-US)

**CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8**

I hereby certify that the enclosed 2 Page Amendment Transmittal Sheet; and 8 Page
Amendment are being transmitted to the United States Patent and Trademark Office via EFS-
Web on August 14, 2018.

Date: August 14, 2018

/Sandy Kim/

Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)

650 Town Center Drive, Suite 1530

Costa Mesa, California 92626

Tel: 714-839-3800

Fax: 714-795-2995

REMARKS

Claims 1-20 are pending in the application.

I. Rejections Under 35 U.S.C. § 112

Claims 3, 9, and 17 stand rejected under 35 U.S.C. § 112. *See* Office Action, ¶ 3. Claims 3, 9, and 17 have been amended to address the rejection. Applicants respectfully request reconsideration of the claims as amended.

II. Rejections Under 35 U.S.C. § 102 and 35 U.S.C. § 103

Claims 1-5, 7-13, and 15-19 stand rejected under 35 U.S.C. § 102 as being unpatentable over Nagaraja (U.S. Publication No. 2018/0103407). *See* Office Action, ¶ 5. In addition, claims 6, 14, and 20 stand rejected under 35 U.S.C. § 103 as being unpatentable over Nagaraja. *See* Office Action, ¶ 7.

Claims 4, 6, 14, 18, and 20 have been canceled. Claims 1, 3, 7, 9, 15, and 17 have been amended. No new matter has been added. Applicants respectfully request reconsideration of the claims as amended.

Claim 1 and 15 recite the base station “transmits to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal triggers aperiodical transmission of the reference signal for beam measurement, and wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement and indicates how many symbols are used to carry the reference signal for beam measurement”, and the based station “transmits the reference signal for beam measurement to the UE”. Similarly, claim 6 recites “the UE receives from a base station a control signal associated with a reference signal for beam measurement, wherein the control signal includes beam-related information for transmitting the reference signal for beam measurement and indicates how many symbols are used to carry the reference signal for beam measurement” and “the UE measures the reference signal for beam measurement from the base station.” Applicants respectfully submit that no combination of cited prior art references discloses the noted limitations.

In particular, Paragraph [0098] of Nagaraja states:

[0098] At 1003, the BS may transmit, to a UE served by the BS, information regarding one or more reference beams and one or more event triggers associated with the one or more reference beams. At 1004, the BS may receive an indication of one of the event triggers. At 1006, the BS may take one or more actions based, at least in part, on the indication.

See Nagaraja, Paragraph [0098].

Based on Paragraph [0098] and FIG.10 of Nagaraja, Nagaraja teaches the BS signals to a UE one or more reference beam (IDs) and one or more event triggers. The BS receives an indication of one of the event triggers from the UE. And the BS takes one or more actions based on the indication. However, Nagaraja fails to disclose that the UE receives a control signal which indicates how many symbols are used to carry the reference signal for beam measurement and **that the UE performs beam measurement based on the reference signal(s)**, as recited in the claims.

In addition, Paragraph [0104] of Nagaraja states:

[0104] Once the one or more reference beams are known to the UE, the UE may receive information regarding one or more event triggers. An event trigger may be used to initiate a mobility event such as a beam switch or inter-cell handover. According to aspects of the present disclosure, an event trigger may be based on relative changes within in a set of measurements associated with the reference beams. The information regarding event triggers may indicate which beam or set of beams should be used with respect to a specific event trigger. Stated otherwise, the event trigger information may indicate which beams are to be measured in an effort to detect an event trigger. Thus, certain reference beams may be associated with certain event triggers.

See Nagaraja, Paragraph [0104].

According to Paragraph [0104] of Nagaraja, the BS signals to a UE one or more reference beam (IDs). Once the UE knows the one or more reference beam (IDs), the UE then receives information regarding one or more event triggers via one or more reference beams.

In contrast, as recited in the claims, the UE receives the control signal and knows how many symbols are used to carry the reference signal for beam measurement by indication of the control signal. Then, the UE receives the reference signal for beam measurement.

Furthermore, Paragraph [0101] of Nagaraja states:

[0101] The reference beams may be based on a beam identification. A BS may indicate or configure a UE with one or more beam IDs which may be used as reference beams by the UE. The beams may be in synchronization subframe,

such as, for example, in a primary synchronization signal (PSS)/secondary synchronization signal (SSS)/reference signal (RS). The one or more reference beams may be part of or transmitted in a synchronization subframe. For example, the reference beams may be part of the PSS, SSS, and/or RS.

See Nagaraja, Paragraph [0101].

In other words, Paragraph [0101] of Nagaraja teaches that the beams are in sync subframes and Paragraph [0073] of Nagaraja only teaches that the processor generates reference symbols. However, Nagaraja fails to disclose the control signal indicates how many symbols are used to carry the reference signal for beam measurement.

In addition, as Nagaraja disclosed, event trigger is defined as changes within measurements associated with reference beams according to Paragraphs [0088], [0090], and [0104] of Nagaraja (i.e. when the condition of the event is met, the event will be triggered by the UE -- e.g. if the RSRP associated with a neighbor cell becoming stronger than the RSRP associated with the serving cell, an Event A3 will be triggered according to [0089]). Therefore, the information regarding one or more reference beams in Nagaraja does not trigger aperiodical transmission of the reference signal. In contrast, as recited in the claims, beam-related information for transmitting the reference signal is transmitted on a control signal used to trigger aperiodical transmission of the reference signal.

For the reasons stated above, Applicants respectfully submit that claims 1-3, 5, 7-13, 15-17, and 19 are patentable over Nagaraja.

III. Conclusion

In view of the foregoing it is respectfully submitted that the pending claims are in condition for allowance. Reconsideration of the rejections is requested. Allowance of the claims at an early date is solicited. The Examiner is invited to contact Applicant's undersigned counsel by telephone at (714) 839-3800 to expedite the prosecution of this case should there be any unresolved matters remaining.

Docket No. 1426-188.101 (1060022-US)
Appl. No. 15/863,267
Amdt. Dated August 14, 2018
Reply to Office Action of May 22, 2018

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Respectfully submitted,
Sang N. Dang
BLUE CAPITAL LAW FIRM, P.C.

Dated: August 14, 2018

/Sang N. Dang/
Reg. No. 51,186
Tel.: (714) 839-3800

IN THE CLAIMS:

1. (Currently Amended) A method of a base station, comprising:
the base station transmits to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal triggers aperiodical transmission of the reference signal for beam measurement, and wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement and indicates how many symbols are used to carry the reference signal for beam measurement; and
the base station transmits the reference signal for beam measurement to the UE.
2. (Original) The method of claim 1, wherein the beam-related information indicates at least a beam on which the reference signal for beam measurement is transmitted.
3. (Currently Amended) The method of claim 1, wherein the beam-related information indicates a first beam, and wherein the reference signal for beam measurement is transmitted on at least a refined beam of the first beam.
4. (Canceled)
5. (Original) The method of claim 1, wherein the control signal is transmitted via a control channel.
6. (Canceled)
7. (Currently Amended) A method of a User Equipment (UE), comprising:
the UE receives from a base station a control signal associated with a reference signal for beam measurement, wherein the control signal includes beam-related information for transmitting the reference signal for beam measurement and indicates how many symbols are used to carry the reference signal for beam measurement; and
the UE measures the reference signal for beam measurement from the base station.
8. (Original) The method of claim 7, wherein the beam-related information indicates

at least a beam on which the reference signal for beam measurement is transmitted.

9. (Currently Amended) The method of claim 7, wherein the beam-related information indicates a first beam, and wherein the reference signal for beam measurement is transmitted on at least a refined beam of the first beam.

10. (Original) The method of claim 7, wherein the UE performs measurement on the reference signal for beam measurement with UE beam(s) associated with the at least a beam indicated by the beam-related information.

11. (Original) The method of claim 7, wherein beam refinement for the UE is performed for the at least a beam indicated by the beam-related information.

12. (Original) The method of claim 7, wherein the reference signal for beam measurement is transmitted aperiodically.

13. (Original) The method of claim 7, wherein the control signal is transmitted via a control channel.

14. (Canceled)

15. (Currently Amended) A base station, comprising:
a control circuit;
a processor installed in the control circuit; and
a memory installed in the control circuit and operatively coupled to the processor;
wherein the processor is configured to execute a program code stored in the memory to:
transmit to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal triggers aperiodical transmission of the reference signal for beam measurement, and wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement and indicates how many symbols are used to carry the reference signal for beam measurement; and
transmit the reference signal for beam measurement to the UE.

16. (Original) The base station of claim 15, wherein the beam-related information indicates at least a beam on which the reference signal for beam measurement is transmitted.

17. (Currently Amended) The base station of claim 15, wherein the beam-related information indicates a first beam, and wherein the reference signal for beam measurement is transmitted on at least a refined beam of the first beam.

18. (Canceled)

19. (Original) The base station of claim 15, wherein the control signal is transmitted via a control channel.

20. (Canceled)



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
15/863,267	01/05/2018	Ko-Chiang Lin	1426-188.101

CONFIRMATION NO. 5504

PUBLICATION NOTICE



OC000000100930653

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

Title:METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

Publication No.US-2018-0198583-A1

Publication Date:07/12/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <https://portal.uspto.gov/pair/PublicPair>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Information Disclosure Statement Transmittal

Docket Number

1426-188.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

In Re Application Of:

Ko-Chiang Lin

Application No.	15/863,267
Filing Date	January 5, 2018
Examiner	Min Jung
Art Unit	2472

Title of Invention

METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

BASIS FOR FILING (Select 1, 2 or 3 below.)

37 CFR 1.97(b)

- 1) ☐ The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53 (d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.

37 CFR 1.97(c)

- 2) ☒ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:

- a) ☒ the statement specified in 37 CFR 1.97(e);

OR

- b) ☐ the fee set forth in 37 CFR 1.17(p).

37 CFR 1.97(d)

- 3) ☐ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(c), and on or before payment of the issue fee, and is accompanied by the Statement as specified in 37 CFR 1.97(e) and the fee set forth in 37 CFR 1.17(p).

Information Disclosure Statement Transmittal

Docket Number

1426-188.101

STATEMENT UNDER 37 CFR 1.97(e) ACCOMPANYING INFORMATION DISCLOSURE STATEMENT

The Information Disclosure Statement submitted herewith is submitted under one of the following conditions, which satisfies the requirement under 37 CFR 1.97(e). (Select 4 or 5 below if applicable.)

- 4) ☒ 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; or
- 5) ☐ 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.

Remarks (Enter Remarks Below or Attach Document Containing Remarks)

Fee set forth in 37 CFR 1.17(p):

- ☒ No additional fee is required.
- ☐ A check in the amount of _____ is attached.
- ☐ The Director is hereby authorized to charge and credit Deposit Account No. _____ as described below.
- ☐ Charge the amount of _____
- ☐ Credit any overpayment.
- ☐ Charge any additional fee required.
- ☐ Payment by credit card. Form PTO-2038 is attached.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Information Disclosure Statement Transmittal

Docket Number

1426-188.101

Correspondence Address

Customer Number 106622

-OR-

Name

Address

City

State

Country

Postal Code

Phone Number

E-mail Address

Certificate of Mailing by Express Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Transmittal Letter, accompanying documents and fee authorization (if appropriate) is being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission)

(Name of Person Transmitting Correspondence)

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Transmittal Letter from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box

Sang N. Dang

Name

Sang N. Dang

Registration Number

51,186

Signatory Capacity

Attorney for Applicant(s)

E-mail Address

sdang@bluecapitallaw.com

eSign

/Sang N. Dang/

Date Signed

05-29-2018

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15863267
	Filing Date		2018-01-05
	First Named Inventor	LIN, KO-CHIANG	
	Art Unit	2472	
	Examiner Name	Min Jung	
	Attorney Docket Number	1426-188.101	

U.S.PATENTS						
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.

U.S.PATENT APPLICATION PUBLICATIONS						
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					

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

FOREIGN PATENT DOCUMENTS								
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	2015080648	WO		2015-06-04	Mattias FRENNE		☐

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

NON-PATENT LITERATURE DOCUMENTS			
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

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15863267
Filing Date	2018-01-05
First Named Inventor	LIN, KO-CHIANG
Art Unit	2472
Examiner Name	Min Jung
Attorney Docket Number	1426-188.101

1	SAMSUNG: "Discussion on DL beam management procedures P-2 and P-3", 3GPP DRAFT; R1-1612509, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Reno, USA; 20161114 - 20161118 13 November 2016 (2016-11-13), XP051176456, Retrieved from the Internet: URL: http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN/Docs/	☐
2	INTEL CORPORATION: "Reference Signal and Procedure for UE Beam Refinement (BMP-3)11, 3GPP DRAFT; R1-1609514 REFERENCE SIGNAL AND PROCEDURE FOR UE BEAM REFINEMENT R1, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLI,vol. RAN WG1, no. Lisbon, Portugal; 20161010 - 20161014 9 October 2016 (2016-10-09), XP051149553, Retrieved from the Internet:	☐
3	European Search Report from corresponding EP Application No. 18150416.8, dated May 22, 2018.	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Ko-Chiang Lin and Richard Lee-Chee Kuo
Title: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A
WIRELESS COMMUNICATION SYSTEM
Serial No.: 15/863,267 Filed: January 5, 2018
Examiner: Min Jung Group Art Unit: 2472
Attorney Docket No.: 1426-188.101 (1060022-US)

**CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8**

I hereby certify that the enclosed 3 Page Information Disclosure Statement Transmittal;
2 Page Information Disclosure by Applicant with 4 references are being transmitted to the
United States Patent and Trademark Office via EFS-Web on May 29, 2018.

Date: May 29, 2018 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995



- (51) International Patent Classification:
H04L 5/00 (2006.01) *H04B 7/02* (2006.01)
- (21) International Application Number:
PCT/SE2014/051152
- (22) International Filing Date:
6 October 2014 (06.10.2014)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/909,637 27 November 2013 (27.11.2013) US
- (71) Applicant: TELEFONAKTIEBOLAGET L M ERICSSON (PUBL) [SE/SE]; SE-164 83 Stockholm (SE).
- (72) Inventors: FRENNE, Mattias; Arkeologvägen 20, SE-754 43 Uppsala (SE). FURUSKOG, Johan; Igeldammsgatan 28, SE-112 49 Stockholm (SE). GÖRANSSON, Bo; Silverdalsvägen 67, SE-191 38 Sollentuna (SE).
- (74) Agent: BOU FAICAL, Roger; Ericsson AB, Patent Unit Kista RAN1, SE-164 80 Stockholm (SE).

- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: METHODS FOR RECEIVING AND SENDING A REPORT COMPRISING CHANNEL STATE INFORMATION

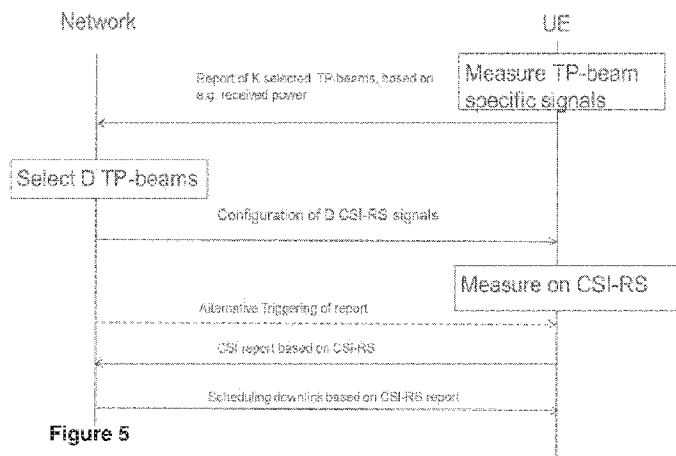


Figure 5

(57) Abstract: Embodiments herein relate to a network node and method performed by a network node (211, 230) for controlling one or more Transmission Points (TPs) which transmit TP beams. The network node selects a set of TP beams based on at least one of: one or more measurements by the wireless device on first beam-specific reference signals of the TP beams and a measured transmission from the wireless device. Each beam in a TP uses one unique signal. The network node configures the wireless device (250) with a set of second beam-specific reference signals. Each second beam-specific signal is associated with a selected TP beam. The node receives a report from the wireless device, comprising channel state information for at least a subset of the selected set of TP beams, measured on the set of second beam-specific signals which are mutually orthogonal. The embodiments also relate to a wireless device (250) and a method therein.

METHODS FOR RECEIVING AND SENDING A REPORT COMPRISING CHANNEL STATE INFORMATION

5 TECHNICAL FIELD

The present disclosure relates generally to a network node and a method therein for receiving a report, comprising channel state information, from a wireless device, the wireless device and a method therein for sending the report to the network node.

BACKGROUND

10 Communication devices such as terminals are also known as e.g. User Equipments (UE), wireless devices, mobile terminals, wireless terminals and/or mobile stations. Terminals are enabled to communicate wirelessly in a cellular communications network or wireless communication system, sometimes also referred to as a cellular radio system or cellular networks. The communication may be performed e.g. between two terminals,
15 between a terminal and a regular telephone and/or between a terminal and a server via a Radio Access Network (RAN) and possibly one or more core networks, comprised within the cellular communications network.

Terminals may further be referred to as mobile telephones, cellular telephones, laptops, or surf plates with wireless capability, just to mention some further examples. The
20 terminals in the present context may be, for example, portable, pocket-storable, hand-held, computer-comprised, or vehicle-mounted mobile devices, enabled to communicate voice and/or data, via the RAN, with another entity, such as another terminal or a server.

The cellular communications network covers a geographical area which is divided into cell areas, wherein each cell area being served by an access node such as a base
25 station, e.g. a Radio Base Station (RBS), which sometimes may be referred to as e.g. "eNB", "eNodeB", "NodeB", "B node", or BTS (Base Transceiver Station), depending on the technology and terminology used. The base stations may be of different classes such as e.g. macro eNodeB, home eNodeB or pico base station, based on transmission power and thereby also cell size. A cell is the geographical area where radio coverage is
30 provided by the base station at a base station site. One base station, situated on the base station site, may serve one or several cells. Further, each base station may support one or several communication technologies. The base stations communicate over the air interface operating on radio frequencies with the terminals within range of the base

stations. In the context of this disclosure, the expression Downlink (DL) is used for the transmission path from the base station to the mobile station. The expression Uplink (UL) is used for the transmission path in the opposite direction i.e. from the mobile station to the base station.

5 In 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE), base stations, which may be referred to as eNodeBs or even eNBs, may be directly connected to one or more core networks.

3GPP LTE radio access standard has been written in order to support high bitrates and low latency both for uplink and downlink traffic. All data transmission is in LTE
10 controlled by the radio base station.

The development of the 5th Generation (5G) access technology and air interface is still very premature but there have been some early publications on potential technology candidates. A candidate on a 5G air interface is to scale the current LTE, which is limited to 20 Mega Hertz (MHz) bandwidth, N times in bandwidth with 1/N times shorter time
15 duration, here abbreviated as LTE-Nx. A typical value may be N=5 so that the carrier has 100 MHz bandwidth and 0.1 millisecond slot lengths. With this approach, many functions in LTE can remain the same, which would simplify the standardization effort and allow for a reuse of technology components.

The carrier frequency for an anticipated 5G system could be much higher than
20 current 3G and 4th Generation (4G) systems, values in the range 10-80 Giga Hertz (GHz) have been discussed. At these high frequencies, an array antenna, or antenna array, must be used to achieve coverage through beamforming gain. Since the wavelength is less than 3 centimeters (cm), an array antenna with a large number of antenna elements may be fit into an antenna enclosure with a size comparable to 3G and 4G base station
25 antennas of today. To achieve a reasonable link budget, a typical example of a total array antenna size is comparable to an A4 sheet of paper.

To provide a sufficient link budget, the beams are typically highly directive and give beamforming gains of 20 decibels (dB) or more since so many antenna elements participate in forming a beam. This means that each beam is relatively narrow in angle, a
30 Half Power Beam Width (HPBW) of 5 degrees is not uncommon. Hence, a sector of a cell may need to be covered with a large number of potential beams. Beamforming may be seen as when a signal is transmitted in such as narrow HPBW, that it is intended for a single wireless device or a group of wireless devices in a similar geographical position. This may be seen in contrast to other beam shaping techniques, such as cell shaping,
35 where the coverage of a cell is dynamically adjusted to follow the geographical positions

of a group of users in the cell. Although beamforming and cell shaping use similar techniques, transmitting a signal over multiple antenna elements and applying individual complex weights to these antenna elements, the notion of beamforming and beams in embodiments herein relates to the narrow HPBW basically intended for a single wireless device or terminal position.

Here, a system with multiple transmission nodes is considered, where each node has an array antenna capable of generating many beams with small HPBW. These nodes may then for instance use one or multiple LTE-Nx carriers, so that a total transmission bandwidth of multiples of hundreds of MHz may be achieved leading to downlink peak user throughputs reaching as much as 10 Gbit/s or more.

In LTE, a wireless device searches for a cell using a cell search procedure, where a unique Primary Synchronization Signal (PSS) and Secondary Synchronization Signal (SSS) are transmitted from each eNB. When a cell has been found, the wireless device may be associated with this cell, and then the cell is known as the serving cell for this wireless device. When a cell has multiple antennas, each antenna may transmit an individual encoded message to the wireless device, thereby multiplying the capacity by the number of layers transmitted. This is well known as MIMO transmissions, and the number of layers transmitted is known as the rank of the transmission. Beamforming, which traditionally is equivalent to a rank 1 transmission, where only one encoded message may be transmitted, but simultaneously from all antennas with individually set complex beamforming weights per antenna. Hence, in beamforming, only a single layer of a Physical Downlink Shared CHannel (PDSCH) is transmitted in a single beam. This beamforming transmission is also possible in LTE, so after a wireless device has been associated with a cell, a set of $N=1,2,4$ or 8 Channel State Information Reference Signals (CSI-RS) may be configured for measurement reference at the wireless device, so that the wireless device may report a preferred rank 1 $N \times 1$ precoding vector containing the complex beamforming weights based on the CSI-RS measurement. The precoding vector is selected from a codebook of rank 1 precoding vectors.

Figure 1 depicts a 5G system example with three Transmission Points (TPs), Transmission Point 1 (TP1), Transmission Point 2 (TP2), Transmission Point 3 (TP3) and a wireless device. Each TP utilizes beamforming for transmission.

The current beamforming usage today does not result in a desired gain of the performance of the wireless communications network.

SUMMARY

It is an object of embodiments herein to improve the performance in a wireless communications network using beamforming for transmitting to a wireless device.

5 According to a first aspect of embodiments herein, the object is achieved by a method performed by a network node for receiving a report from a wireless device, the network node controlling one or more Transmission Points, TPs and the one or more TPs transmitting TP beams, the method comprising: selecting a set of TP beams from the TP beams, wherein the selecting is based on at least one of: one or more measurements by
10 the wireless device on first beam-specific reference signals of the TP beams, and a measured transmission from the wireless device by the one or more TPs, wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP out of the one or more TPs uses one unique signal from a set of sequences used in this TP. The method further comprising: configuring the wireless device with a set of second
15 beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, and wherein each second beam-specific reference signal is associated with a selected TP beam of the set of TP beams, and receiving the report from the wireless device, the report comprising channel state information for at least a subset of the selected set of TP beams, measured on the
20 configured set of second beam-specific reference signals; wherein the second beam-specific reference signals are mutually orthogonal.

 According to a second aspect of embodiments herein, the object is achieved by a method performed by a wireless device for sending a report to a network node, the
25 network node controlling one or more Transmission Points, TPs, the one or more TPs transmitting TP beams, wherein each of TP beams has a first beam-specific reference signal, the method comprising: receiving a configuration from the network node with a set of second beam-specific reference signals being beam-specific downlink reference signals, wherein each second beam-specific reference signal is associated with one of a
30 selected set of TP beams, selected by the network node based on at least one or more measurements by the wireless device on the first beam-specific reference signals of the TP beams. The method further comprising: performing one or more measurements on the set of second beam-specific reference signals, wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP out of the one or more
35 TPs uses one unique signal from a set of sequences used in this TP, and sending a report

to the network node, the report comprising channel state information for at least a subset of the set of selected TP beams, measured on the configured set of second beam-specific reference signals; wherein the second beam-specific reference signals are mutually orthogonal.

5

According to a third aspect of embodiments herein, the object is achieved by the network node. The network node is configured to receive a report from a wireless device. The network node being configured to control one or more Transmission Points, TPs, and the one or more TPs being configured to transmit TP beams, the network node being further configured to: select a set of TP beams from the TP beams, wherein to select is based on at least one of: one or more measurements by the wireless device on first beam-specific reference signals of the TP beams, and a transmission from the wireless device configured to be measured by the one or more TPs, wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP out of the one or more TPs, uses one unique signal from a set of sequences used in this TP. The network node is further configured to configure the wireless device with the set of second beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, and wherein each second beam-specific reference signal is associated with a selected TP beam, and to receive the report from the wireless device, the report comprising channel state information for at least a subset of the selected set of TP beams, measured on the configured set of second beam-specific reference signals; wherein the second beam-specific reference signals are mutually orthogonal.

According to a fourth aspect of embodiments herein, the object is achieved by the wireless device. The wireless device is configured to send the report to the network node. The network node is configured to control the one or more TPs. The one or more TPs are configured to transmit the TP beams. Each of the TP beams has a first beam-specific reference signal. The wireless device is configured to receive the configuration from the network node with the set of second beam-specific reference signals. The set of second beam-specific reference signals are beam-specific downlink reference signals. Each of the second beam-specific reference signals is associated with one of the selected set of TP beams. The selected set of TP beams are selected by the network node based on the at least one of: a) the one or more measurements by the wireless device on first beam-specific reference signals of the TP beams, and b) the transmission from the wireless

device configured to be measured by the one or more TPs. The configuration is for the wireless device to perform one or more measurements on the set of second beam-specific reference signals. The first beam-specific reference signals of the TP beams are defined so that each beam in a TP out of the one or more TPs, uses one unique signal from the set of sequences used in this TP. The wireless device is further configured to send a report to the network node. The report comprises channel state information for at least the subset of the set of selected TP beams, configured to be measured on the configured set of second beam-specific reference signals, wherein the second beam-specific reference signals are mutually orthogonal.

By the network node selecting the set of TP beams, based on the one or more measurements by the wireless device, and configuring the wireless device with the set of second beam-specific reference signals which are mutually orthogonal, the wireless device may report channel state information for at least a subset of the selected set of TP beams. Thus, an advantage of embodiments herein is that the overhead for quality estimates may be reduced. Moreover, the wireless device may quickly switch to from one TP beam to another TP beam, which improves mobility and gives diversity for both data and control signalling.

Further advantages of some embodiments disclosed herein are discussed below.

BRIEF DESCRIPTION OF THE DRAWINGS

Examples of embodiments herein are described in more detail with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram illustrating a 5G system example with three TPs.

Figure 2 is a schematic block diagram illustrating embodiments in a wireless communications network, according to some embodiments.

Figure 3 is a flowchart illustrating embodiments of a method in a network node, according to some embodiments.

Figure 4 is a flowchart illustrating embodiments of a method in a wireless device, according to some embodiments.

Figure 5 is a schematic diagram illustrating embodiments of a method in a wireless communications network, according to some embodiments.

Figure 6 is a schematic diagram illustrating embodiments of a method in a wireless communications network, according to some embodiments.

Figure 7 is a block diagram of a network node that is configured according to some embodiments.

Figure 8 is a block diagram of a wireless device that is configured according to some

5

DETAILED DESCRIPTION

As part of the solution according to embodiments herein, one or more problems that may be associated with use of at least some of the prior art solutions, and that may be addressed by embodiments herein will first be identified and discussed.

10 Since the beams in beamforming are narrow, to provide high beamforming gain and coverage for the transmitted signals, there is a mobility problem and the transmission point may quickly lose track of the wireless device, i.e., there is a sudden large drop of link gain when the wireless device is moving outside the narrow beam coverage area.

It may also be a problem how to select transmission points and beams within each
15 transmission point in a dynamic manner, without the need to frequently change the serving transmission point.

It may be further a problem how to provide coverage and robust reception of synchronization signals and reference signals needed to ensure mobility in the 5G network.

20 These problems are further discussed below.

At high (>10 GHz) carrier frequencies such as those projected to be used in 5G systems, the number of antenna elements at the transmitter and/or receiver side are significantly increased compared to common 3G and 4G systems, which typically operate at frequencies below 3 GHz, so that the increased path loss may be compensated for by
25 beamforming. If these beams are narrow, many beams are needed to span the coverage area. It may then be a problem how to find cells, i.e., to perform cell search, and how to find the suitable beam or beams within a detected cell. It may also be a problem how to find multiple cells and the corresponding suitable beams within each cell.

30 A set of TPs may be considered wherein each TP may, by use of an array antenna, generate transmission of a large number of beams having different pointing direction and/or polarization. The use of a large number of beams may be typical for a 5G system deployed at carrier frequencies above 10 GHz, where the array antenna may consist of many antenna elements to achieve a large array gain. An array antenna consisting of

multiple antenna elements may be used to compensate for the reduced aperture size of each element, which is a function of the carrier frequency, compared to systems operating at traditional cellular carrier frequencies. Moreover, the large antenna gain may be in turn needed to overcome the path loss at these high frequencies. The large array gain may
5 result in that each beam is rather narrow, expressed in terms of HPBW, typically only 5-10 degrees or even smaller, depending on the design of the array antenna.

Since the large array gain may be needed also for unicast control channels, these may need to be beamformed as well. Due to wireless device mobility, channel propagation, and to the fact that beams are narrow, a wireless device which is reached by
10 a given beam may suddenly be outside the main lobe of that beam, resulting in a significant drop in received signal strength from that beam. This may even lead to radio link failure since the control channel cannot be received as well.

Hence, there is a problem on how a wireless device selects cells, TPs within a cell, and beams within a cell, to maintain connection in a robust manner. Note that a cell in this
15 respect may contain multiple TPs, known as a shared cell. The shared cell reduces the need for frequent cell handovers which involves higher layer signaling and reconfigurations since a wireless device may seamlessly move its access to different TPs within the same cell.

Furthermore, it may be beneficial if the TP and beam selection is blind, and it may
20 hence be performed without an active connection to the cell, that is, without extensive control signaling between the wireless device and the cell for which beam the wireless device finds useful.

Embodiments will now be described more fully hereinafter with reference to the
25 accompanying drawings, in which examples of the claimed subject matter are shown. The claimed subject matter may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the claimed subject matter to those skilled in the art. It should
30 also be noted that these embodiments are not mutually exclusive. Components from one embodiment may be tacitly assumed to be present/used in another embodiment.

Figure 2 depicts a **wireless communications network 200** in which embodiments herein may be implemented. The wireless communications network 200 may for example

be a network such as a Long-Term Evolution (LTE), e.g. LTE Frequency Division Duplex (FDD), LTE Time Division Duplex (TDD), LTE Half-Duplex Frequency Division Duplex (HD-FDD), LTE operating in an unlicensed band, Wideband Code Division Multiple Access (WCDMA), Universal Terrestrial Radio Access (UTRA) TDD, Global System for
5 Mobile communications (GSM) network, GSM/Enhanced Data Rate for GSM Evolution (EDGE) Radio Access Network (GERAN) network, EDGE network, network comprising of any combination of Radio Access Technologies (RATs) such as e.g. Multi-Standard Radio (MSR) base stations, multi-RAT base stations etc., any 3rd Generation Partnership Project (3GPP) cellular network, WiFi networks, Worldwide Interoperability for Microwave
10 Access (WiMax), 5G system or any cellular network or system.

The wireless communications network 200 comprises a **first transmission point 211**, a **second transmission point 212** and a **third transmission point 213**. Any one or more of the first transmission point 211, the second transmission point 212 and the third
15 transmission point 213 may be referred to herein as the one or more TPs 211, 212, 213. Each of the first transmission point 211, the second transmission point 212 and the third transmission point 213 transmits TP beams. Each of the first transmission point 211, the second transmission point 212 and the third transmission point 213 may be, for example, a base station such as e.g., an eNB, an eNodeB, or a Home Node B, a Home eNode B, a
20 femto Base Station, BS, a pico BS or any other network unit capable to serve a device or a machine type communication device in the wireless communications network 200. In some particular embodiments, the first transmission point 211, the second transmission point 212 and the third transmission point 213 may be a stationary or fixed relay node or a mobile relay node. The wireless communications network 200 covers a geographical area
25 which is divided into cell areas, wherein each cell area is served by a TP, although one TP may serve one or several cells, and one cell may be served by more than one TP. In the non-limiting example depicted in Figure 2, the first transmission point 211 and the third transmission point 213 serve a **first cell 221**, and the second transmission point 212 serves a **second cell 222**. The first cell 221, may be referred to in some embodiments
30 herein as "a cell 221", "one cell 221" or "the cell 221". The first cell 221 and the second cell 222 may be referred to in some embodiments herein as "different cells 221, 222". Each of the first transmission point 211, the second transmission point 212 and the third transmission point 213 may be of different classes, such as e.g. macro eNodeB, home eNodeB or pico base station, based on transmission power and thereby also cell size.
35 Typically, the wireless communications network 200 may comprise more cells similar to

the first cell 221 and the second cell 222, served by their respective one or more TPs. This is not depicted in Figure 2 for the sake of simplicity. Each of the first transmission point 211, the second transmission point 212 and the third transmission point 213 may support one or several communication technologies, and its name may depend on the technology and terminology used. In 3GPP LTE, the first transmission point 211, the second transmission point 212 and the third transmission point 213, which may be referred to as eNodeBs or even eNBs, and may be directly connected to a **scheduling network node 230**. The scheduling network node 230 may be a logical function performing scheduling of wireless devices in the wireless communications network 200 that are within the coverage of a group of coordinated TPs. The physical location of the scheduling network node 230 may be in one of the first transmission point 211, the second transmission point 212 and the third transmission point 213, or in a dedicated scheduling node, as depicted in Figure 2. In some embodiments, any one or more of the first transmission point 211, the second transmission point 212 and the third transmission point 213 may be realized as a Remote Radio Head (RRH) connected to a central node housing the scheduling function, i.e., the scheduling network node 230.

The first transmission point 211 may communicate with the scheduling network node 230 over a **first link 241**. The second transmission point 212 may communicate with the scheduling network node 230 over a **second link 242**. The third transmission point 213 may communicate with the scheduling network node 230 over a **third link 243**.

Any of the first transmission point 211 and the scheduling network node 230 may be referred to herein as a **network node 211, 230**. The network node 211, 230 controls one or more TPs, such as any of the first transmission point 211, the second transmission point 212 and the third transmission point 213.

The first transmission point 211 may communicate with the second transmission point 212 over a **first radio link 244**. The first transmission point 211 may communicate with the third transmission point 213 over a **second radio link 245**.

A number of wireless devices may be located in the wireless communications network 200. In the example scenario of Figure 2, only one wireless device is shown, **wireless device 250**. The wireless device 250 may communicate with the first transmission point 211 over a **third radio link 261**, with the second transmission point 212 over a **fourth radio link 262**, and with the third transmission point 213 over a **fifth radio link 263**.

The wireless device 250 is a wireless communication device such as a UE which is also known as e.g. mobile terminal, wireless terminal and/or mobile station. The device is wireless, i.e., it is enabled to communicate wirelessly in the wireless communication network 200, sometimes also referred to as a cellular radio system or cellular network.

- 5 The communication may be performed e.g., between two devices, between a device and a regular telephone and/or between a device and a server. The communication may be performed e.g., via a RAN and possibly one or more core networks, comprised within the wireless communications network 200.

- 10 The wireless device 250 may further be referred to as a mobile telephone, cellular telephone, or laptop with wireless capability, just to mention some further examples. The wireless device 250 in the present context may be, for example, portable, pocket-storable, hand-held, computer-comprised, or vehicle-mounted mobile devices, enabled to communicate voice and/or data, via the RAN, with another entity, such as a server, a
15 laptop, a Personal Digital Assistant (PDA), or a tablet computer, sometimes referred to as a surf plate with wireless capability, a Machine-to-Machine (M2M) device, a device equipped with a wireless interface, such as a printer or a file storage device or any other radio network unit capable of communicating over a radio link in a cellular communications system. Further examples of different wireless devices, such as the
20 wireless device 250, that may be served by such a system include, modems, or Machine Type Communication (MTC) devices such as sensors.

- In embodiments herein, it is first proposed to introduce one or more TP beam-specific reference signals. These one or more TP beam-specific reference signals may
25 be referred to in some embodiments herein as a first beam-specific reference signal/s of the TP beams, so that the wireless device 250, may detect and/or measure on a beam from any TP, such as the first transmission point 211, the second transmission point 212 and the third transmission point 213, in any cell, such as the first cell 221, and the second cell 222, in a neighborhood of the wireless device 250. The TP beam-specific reference
30 signal, such as the first beam-specific reference signals of the TP beams, from a TP, may be detectable blindly, i.e., without the need to actively communicate with the cell, i.e., without receiving configuration information of the TP beam-specific reference signals, from for example, the network node 211, 230. The signal may hence either be blindly detected as part of the initial cell search, or alternatively, the detection may be aided by

previously obtained information, such as broadcasted system information on the 5G carrier or control messages sent on an assisting legacy cellular system, such as LTE.

Furthermore, these reference signals, i.e., first beam-specific reference signals of the TP beams, may alternatively also be detected based on time domain detection, so that
5 the wireless device 250 may not need to perform accurate time frequency synchronization and carry out the Discrete Fourier Transform (DFT), i.e. transfer to frequency domain, before the wireless device 250 may detect the TP-beam. The wireless device 250 may choose to implement time domain based beam detection, with the benefit of reduced number of mathematical operations, which may reduce battery consumption. This also
10 has the advantage that the LTE cell search algorithms in the wireless device 250 may be reused for TP beam detection. The wireless device 250 may then be implemented to perform time domain search of beams by correlation of the received signal with a set of TP beam specific signals. This time domain processing may be performed in parallel with normal receiver operation, which includes a DFT and is performed in frequency domain.
15 Hence, the TP beam search may be implemented by a separate processing, which allows the wireless device 250 to perform continuous TP beam searches without interrupting normal receiver operation. Based on the detection of the first beam-specific reference signals, the wireless device 250 may determine how to address the network node 211, 230 in the best way by selecting the best set of UL transmit antenna/s or beams to use
20 when transmitting an UL message intended for the network node 211, 230. Such an UL message may be anything transmitted in the UL, e.g., a random access preamble, a scheduling request or an UL data transmission.

25 In general, embodiments herein may comprise a reporting procedure comprising two steps. Some embodiments may comprise a first step of a reporting procedure.

In a first step of these embodiments, the wireless device 250 may search for TP beams, using a procedure similar to LTE cell search. The wireless device 250 may then report detected TP beams, possibly accompanied with a received power report or other
30 ranking of each detected TP beam or a selection of the detected TP beams. Selection may be carried out using a threshold value, e.g., configured by higher layers or fixed in specifications, or it may simply report all detected TP beams up to a specific maximum number of reports or a specific maximum number of beams.

In one embodiment, a large number of TP beam reference signals or equivalently
35 beam-specific sequences, such as the first beam-specific reference signals of the TP

beams, are defined so that each beam in a TP, such as the first transmission point 211 and the third transmission point 213 in a given cell, such as the first cell 221, uses one unique signal from a set of sequences used in this cell. The reference signals, such as the first beam-specific reference signals of the TP beams, are grouped, and the grouping of sequences may be known to the wireless device 250 so the wireless device 250 may know whether two detected beams belong to the same TP or not, or alternatively to the same cluster of TPs or not. In a further embodiment, this may be utilized by the network node 211, 230, by configuring, using higher layer signaling, the wireless device 250 to restrict the reporting of detected beams to measurements on TP beams from a single TP only, of, for example, the first transmission point 211, the second transmission point 212 and the third transmission point 213, or alternatively, only TPs within the same cluster of TPs. Which TP, of, for example, the first transmission point 211, the second transmission point 212 and the third transmission point 213, or cluster may also be configured by higher layers. One advantage of such restriction may be the case where a backhaul between different TPs, or clusters of TPs have a restriction in latency and/or bandwidth, so that fast switching between different TPs is not feasible, while switching between beams within the same TP is still feasible. The network node 211, 230 may perform the configuration by signalling messages on an assisting legacy cellular system. In yet another embodiment, system information already obtained by the wireless device 250 on the 5G carrier dictates if the wireless device 250 should report measurements on a single or a multiple of reference signal groups.

In an alternative embodiment, a large number of reference signals, such as the first beam-specific reference signals of the TP beams, or equivalently beam-specific sequences are defined, so that each beam in a TP in a given cell, uses one unique signal from a set of sequences used in this cell. The reference signals, are grouped into groups where reference signals within one group are used within one cell only, and the grouping of sequences may be known to the wireless device 250 so the wireless device 250 may know whether two detected TP beams belong to the same cell or not. When the wireless device 250 is not connected to a cell, e.g. in Radio Resource Configuration (RRC)_IDLE mode, the wireless device 250 may identify the cell identity by detecting a TP beam belonging to that cell. This cell identity may then be used in the following procedures to attach to the cell.

The reported TP beams associated to multiple cells, may also be used by the network node 211, 230 to make mobility decisions, i.e., to move a wireless device such as wireless device 250 between cells, by sending a hand-over command.

5 In another embodiment, the PSS/SSS used in LTE, or scaled versions thereof in case of LTE-Nx, may be re-used as TP beam sequences, such as the first beam-specific reference signals of the TP beams. These 504 sequences may be further grouped into sets of, e.g., 64 sequences, and this set of sequences may then be restricted to be used within one TP, only, limiting the number of possible beams per TP to 64. Alternatively, the
10 length of PSS/SSS may be extended, to be longer, i.e., use more Resource Elements (RE), than in the current LTE system, so that more than 504 sequences may be supported, for instance by using longer Zadoff-Chu sequences. Using longer sequences and transmitting the TP beam sequences, over a wider bandwidth may increase the processing gain and thus enable detection of weaker beams as well.

15 If a large number, e.g., all 64 in the example above, of PSS/SSS sequences, or equivalently TP-beam detection signals, such as the first beam-specific reference signals of the TP beams, are transmitted in the same Orthogonal Frequency Division Multiplexing (OFDM) symbol from a TP, the energy per PSS/SSS may need to be scaled to keep the
20 total transmit power within bounds. Hence, the transmitted power per sequence may be reduced by $-10 \cdot \log_{10}(64)$ dB, leading to a degradation in beam detection probability. Therefore, in an alternative embodiment, the number of PSS/SSS sequences to be transmitted in parallel in the same OFDM symbol, e.g., by code division multiplexing, may be limited, and if more beams are needed, additional PSS/SSS for the remaining beams
25 may be time multiplexed or frequency multiplexed, for instance, transmitted in another OFDM symbol or on different frequency resources. In this way may the energy per beam detection reference signal may be kept sufficiently high.

30 Some embodiments may comprise a second step of the reporting procedure.

In this second step of some of these embodiments herein, the network node 211, 230 may select a set of TP beams that the wireless device 250 may use for a more refined, second step feedback. This selected set of TP beams may belong to the same TP or a different TP within a cell, or even different TP-beams in different cells. In the latter

case, coordinated transmission between cells, may be achieved, which may provide benefits if the backhaul signaling has low delay and sufficient capacity.

The TP beam selection may be based on the reported TP beams in the first step
5 described above. Alternatively, TP beams may be configured based on uplink
measurement information at the transmission point. This alternative may be feasible
whenever the uplink and downlink hardware chains are well calibrated so that a downlink
beam may be inferred from a corresponding reception in an uplink beam. It may also be
possible that the network node 211, 230 uses a combination of information from uplink
10 beam detection and reports from the wireless device 250 when deciding the set of TP
beams to configure the wireless device 250. Uplink beam detection may require signals to
be transmitted from the wireless device 250 so that the network node 211, 230 may
perform the associated beam detection measurements. Either the network node 211, 230
does this blindly based on uplink data traffic from the wireless device 250; or alternatively,
15 the network node 211, 230 may configure, for example, Sounding Reference Signals
(SRS) to the wireless device 250, so that the network node 211, 230 may measure on
these signals. The SRS transmitted from the wireless device 250 may also be transmitted
in uplink beams, in which case beam specific SRS is transmitted, beam-specific SRS. In
this case, each beam may have a unique beam SRS, based on a certain reference signal
20 sequence, wherein these signals are uplink signals, such as beam-specific uplink
reference signals, or other attributes such as the time frequency location of the beam-
specific SRS. The network node 211, 230 may then get simultaneous information on
which pair of one transmit beam from the wireless device 250 and one receive beam at
the network node 211, 230 side has good channel quality, e.g., high Signal to Noise Ratio
25 (SNR). This may be accomplished by the network node 211, 230 by correlating, for each
receive beam, with the different SRS-beam signals. Knowing which uplink beam to use is
also beneficial when scheduling the uplink data transmission from the wireless device
250, which scheduling information then would include a beam identity detected from
beam-specific SRS. The uplink measurements for beam selection may also be done on
30 the random access preamble transmitted by the wireless device 250 when accessing the
wireless communications network 200, or during hand-over.

The network node 211, 230 may then configure the wireless device 250 with a set of
second beam-specific reference signals, for example, a set of D Channel State
35 Information Reference Signals (CSI-RS), each corresponding to a selected TP beam.

Note that these second beam-specific reference signals, e.g., CSI-RS, may be beamformed so that which beam actually may be selected, i.e., the beam ID if it exists, may be transparent to the wireless device 250. Hence, these D CSI-RS, may be beam-specific reference signals. This may give the further freedom to the network node 211, 230 to use a different beam or beamforming weight vector than what was used in the first step of the reporting procedure of embodiments herein, since the actual beamforming weight vector may be transparent to the wireless device 250.

When the second beam-specific reference signal, e.g., the beam specific CSI-RS, is configured to the wireless device 250, the wireless device 250 then may report channel state information for the set of the e.g., D TP beams, where each beam may be considered as a virtual antenna. This reporting may be different from the reporting in the first step, since the TP beams may be fixed and that the reporting may be intended to follow fast fading and polarization state of the channel. Hence, a unique and orthogonal reference signal may be transmitted in each TP-beam for the purpose of channel state information feedback. This reporting may be different from the reporting in the first step, since the CSI-RS may typically be more often transmitted and typically be with a larger bandwidth, as to provide a more refined measurement.

In one embodiment, the wireless device 250 may be configured to measure a number D of orthogonal reference signals that correspond to the set of second beam-specific reference signals, e.g., CSI-RS, i.e. location and sequence used for the Reference Signals (RSs). Each of the second beam-specific reference signals, e.g., D CSI-RS, may be transmitted from one TP beam in each transmission interval, e.g., each CSI-RS transmission interval. The actual TP beam that may be used in a transmission is unknown to the wireless device 250, which may measure on the configured signal only. The wireless device 250 may produce a measurement report based on the measurements, e.g., D measurements or a subset of the D measurements, i.e. TP beam selection, that is fed back to the network node 211, 230, who may know which transmission interval the report may be based on. In the next transmission interval, the set of TP beams may have changed. The number D and the set of second beam-specific reference signals, e.g., the set of CSI-RS, may remain the same, unless the wireless device 250 is reconfigured. A precoding vector/matrix codebook defined over D virtual antennas may be used for the purpose of this feedback signaling.

In another embodiment, the wireless device 250 may be dynamically scheduled to measure and report on a subset of a larger set of TP beams. The larger set may be the TP beams reported in the first step or explicitly configured with higher layer signaling. The dynamic signaling may be included in the scheduling message to the wireless device 250, for instance when triggering an aperiodic CSI report. For example, the aperiodic CSI triggering as defined in LTE, may be extended to also include information about which TP-beams the wireless device 250 shall provide a report for.

As in the previous embodiment, the wireless device 250 may produce a report that is fed back to the network node 211, 230. In next scheduling assignment or triggering event, another subset may be selected.

In view of the foregoing, embodiments herein may comprise the following:

1. A TP and a given beam transmitted from that TP (TP-beam) may be identified by the wireless device 250, e.g., by a TP beam specific reference signal, such as the first beam-specific reference signal of the TP beams.
2. The TP beam signals may be identifiable without configuration messages to the wireless device 250, i.e., they may be blindly detected.
3. The TP beam signals may also be designed so that the TP beam may be detected based on the received time domain signal.
4. The wireless device 250 may report to the network node 211, 230 a list of measures, one measure for each detected TP beam, where such measure may for instance be the received power.
5. The network node 211, 230 may configure, or dynamically schedule, a set of K TP beams, or CSI reference signals, such as the second beam-specific reference signals, the wireless device 250 may measure on to report, for example, Channel State Information (CSI).

Embodiments of a method performed by the network node 211, 230 for receiving a report from the wireless device 250, will now be described with reference to the flowchart depicted depicted in **Figure 3**. As stated earlier, the network node 211, 230 controls the one or more TPs 211, 212, 213 and the one or more TPs 211, 212, 213 transmit TP beams. The network node 211, 230 and the wireless device 250 operate in the wireless communications network 200, as stated earlier. Figure 3 depicts a flowchart of the actions that are or may be performed by the network node 211, 230 in embodiments herein.

As stated earlier, the network node 211, 230 may be one of: the TP 211 and the scheduling network node 230. Some of the actions below involve receiving, sending or measuring actions. It is understood that in some embodiments wherein the network node 230 may be, for example, a scheduling network node 230 without radio receiver or
5 transmitter capability, the sending, receiving or measuring actions may comprise sending or receiving through an intermediary node, such as one of the one or more TPs 211, 212, 213.

The method may comprise the following actions, which actions may as well be
10 carried out in another suitable order than that described below. In some embodiments, all the actions may be carried out, whereas in other embodiments only some action/s may be carried out. In Figure 3, optional actions are represented with dashed lines.

In some embodiments, any of the first beam-specific reference signals and the
15 second beam-specific reference signals are one of: channel state information reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.

Action 301

20 The network node 211, 230 may receive a prereport from the wireless device 250 of a preset of detected TP beams by the wireless device 250. The preset or pre-set is understood to be equivalent to a first set. Preset is used herein to distinguish this first set from a "set", i.e., a second set, of TP beams, which are selected by the network node 211, 230, as will be described later in Action 304.

25 The prereport may comprise information on the set of detected TP beams by the wireless device 250. The prereport is understood to be equivalent to a first report. In some embodiments, this action may be implemented by receiving a measurement report message from the wireless device 250. In some embodiments, the measurement report may comprise a list of detected TP beams, and to each, for example, an associated
30 Received Reference Signal Power (RSRP).

In some embodiments, the preset of detected TP beams comprised in the received prereport has been selected by the wireless device 250 based on the first beam-specific reference signals of the TP beams, wherein the first beam-specific reference signals are downlink beam-specific reference signals.

In some embodiments, the first beam-specific reference signals are detectable by the wireless device 250 without being in connected mode to the one or more TPs 211, 212, 213 transmitting the TP beams comprising the first beam-specific reference signals.

5 In some embodiments, the first beam-specific reference signals are grouped, wherein the first beam-specific reference signals within one group are used within one cell 221 only.

Action 302

10 As explained earlier, in some embodiments, the wireless device 250 may perform a transmission, which transmission may comprise one or more uplink reference signals.

In some embodiments, the transmission from the wireless device 250 is done in uplink beams.

In some of these embodiments, the uplink reference signals are beam-specific uplink reference signals.

15 In this action, the network node 211, 230 may configure the wireless device 250 with the beam-specific uplink reference signals, so that the network node 211, 230 can measure on these beam-specific uplink reference signals. In some embodiments, this action may be implemented by sending a Radio Resource Configuration (RRC) message, to the wireless device 250.

20 In some embodiments, the uplink reference signals are beam-specific sounding reference signals.

In some particular embodiments, the beam-specific uplink reference signals are beam-specific sounding reference signals.

25 Action 303

The network node 211, 230 may measure the transmission from the wireless device 250.

As stated earlier, in some of these embodiments, the network node 211, 230 may measure the transmission by the wireless device 250 of the uplink reference signals.

30 In some of these embodiments, the network node 211, 230 may measure the transmission by the wireless device 250 of the beam-specific uplink reference signals.

In some embodiments, the measuring is done blindly on received signals, without configuring the beam-specific uplink reference signals, for example, uplink sounding reference signals.

35

Action 304

The network node 211, 230 selects a set of TP beams from the TP beams. The selecting is based on at least one of: a) one or more measurements by the wireless device 250 on the first beam-specific reference signals of the TP beams, and b) a measured transmission from the wireless device 250 by the one or more TPs 211, 212, 213. As stated earlier, the first beam-specific reference signals of the TP beams are defined so that each beam in a TP 211, 212, 213 out of the one or more TPs 211, 212, 213, uses one unique signal from a set of sequences used in this TP 211, 212, 213.

The selecting is performed for the wireless device 250 to perform one or more measurements on the set of second beam-specific reference signals which are mutually orthogonal.

In some embodiments, the selecting of the set of TP beams by the network node 211, 230, based on the first beam-specific reference signals of the TP beams, comprises selecting the set of TP beams at least based on the received prereport from the wireless device 250, as described in action 301.

In some embodiments, the selecting of the set of TP beams by the network node 211, 230, based on the measured transmission from the wireless device 250 is based on one or more measurements on the uplink reference signals, as discussed earlier and in action 303.

In some embodiments, wherein the uplink reference signals are beam-specific uplink reference signals, as described in action 303.

In some embodiments, the selected set of TP beams from the TP beams belong to one of: the same TP 211, 212, 213, different TPs 211, 213 within the cell 221, and different TP beams in different cells 221, 222.

Action 305

The network node 211, 230 configures the wireless device 250 with the set of second beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, and wherein each second beam-specific reference signal is associated with a selected TP beam of the set of TP beams.

In some embodiments, this action may be implemented by sending an RRC message, to the wireless device 250.

In some embodiments, the network node 211, 230 configures the wireless device 250 to only report detected TP beams within a certain group. In some embodiments, this

action may be implemented by sending an RRC message, or a broadcasted control signalling message, to the wireless device 250.

Action 306

5 The network node 211, 230 may trigger the report from the wireless device 250 by for example, sending a message to the wireless device 250, such as a Downlink Control Information message.

Action 307

10 The network node 211, 230 receives the report from the wireless device 250, the report comprising channel state information for at least a subset of the selected set of TP beams, measured on the configured set of second beam-specific reference signals. The report is understood to be equivalent to a second report from the wireless device 250.

15 In some embodiments, the report comprises at least one index to a precoding codebook.

 In some embodiments, this action may be implemented by receiving an Uplink Control Information (UCI) message, from the wireless device 250.

Action 308

20 The network node 211, 230 may select one uplink beam from the uplink beams transmitted by the wireless device 250 for scheduling of uplink transmission, based on, for example, the received report. For example, the network node 211, 230, may select the uplink beam with the highest or best received channel quality, according to a determined criterion (e.g., based on a specific threshold).

25 In some embodiments, the selecting of the uplink beam is based on a correlation of each of the uplink beams transmitted by the wireless device 250 with each beam-specific uplink signal.

Action 309

30 The network node 211, 230 may schedule the wireless device 250, based on the received report. In some particular embodiments, the network node 211, 230 may schedule the wireless device 250, based on the selected uplink beam from the uplink beams transmitted by the wireless device 250 in action 308. For example, the network node 211, 230, may schedule the wireless device 250 in the uplink beam with the highest

or best received channel quality, according to the determined criterion (e.g., based on the specific threshold).

In some embodiments, this action may be implemented by sending a scheduling message, such as a DCI message, to the wireless device 250.

5

Embodiments of a method performed by the wireless device 250 for sending the report to the network node 211, 230, will now be described with reference to the flowchart depicted depicted in **Figure 4**. As stated earlier, the network node 211, 230 controls one or more TPs 211, 212, 213 and the one or more TPs 211, 212, 213 transmit TP beams, wherein each of TP beams has the first beam-specific reference signal. The network node 211, 230 and the wireless device 250 operate in the wireless communications network 200, as stated earlier. Figure 4 depicts a flowchart of the actions that are or may be performed by the wireless device 250 in embodiments herein.

10

15

As stated earlier, the network node 211, 230 may be one of: the TP 211 and the scheduling network node 230.

In some embodiments, the first beam-specific reference signals and the second beam-specific reference signals, as described earlier, are one of: channel state information reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.

20

The method may comprise the following actions, which actions may as well be carried out in another suitable order than that described below. In some embodiments, all the actions may be carried out, whereas in other embodiments only some action/s may be carried out. In Figure 4, optional actions are represented with dashed lines.

25

Some of the detailed description of elements of the following actions and nodes correspond to those described earlier in relation to Figure 3, and will therefore not be repeated here.

30

Action 401

The wireless device 250 may search for TP beams. In some embodiments, the wireless device 250 searches for TB-beams, using a procedure similar to LTE cell search.

Action 402

The wireless device 250 may detect the TP beams. In some embodiments, this may be implemented by detecting the first beam-specific reference signals in the TP beams.

In some embodiments, the first beam-specific reference signals are detectable by the wireless device 250 without being in connected mode to the one or more TPs 211, 212, 213 transmitting the TP beams comprising the first beam-specific reference signals.

In some embodiments, the first beam-specific reference signals are grouped, and the first beam-specific reference signals within one group are used within one cell only 221.

In some embodiments, the Primary Synchronization Signals, positioning reference signals or the Secondary Synchronization Signals are grouped into sets of a defined number of sequences, and each of these sets of a defined number of sequences is restricted to be used within one TP 211, 212, 213 only.

Action 403

The wireless device 250 may identify a cell, such as the first cell 221, by detecting a TP beam belonging to that cell 221.

Action 404

The wireless device 250 may select a preset of detected TP beams, as described above.

In some embodiments, the preset of detected TP beams has been selected by the wireless device 250 based on the first beam-specific reference signals of the TP beams, wherein the first beam-specific reference signals are downlink beam-specific reference signals.

In some embodiments, selection of the present may be carried out using a threshold value, configured by higher layers or fixed in specifications, or the wireless device 250 may simply report all detected TP beams up to a specific maximum number of reports or a maximum number of beams.

Action 405

The wireless device 250 may send the prereport of the selected preset of detected TP beams to the network node 211, 230. In some embodiments, this action may be implemented by sending an RRC message, to the network node 211, 230.

The set of selected TP beams may then be selected by the network node 211, 230 at least based on the sent prereport.

In some embodiments, the preset of detected TP beams may possibly be accompanied with a received power report or other ranking of each detected TP beam.

5

Action 406

The wireless device 250 may receive the configuration from the network node 211, 230 with the beam-specific reference signals which are beam-specific uplink reference signals, so that the network node 211, 230 can measure on these beam-specific uplink
10 reference signals. In some embodiments, this action may be implemented by receiving an RRC message, from the network node 211, 230.

In some embodiments, the beam-specific uplink reference signals are beam-specific sounding reference signals.

15

Action 407

As explained earlier, in some embodiments, the wireless device 250 may perform a transmission, which transmission may comprise the one or more uplink reference signals.

In some embodiments, the transmission from the wireless device 250 is done in uplink beams. In some of these embodiments, the uplink reference signals are beam-
20 specific uplink reference signals. In some embodiments, the uplink reference signals are beam-specific sounding reference signals.

In this action, the wireless device 250 may transmit the beam-specific uplink reference signals.

In some embodiments, the set of selected TP beams are selected by the network
25 node 211, 230 at least based on the measured transmission from the wireless device 250, as described earlier. In some embodiments, this is based on the one or more measurements on the uplink reference signals

Action 408

The wireless device 250 receives the configuration from the network node 211, 230 with the set of second beam-specific reference signals. In some embodiments, this action
30 may be implemented by receiving an RRC message, from the network node 211, 230.

The set of second beam-specific reference signals are beam-specific downlink reference signals, wherein each second beam-specific reference signal is associated with
35 one of the selected set of TP beams. The set of TP beams are selected by the network

node 211, 230 based on at least one of: a) the one or more measurements by the wireless device 250 on the first beam-specific reference signals of the TP beams, and b) the measured transmission from the wireless device 250 by the one or more TPs 211, 212, 213. The configuration is for the wireless device 250 to perform one or more
5 measurements on the set of second beam-specific reference signals which are mutually orthogonal.

As stated earlier, the first beam-specific reference signals of the TP beams are defined so that each beam in a TP 211, 212, 213 out of the one or more TPs 211, 212,
10 213, uses one unique signal from the set of sequences used in this TP 211, 212, 213.

In some embodiments, the set of selected TP beams that are selected by the network node 211, 230 belong to one of: the same TP 211, 212, 213, different TPs 211, 213 within the cell 221, and different TP beams in different cells 221, 222.

Action 409

The wireless device 250 may receive a configuration from the network node 211, 230 to only report detected TP beams within a certain group. In some embodiments, this action may be implemented by receiving an RRC or broadcast control message, from the
20 network node 211, 230.

In some embodiments, selecting the preset of detected TP beams may be based on one of: a threshold value for a measured variable in the detected TP beams, and a maximum number of TP beams.

Action 410

The wireless device 250 may receive from the network node 211, 230 the trigger for the report. As stated earlier, in some embodiments, this action may be implemented by receiving a DCI message, from the network node 211, 230.

Action 411

The wireless device 250 may measure the channel state information for the set of selected TP beams, based on the configured set of second beam-specific reference signals.

Action 412

The wireless device 250 may send the report to the network node 211, 230, the report comprising channel state information for at least the subset of the set of selected
5 TP beams, measured on the configured set of second beam-specific reference signals.

In some embodiments, the report comprises at least one index to the precoding codebook.

Action 413

10 The wireless device 250 may receive the scheduling message from the network node 211, 230, wherein the message is based on the sent report.

By the network node doing a pre-selection of possible beams, only beams that are likely to be used in the data transmission by the network node to the wireless device are
15 selected. Thus, by at least some of the steps or actions described herein, the wireless device 250 may quickly switch from one TP beam to another TP beam which improves mobility and gives diversity for both data and control signalling.

One of the main advantages of embodiments herein disclosed here may be that the overhead for quality estimates may be reduced. By doing a pre-selection of possible
20 beams, e.g., the first step of the reporting procedure described above, or actions 304, 404, only beams that are likely to be used in the data transmission is selected. When possible TP-beam candidates have been selected, detailed CSI may be reported more frequently. This in contrast to if detailed CSI should be reported from all TP-beams which would require a substantial overhead.

25 Thus, the problem identified in the prior art on how to select transmission points and beams within each transmission point in a dynamic manner, without the need to frequently change the serving transmission point, is addressed by at least some of the embodiments herein by allowing the set of selected or configured TP beams in the second step, or in action 304, to belong to multiple transmission points so that a good connection is likely to
30 be present at least one of the transmission points and that the network, e.g., the network node 211, 230, may quickly switch the transmission to another beam in another transmission point, without a need for changing serving transmission point.

Also, the problem identified in the prior art on how to provide coverage and robust reception of synchronization signals and reference signals needed to ensure mobility in
35 the 5G network is addressed by at least some of the embodiments herein by providing, or

transmitting, beamformed PSS and SSS signals with narrow beams, and thus extended coverage, and at the same time allowing for detecting the PSS and SSS without prior knowledge, i.e., blind detection, of the utilized beamforming weights, or used PSS or SSS sequences. Hence, new TP beams may be detected and reported to the network node
5 211, 230 when the wireless device 250 moves around, and a new TP becomes discoverable, within the range of the wireless device 250.

Figure 5 and Figure 6 depict, respectively, schematic diagrams of methods in the network node 211, 230 and the wireless device 250, according to some embodiments
10 herein, and as just described in reference to Figures 3 and 4, respectively. In the exemplary non-limiting example of Figure 5, the wireless device 250, depicted as "UE" in Figures 5 and 6, measures TP-beams specific signals, such as the first beam-specific reference signals. The wireless device 250 then selects a preset of the measured TP beams as explained in action 404, based on e.g., received power, and sends the
15 prereport to the network node 211, 230, that is the "report of K selected TP-beams", according to action 405. The network node 211, 230, depicted as "Network" in Figures 5 and 6, performs a selection of D TP beams, as described in action 304, according to the preset selected by the wireless device 250. The network node 211, 230 then configures the wireless device 250 with a number D of CSI-RS signals, that is the the set of second
20 beam-specific reference signals, as in action 305. The wireless device 250 then measures the CSI-RS on the set of selected TP beams, as in action 411. After having optionally received a trigger from the network node 211, 230, the wireless device 250 then sends the report to the network node, the CSI report based on the CSI-RS, as in action 412. Based on the CSI-RS report, the network node 211, 230 then sends a scheduling of downlink
25 based on the received CSI-RS report, as in actions 309 and 413.

In the exemplary non-limiting example of Figure 6, the network node 211, 230 configures the wireless device 250 with the beam-specific uplink reference signals as described in action 302, which in this embodiment are beam-specific SRS. The wireless
30 device 250 then transmits the beam-specific uplink reference signals, beam-SRS, as in action 407. The network node 211, 230 performs the selection of action 304 according to the measurement of the transmission by the wireless device 250, of the beam-specific uplink reference signals configured by the network node 211, 230, which in this example are beam-specific SRS, or beam-SRS, as described in action 303, and selects D downlink
35 TP-beams, as described in action 304. The network node 211, 230 then configures the

wireless device 250 with the D CSI-RS signals, as discussed in action 305. The wireless device 250 then measures the CSI-RS on the set of selected TP beams, as in action 411. After having optionally received the trigger from the network node 211, 230 described in action 306, the wireless device 250 then sends the report to the network node, the CSI
5 report based on the CSI-RS, as in action 412. Based on the CSI-RS report, the network node 211, 230 then sends a scheduling of downlink based on the received CSI-RS report, as in actions 309 and 413.

To perform the method actions described above in relation to Figures 3, 5 and 6, the
10 network node 211, 230 is configured to receive the report from the wireless device 250. The network node 211, 230 comprises the following arrangement depicted in **Figure 7**. The network node 211, 230 is configured to control the one or more Transmission Points, TPs, 211, 212, 213. The one or more TPs 211, 212, 213 are configured to transmit TP beams. The network node 211, 230 and the wireless device 250 are configured to
15 operate in the wireless communications network 200. The detailed description of some of the following corresponds to the same references provided above, in relation to the actions described for the network node 211, 230, and will thus not be repeated here.

In some embodiments, the network node 211, 230 is one of: the TP 211 and the scheduling network node 230.

20 In some embodiments, as stated earlier, any of the first beam-specific reference signals and the second beam-specific reference signals are one of: channel state information reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.

25 The network node 211, 230 may be configured to select the set of TP beams from the TP beams, wherein to select is based on at least one of: one or more measurements by the wireless device 250 on first beam-specific reference signals of the TP beams, and a transmission from the wireless device 250 configured to be measured by the one or more TPs 211, 212, 213. To select may be configured to be performed for the wireless
30 device 250 to perform one or more measurements on the set of second beam-specific reference signals. The first beam-specific reference signals of the TP beams are defined so that each beam in a TP 211, 212, 213 out of the one or more TPs 211, 212, 213, uses one unique signal from a set of sequences used in this TP 211, 212, 213.

In some embodiments, this may be performed by a **selecting module 701**
35 comprised in the network node 211, 230.

In some embodiments, the first beam-specific reference signals are detectable by the wireless device 250 without being in connected mode to the one or more TPs 211, 212, 213 configured to transmit the TP beams comprising the first beam-specific reference signals.

In some embodiments, the first beam-specific reference signals are grouped, and wherein the first beam-specific reference signals within one group are configured to be used within one cell 221 only.

In some embodiments, the network node 211, 230 is further configured to select one uplink beam from the uplink beams configured to be transmitted by the wireless device 250 for scheduling of uplink transmission.

This may also be performed by the selecting module 701.

In some embodiments, to select the uplink beam is based on the correlation of each of the uplink beams configured to be transmitted by the wireless device 250 with each beam-specific uplink signal.

In some embodiments, the selected set of TP beams from the TP beams belong to one of: the same TP 211, 212, 213, different TPs 211, 213 within the cell 221, and different TP beams in different cells 221, 222.

The network node 211, 230 may be configured to configure the wireless device 250 with the set of second beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, and wherein each second beam-specific reference signal is associated with the selected TP beam of the set of TP beams. The second beam-specific reference signals are mutually orthogonal.

In some embodiments, this may be performed by a **configuring module 702** comprised in the network node 211, 230.

In some embodiments, the transmission from the wireless device 250 is done in uplink beams, and the network node 211, 230 is further configured to configure the wireless device 250 with the beam-specific uplink reference signals, so that the network node 211, 230 can measure on these beam-specific uplink reference signals.

This may also be performed by the configuring module 702.

In some embodiments, the beam-specific uplink reference signals are beam-specific sounding reference signals.

The network node 211, 230 may be configured to receive the report from the wireless device 250, the report comprising channel state information for at least the subset of the selected set of TP beams, measured on the configured set of second beam-specific reference signals.

In some embodiments, this may be performed by a **receiving module 703** comprised in the network node 211, 230.

In some embodiments, the report comprises at least one index to the precoding codebook.

In some embodiments, the network node 211, 230 is further configured to receive the prereport from the wireless device 250 of the detected TP beams by the wireless device 250, and wherein to select the set of TP beams by the network node 211, 230, based on the first beam-specific reference signals of the TP beams, comprises to select the set of TP beams at least based on the prereport configured to be received from the wireless device 250.

In some embodiments, this may also be performed by the receiving module 703.

In some embodiments, the preset of detected TP beams comprised in the received prereport has been selected by the wireless device 250 based on the first beam-specific reference signals of the TP beams, wherein the first beam-specific reference signals are downlink beam-specific reference signals.

In some embodiments, the network node 211, 230 may be configured to schedule the wireless device 250, based on the received report.

In some embodiments, this may be performed by a **scheduling module 704** comprised in the network node 211, 230.

In some embodiments, the network node 211, 230 may be configured to measure the transmission from the wireless device 250, and to select the set of TP beams by the network node 211, 230 based on the transmission from the wireless device 250 configured to be measured is based on one or more measurements on uplink reference signals.

In some embodiments, this may be performed by a **measuring module 705** comprised in the network node 211, 230.

In some embodiments, wherein the transmission from the wireless device 250 is done in uplink beams, the network node 211, 230 is further configured to measure the transmission by the wireless device 250 of the beam-specific uplink reference signals.

In some embodiments, this may also be performed by the measuring module 705.

5 In some embodiments, to measure is configured to be done blindly on received signals, without configuring uplink sounding reference signals.

In some embodiments, the network node 211, 230 may configured to trigger the report from the wireless device 250.

10 In some embodiments, this may be performed by a **triggering module 706** comprised in the network node 211, 230.

The embodiments herein for receiving the report from the wireless device 250 may be implemented through one or more processors, such as the **processing module 707** in the network node 211, 230 depicted in Figure 7, together with computer program code for performing the functions and actions of the embodiments herein. The program code mentioned above may also be provided as a computer program product, for instance in the form of a data carrier carrying computer program code for performing the
15 embodiments herein when being loaded into the in the network node 211, 230. One such carrier may be in the form of a CD ROM disc. It may be however feasible with other data carriers such as a memory stick. The computer program code may furthermore be provided as pure program code on a server and downloaded to the network node 211, 230.

25 The network node 211, 230 may further comprise a **memory module 708** comprising one or more memory units. The memory module 708 may be arranged to be used to store data in relation to applications to perform the methods herein when being executed in the network node 211, 230. Memory module 708 may be in communication with the processing module 707. Any of the other information processed by the
30 processing module 707 may also be stored in the memory module 708.

In some embodiments, information may be received from, e.g., the wireless device 250, through a **receiving port 709**. In some embodiments, the receiving port 709 may be, for example, connected to the one or more antennas in the network node 211, 230. In
35 other embodiments, the network node 211, 230 may receive information from another

structure in the wireless communications network 200 through the receiving port 709. Since the receiving port 709 may be in communication with the processing module 707, the receiving port 709 may then send the received information to the processing module 707. The receiving port 709 may also be configured to receive other information.

5 The information processed by the processing module 707 in relation to the embodiments of method herein may be stored in the memory module 708 which, as stated earlier, may be in communication with the processing module 707 and the receiving port 709.

10 The processing module 707 may be further configured to transmit or send information to e.g., the wireless device 250, or another node in the wireless communications network 200, through a **sending port 710**, which may be in communication with the processing module 707, and the memory module 708.

15 Those skilled in the art will also appreciate that the different modules 701-706 described above may refer to a combination of analog and digital modules, and/or one or more processors configured with software and/or firmware, e.g., stored in memory, that, when executed by the one or more processors such as the processing module 707, perform as described above. One or more of these processors, as well as the other digital
20 hardware, may be included in a single application-specific integrated circuit (ASIC), or several processors and various digital hardware may be distributed among several separate components, whether individually packaged or assembled into a system-on-a-chip (SoC).

25 Thus, the methods according to the embodiments described herein for the network node 211, 230 are respectively implemented by means of a computer program product, comprising instructions, i.e., software code portions, which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the network node 211, 230. The computer program product may be stored
30 on a computer-readable storage medium. The computer-readable storage medium, having stored thereon the computer program, may comprise instructions which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the network node 211, 230. In some embodiments, the computer-readable storage medium may be a non-transitory computer-
35 readable storage medium.

To perform the method actions described above in relation to Figures 4, 5 and 6 the wireless device 250 is configured to send the report to the network node 211, 230. The wireless device 250 comprises the following arrangement depicted in Figure 8. The network node 211, 230 is configured to control the one or more Transmission Points, TPs, 211, 212, 213. The one or more TPs 211, 212, 213 are configured to transmit TP beams. Each of TP beams has the first beam-specific reference signal. The network node 211, 230 and the wireless device 250 are configured to operate in the wireless communications network 200. The detailed description of some of the following corresponds to the same references provided above, in relation to the actions described for the wireless device 250, and will thus not be repeated here.

In some embodiments, the network node 211, 230 is one of: the TP 211 and the scheduling network node 230.

In some embodiments, any of the first beam-specific reference signals and the second beam-specific reference signals are one of: channel state information reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.

The wireless device 250 may be configured to receive a configuration from the network node 211, 230 with the set of second beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, wherein each second beam-specific reference signal is associated with one of the selected set of TP beams, selected by the network node 211, 230 based on at least one of: one or more measurements by the wireless device 250 on first beam-specific reference signals of the TP beams, and a transmission from the wireless device 250 configured to be measured by the one or more TPs 211, 212, 213, wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP 211, 212, 213 out of the one or more TPs 211, 212, 213, uses one unique signal from a set of sequences used in this TP 211, 212, 213,

The configuration may be for the wireless device 250 to perform one or more measurements on the set of second beam-specific reference signals which are mutually orthogonal.

In some embodiments, this may be performed by a **receiving module 801** comprised in the wireless device 250.

In some embodiments, the wireless device 250 is further configured to receive the scheduling message from the network node 211, 230, wherein the message is based on the report configured to be sent.

This may also be performed by the receiving module 801.

5 In some embodiments, the set of selected TP beams configured to be selected by the network node 211, 230 at least based on the transmission configured to be measured from the wireless device 250, is based on one or more measurements on uplink reference signals.

10 In some embodiments, the first beam-specific reference signals are grouped, and wherein the first beam-specific reference signals within one group are configured to be used within one cell only 221.

In some embodiments, the transmission from the wireless device 250 is configured to be done in uplink beams, wherein the uplink reference signals are beam-specific uplink reference signals and the wireless device 250 is further configured to receive the
15 configuration from the network node 211, 230 with the beam-specific uplink reference signals. The network node 211, 230 can then measure on these beam-specific uplink reference signals.

This may also be performed by the receiving module 801.

20 In some embodiments, the beam-specific uplink reference signals are beam-specific sounding reference signals.

In some embodiments, the wireless device 250 is further configured to receive from the network node 211, 230 the trigger for the report.

This may also be performed by the receiving module 801.

25 In some embodiments, the set of selected TP beams that are selected by the network node 211, 230 belong to one of: the same TP 211, 212, 213, different TPs 211, 213 within the cell 221, and different TP beams in different cells 221, 222.

In some embodiments, the report comprises at least one index to the precoding codebook.

30 In some embodiments, the Primary Synchronization Signals, positioning reference signals or the Secondary Synchronization Signals are grouped into sets of the defined number of sequences, and wherein each of these sets of the defined number of sequences is configured to be restricted to be used within one TP 211, 212, 213 only.

The wireless device 250 may be configured to send the report to the network node 211, 230, the report comprising channel state information for at least the subset of the set of selected TP beams, configured to be measured on the configured set of second beam-specific reference signals.

5 This may be performed by a **sending module 802** comprised in the wireless device 250.

In some embodiments, the wireless device 250 is further configured to send the prereport of the selected preset of detected TP beams to the network node 211, 230. The set of selected TP beams may be configured to be selected by the network node 211, 230
10 at least based on the prereport configured to be sent.

This may also be performed by the sending module 802.

In some embodiments, the preset of detected TP beams comprised in the sent prereport is configured to have been selected by the wireless device 250 based on the first beam-specific reference signals of the TP beams, wherein the first beam-specific
15 reference signals are downlink beam-specific reference signals.

In some embodiments, the wireless device 250 may be configured to search for TP beams.

This may be performed by a **searching module 803** comprised in the wireless
20 device 250.

In some embodiments, the wireless device 250 may be configured to detect the TP beams.

This may be performed by a **detecting module 804** comprised in the wireless
25 device 250.

In some embodiments, the first beam-specific reference signals are detectable by the wireless device 250 without being in connected mode to the one or more TPs 211, 212, 213 configured to transmit the TP beams comprising the first beam-specific reference
30 signals.

In some embodiments, the wireless device 250 may be configured to select the preset of detected TP beams.

This may be performed by a **selecting module 805** comprised in the wireless
35 device 250.

In some embodiments, the wireless device 250 is further configured to receive the configuration from the network node 211, 230 to only report detected TP beams within the certain group. This may also be performed by the receiving module 801.

In some embodiments, wherein the wireless device 250 is further configured to
5 select the preset of detected TP beams based on one of: the threshold value for the measured variable in the detected TP beams, and the maximum number of TP beams.

This may also be performed by the selecting module 805.

In some embodiments, the wireless device 250 may be configured to transmit the
10 uplink reference signals.

In some embodiments, the wireless device 250 may be configured to transmit the beam-specific uplink reference signals.

This may be performed by a **transmitting module 806** comprised in the wireless device 250.

In some embodiments, the wireless device 250 may be configured to identify the cell
15 221 by detecting the TP beam belonging to that cell 221.

This may be performed by an **identifying module 807** comprised in the wireless device 250.

In some embodiments, the wireless device 250 may be configured to measure the channel state information for the set of selected TP beams, based on the configured set of second beam-specific reference signals.

This may be performed by a **measuring module 808** comprised in the wireless
25 device 250.

The embodiments herein for send the report to the network node 211, 230 may be implemented through one or more processors, such as the **processing module 809** in the wireless device 250 depicted in Figure 8, together with computer program code for
30 performing the functions and actions of the embodiments herein. The program code mentioned above may also be provided as a computer program product, for instance in the form of a data carrier carrying computer program code for performing the embodiments herein when being loaded into the in the wireless device 250. One such carrier may be in the form of a CD ROM disc. It may be however feasible with other data

carriers such as a memory stick. The computer program code may furthermore be provided as pure program code on a server and downloaded to the wireless device 250.

The wireless device 250 may further comprise a **memory module 810** comprising one or more memory units. The memory module 810 may be arranged to be used to store data in relation to applications to perform the methods herein when being executed in the wireless device 250. Memory module 810 may be in communication with the processing module 809. Any of the other information processed by the processing module 809 may also be stored in the memory module 810.

In some embodiments, information may be received from, e.g., the network node 211, 230, through a **receiving port 811**. In some embodiments, the receiving port 811 may be, for example, connected to the one or more antennas in the wireless device 250. In other embodiments, the wireless device 250 may receive information from another structure in the wireless communications network 200 through the receiving port 811. Since the receiving port 811 may be in communication with the processing module 809, the receiving port 811 may then send the received information to the processing module 809. The receiving port 811 may also be configured to receive other information.

The information processed by the processing module 809 in relation to the embodiments of method herein may be stored in the memory module 810 which, as stated earlier, may be in communication with the processing module 809 and the receiving port 811.

The processing module 809 may be further configured to transmit or send information to e.g., the network node 211, 230, through a **sending port 812**, which may be in communication with the processing module 809, and the memory module 810.

Those skilled in the art will also appreciate that the different modules 801-808 described above may refer to a combination of analog and digital modules, and/or one or more processors configured with software and/or firmware, e.g., stored in memory, that, when executed by the one or more processors such as the processing module 809, perform as described above. One or more of these processors, as well as the other digital hardware, may be included in a single application-specific integrated circuit (ASIC), or several processors and various digital hardware may be distributed among several

separate components, whether individually packaged or assembled into a system-on-a-chip (SoC).

Thus, the methods according to the embodiments described herein for the wireless device 250 are respectively implemented by means of a computer program product, comprising instructions, i.e., software code portions, which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the wireless device 250. The computer program product may be stored on a computer-readable storage medium. The computer-readable storage medium, having stored thereon the computer program, may comprise instructions which, when executed on at least one processor, cause the at least one processor to carry out the actions described herein, as performed by the wireless device 250. In some embodiments, the computer-readable storage medium may be a non-transitory computer-readable storage medium.

When using the word "comprise" or "comprising" it shall be interpreted as non-limiting, i.e. meaning "consist at least of".

The modules described may be for performing any of the pertinent embodiments described.

The embodiments herein are not limited to the above described preferred embodiments. Various alternatives, modifications and equivalents may be used. Therefore, the above embodiments should not be taken as limiting the scope of the invention.

CLAIMS:

1. A method performed by a network node (211, 230) for receiving a report from a wireless device (250), the network node (211, 230) controlling one or more Transmission Points, TPs, (211, 212, 213) and the one or more TPs (211, 212, 213) transmitting TP beams, the method comprising:
- 5 *selecting* (304) a set of TP beams from the TP beams, wherein the selecting is based on at least one of: one or more measurements by the wireless device (250) on first beam-specific reference signals of the TP beams, and a measured transmission from the wireless device (250) by the one or more TPs
- 10 (211, 212, 213), wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP (211, 212, 213) out of the one or more TPs (211, 212, 213), uses one unique signal from a set of sequences used in this TP (211, 212, 213),
- configuring* (305) the wireless device (250) with a set of second beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, and wherein each second beam-specific reference signal is associated with a selected TP beam of the set of TP beams, and
- 15 *receiving* (307) the report from the wireless device (250), the report comprising channel state information for at least a subset of the selected set of TP beams, measured on the configured set of second beam-specific reference signals; wherein the second beam-specific reference signals are mutually orthogonal.
- 20 2. The method of claim 1, wherein any of the first beam-specific reference signals and the second beam-specific reference signals are one of: channel state information reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.
- 25 3. The method of any of claims 1-2, further comprising:
- 30 *measuring* (303) the transmission from the wireless device (250), and wherein the selecting of the set of TP beams is based on one or more measurements on uplink reference signals.

4. The method of any of claim 3 , further comprising:
 selecting (308) one uplink beam from the uplink beams transmitted by the wireless device (250) for scheduling of uplink transmission; wherein the selecting is based on a correlation of each of the uplink beams with each beam-specific uplink signal.
5. The method of any of claims 1-4, wherein the report comprises at least one index to a precoding codebook.
6. A method performed by a wireless device (250) for sending a report to a network node (211, 230), the network node (211, 230) controlling one or more Transmission Points, TPs, (211, 212, 213) the one or more TPs (211, 212, 213) transmitting Transmission Point, TP, beams, wherein each of TP beams has a first beam-specific reference signal, the method comprising:
 receiving (408) a configuration from the network node (211, 230) with a set of second beam-specific reference signals being beam-specific downlink reference signals, wherein each second beam-specific reference signal is associated with one of a selected set of TP beams, selected by the network node (211, 230) based on at least one or more measurements by the wireless device (250) on the first beam-specific reference signals of the TP beams;
 performing one or more measurements on the set of second beam-specific reference signals, wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP (211, 212, 213) out of the one or more TPs (211, 212, 213), uses one unique signal from a set of sequences used in this TP (211, 212, 213), and
 sending (412) a report to the network node (211, 230), the report comprising channel state information for at least a subset of the set of selected TP beams, measured on the configured set of second beam-specific reference signals; wherein the second beam-specific reference signals are mutually orthogonal.
7. The method of claim 6, wherein any of the first beam-specific reference signals and the second beam-specific reference signals are one of: channel state information

reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.

- 5 8. A network node (211, 230) configured to receive a report from a wireless device (250), the network node (211, 230) being configured to control one or more Transmission Points, TPs, (211, 212, 213) and the one or more TPs (211, 212, 213) being configured to transmit TP beams, the network node (211, 230) being configured to:
- 10 select a set of TP beams from the TP beams, wherein to select is based on at least one of: one or more measurements by the wireless device (250) on first beam-specific reference signals of the TP beams, and a transmission from the wireless device (250) configured to be measured by the one or more TPs (211, 212, 213), wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP (211, 212, 213) out of the one or more TPs
- 15 (211, 212, 213), uses one unique signal from a set of sequences used in this TP (211, 212, 213),
- configure the wireless device (250) with the set of second beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, and wherein each second beam-specific
- 20 reference signal is associated with a selected TP beam, and
- receive the report from the wireless device (250), the report comprising channel state information for at least a subset of the selected set of TP beams, measured on the configured set of second beam-specific reference signals; wherein the second beam-specific reference signals are mutually orthogonal.
- 25 9. The network node (211, 230) of claim 8, wherein any of the first beam-specific reference signals and the second beam-specific reference signals are one of: channel state information reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.
- 30 10. The network node (211, 230) of any of claims 8-9, is further configured to measure the transmission from the wireless device (250), and to select the set of TP beams based on one or more measurements on uplink reference signals.
- 35

11. The network node (211, 230) of any of claims 10, is further configured to select one uplink beam from the uplink beams configured to be transmitted by the wireless device (250) for scheduling of uplink transmission; the selection of the uplink beam is based on a correlation of each of the uplink beams with each beam-specific uplink signal.
12. The network node (211, 230) of any of claims 8-11, wherein the report comprises at least one index to a precoding codebook.
13. A wireless device (250) configured to send a report to a network node (211, 230), the network node (211, 230) being configured to control one or more Transmission Points, TPs, (211, 212, 213) the one or more TPs (211, 212, 213) being configured to transmit Transmission Point, TP, beams, wherein each of TP beams has a first beam-specific reference signal, the wireless device (250) being configured to:
- receive a configuration from the network node (211, 230) with a set of second beam-specific reference signals, wherein the set of second beam-specific reference signals are beam-specific downlink reference signals, wherein each second beam-specific reference signal is associated with one of a selected set of TP beams, selected by the network node (211, 230) based on at least one of: one or more measurements by the wireless device (250) on first beam-specific reference signals of the TP beams, and a transmission from the wireless device (250) configured to be measured by the one or more TPs (211, 212, 213), and wherein the configuration is for the wireless device (250) to perform one or more measurements on the set of second beam-specific reference signals, wherein the first beam-specific reference signals of the TP beams are defined so that each beam in a TP (211, 212, 213) out of the one or more TPs (211, 212, 213), uses one unique signal from a set of sequences used in this TP (211, 212, 213), and send a report to the network node (211, 230), the report comprising channel state information for at least a subset of the set of selected TP beams, configured to be measured on the configured set of second beam-specific reference signals, wherein the second beam-specific reference signals are mutually orthogonal.

14. The wireless device (250) of claim 13, wherein any of the first beam-specific reference signals and the second beam-specific reference signals are one of: channel state information reference signals, positioning reference signals, Primary Synchronization Signals and Secondary Synchronization Signals.

5

1/8

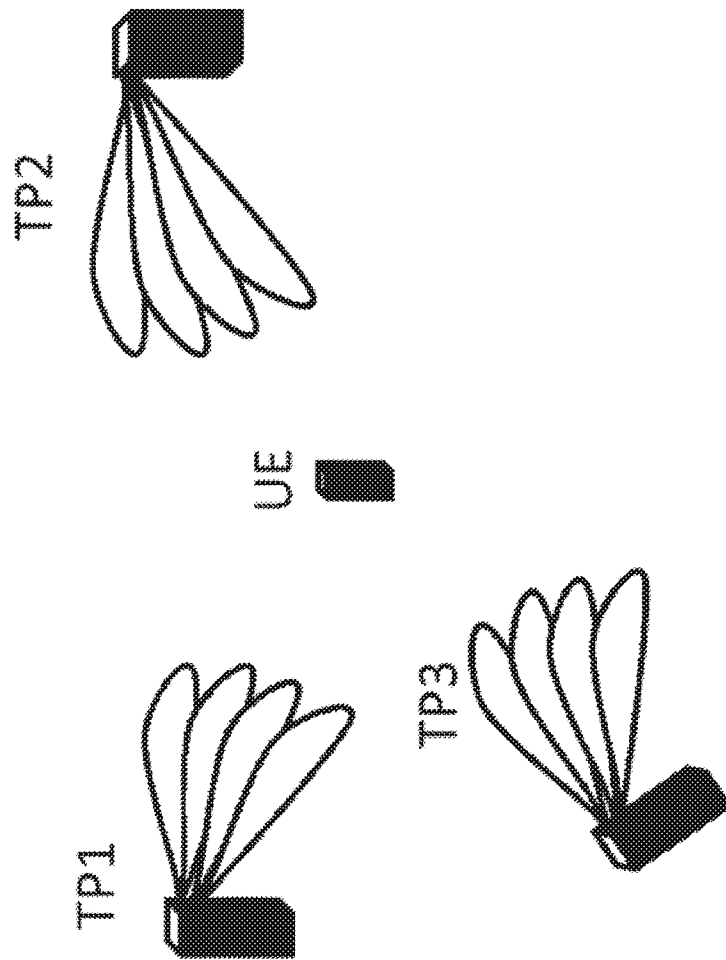


Figure 1

2/8

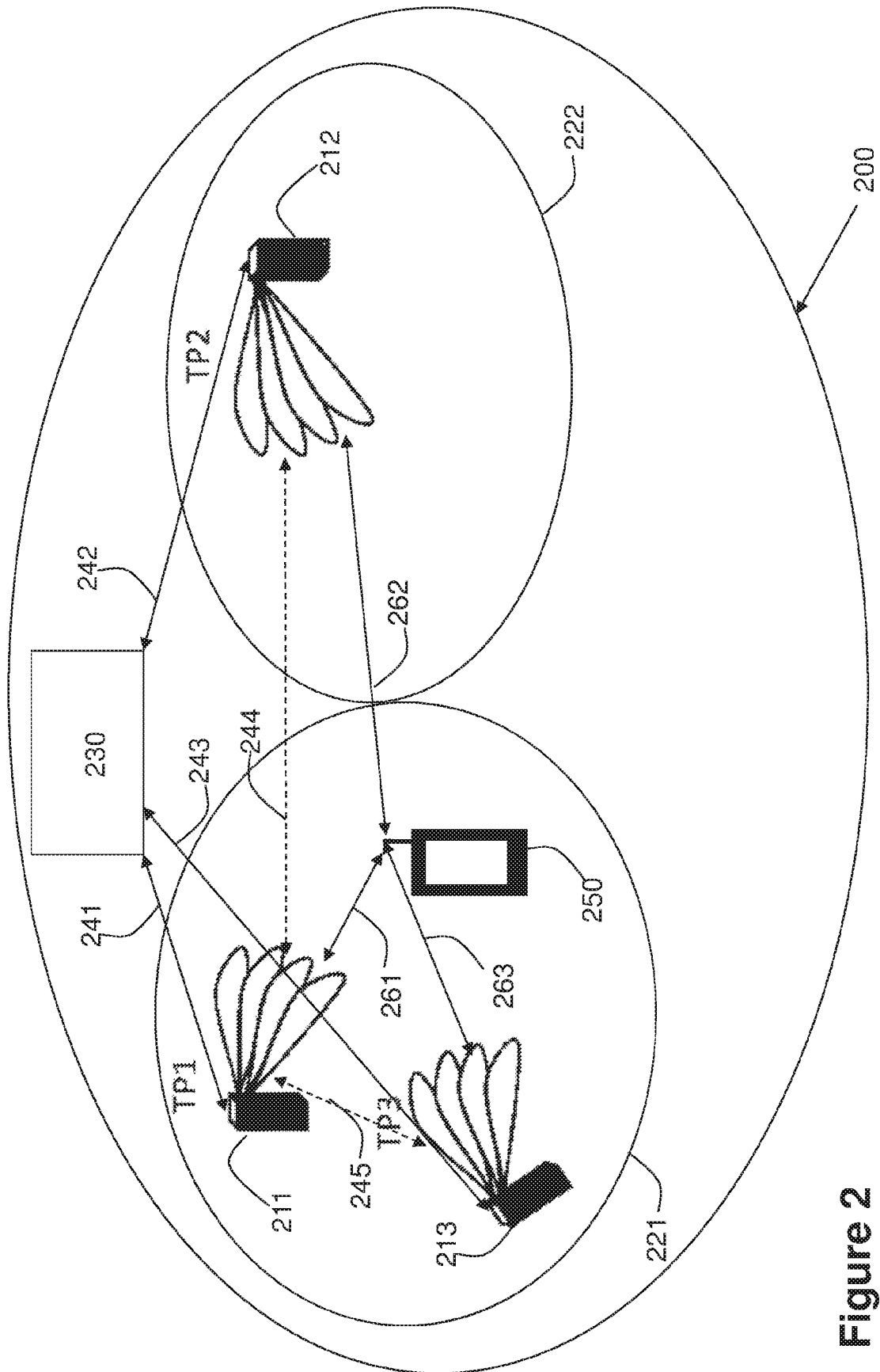


Figure 2

3/8

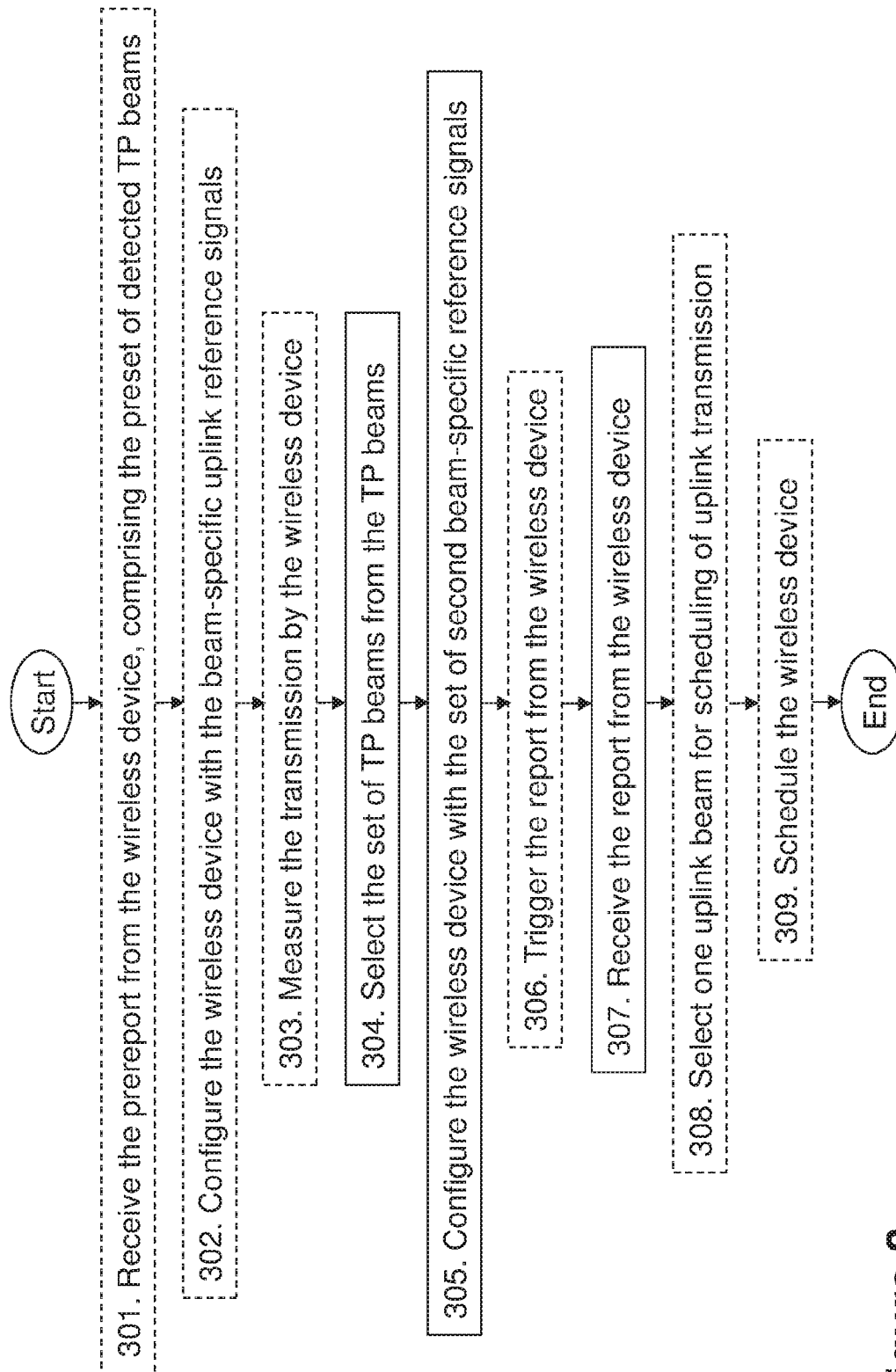
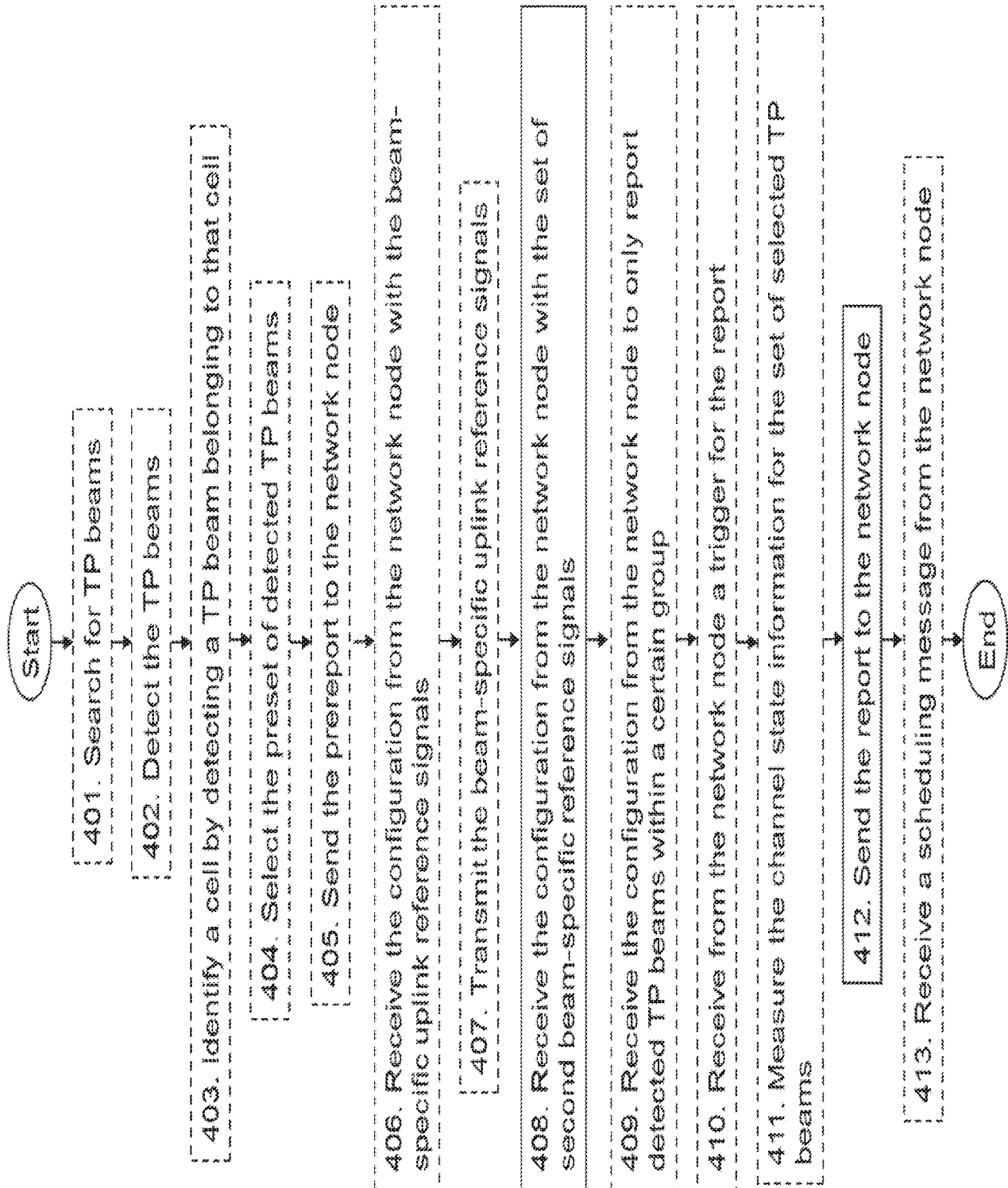


Figure 3

4/8



5/8

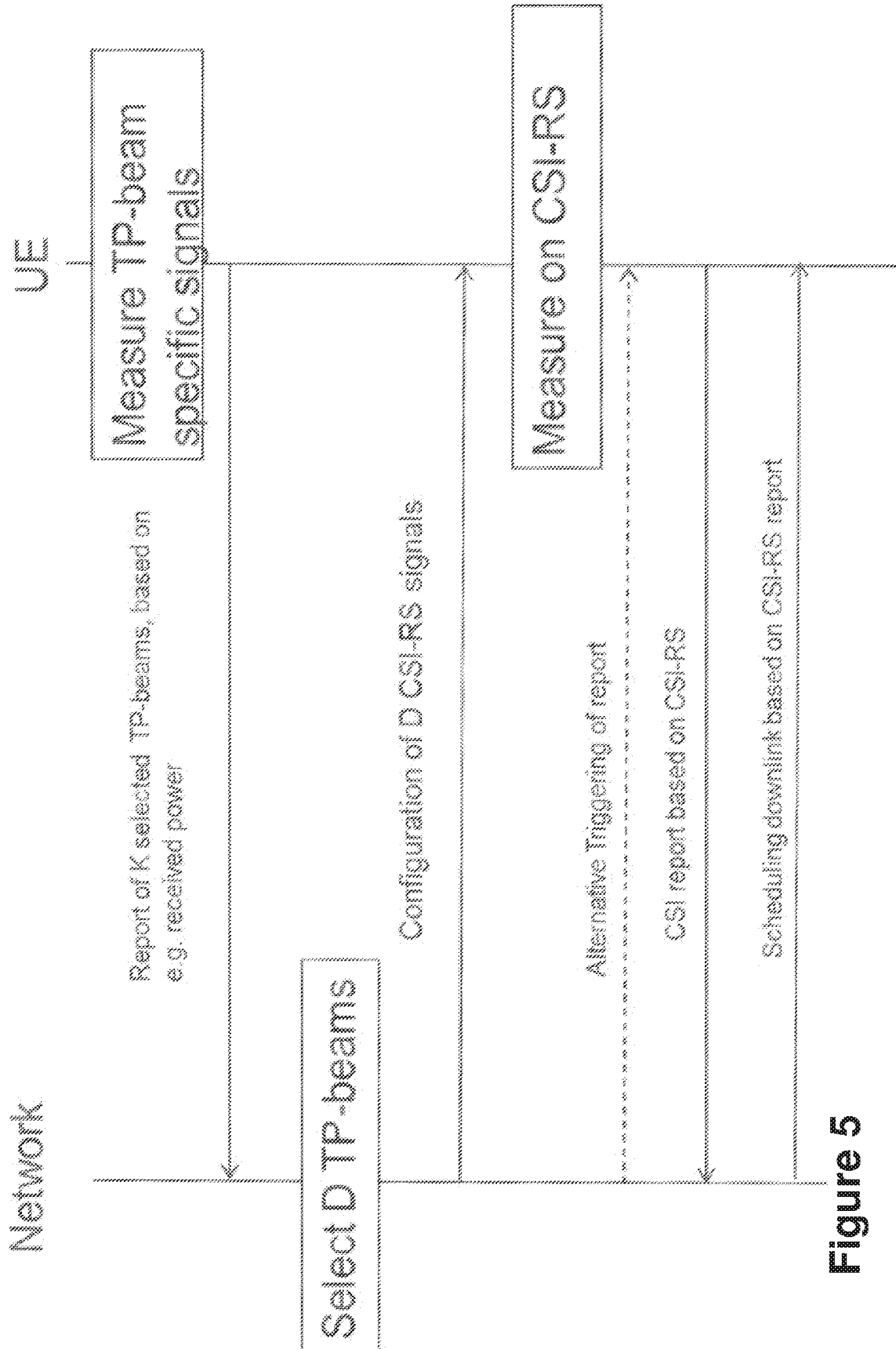


Figure 5

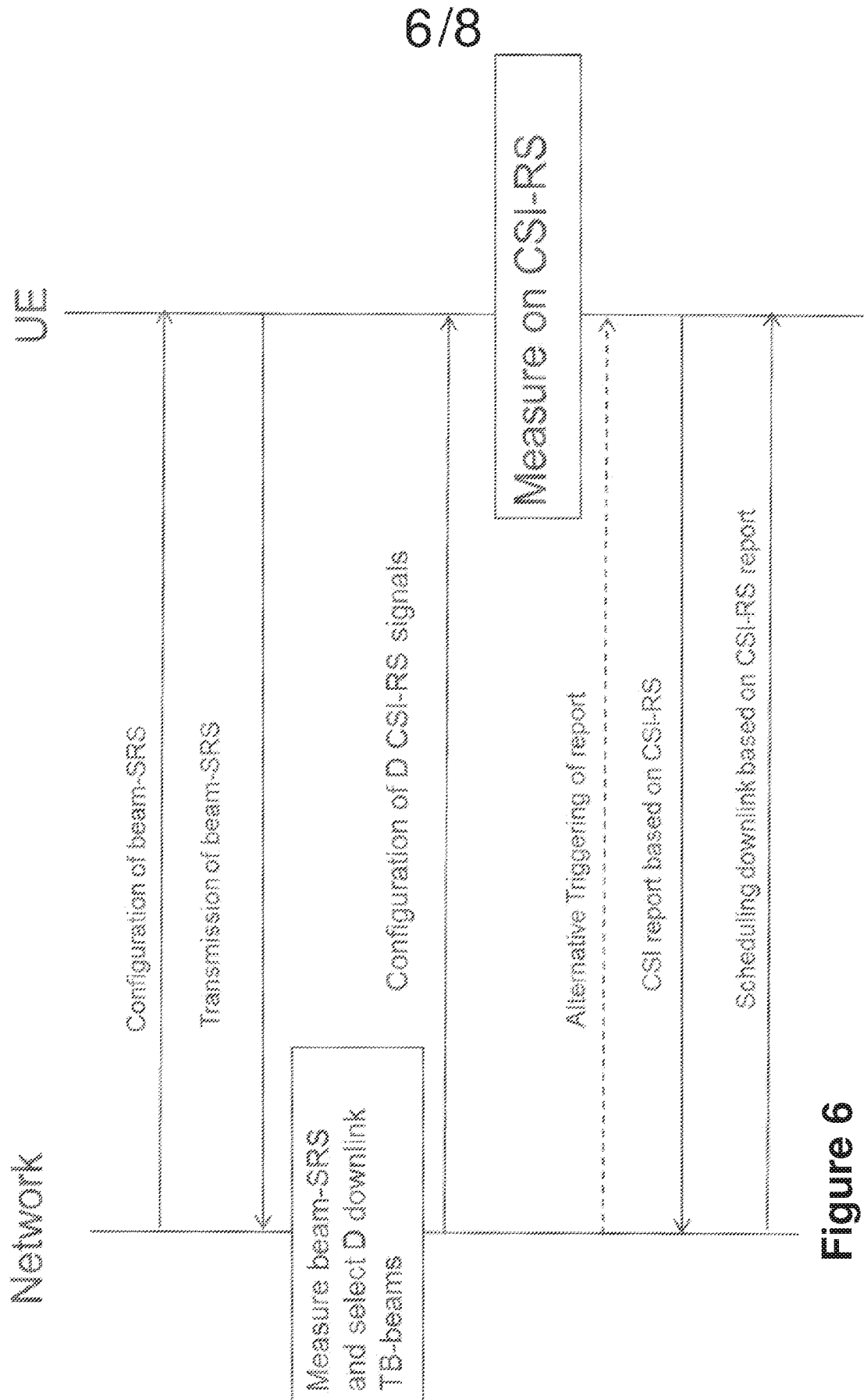


Figure 6

7/8

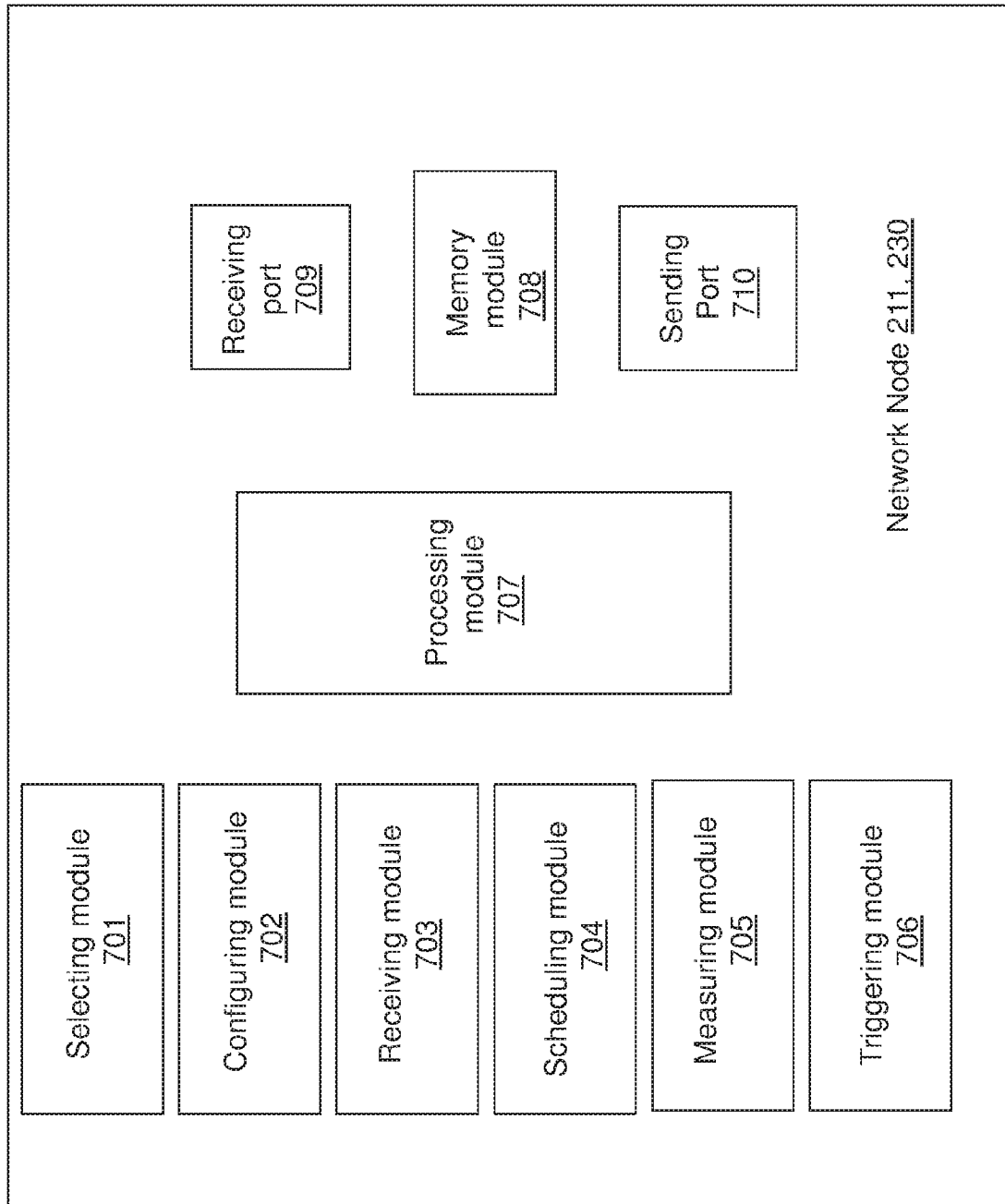


Figure 7

8/8

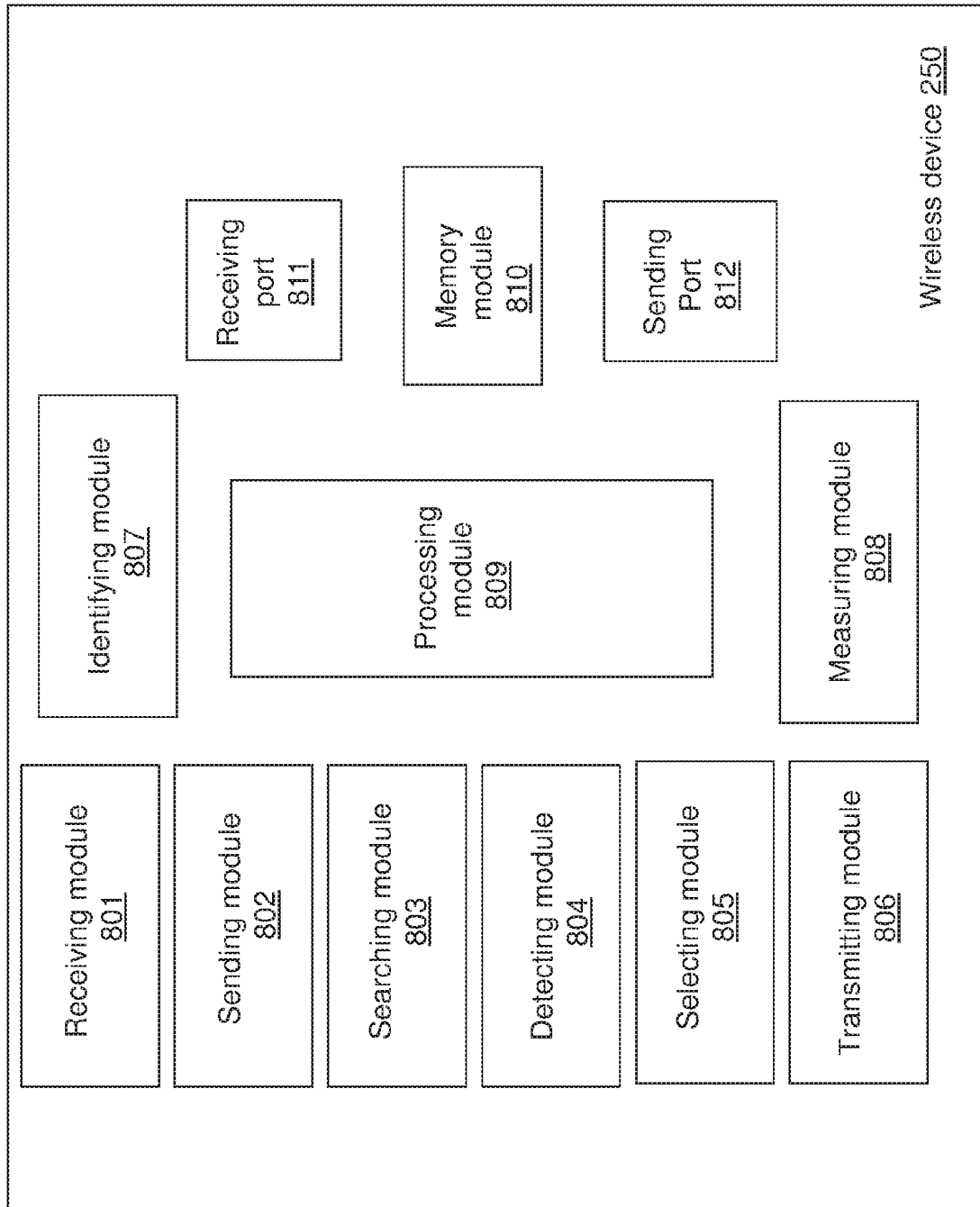


Figure 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2014/051152

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04B, H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20120281554 A1 (GAO SHIWEI ET AL), 8 November 2012 (2012-11-08); abstract; paragraphs [0062], [0089], [0123], [0124]; figures 15-16	1, 6, 8, 13
Y	--	2-5, 7, 9-12, 14
Y	US 20130301434 A1 (KRISHNAMURTHY SANDEEP H ET AL), 14 November 2013 (2013-11-14); abstract; paragraphs [0020], [0039], [0046] -----	2-5, 7, 9-12, 14

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"Q" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27-02-2015

Date of mailing of the international search report

02-03-2015

Name and mailing address of the ISA/SE

Patent- och registreringsverket

Box 5055

S-102 42 STOCKHOLM

Facsimile No. + 46 8 666 02 66

Authorized officer

Magdalena Nohrborg

Telephone No. + 46 8 782 25 00

Petitioners' Exhibit 1002, p. 103

Continuation of: second sheet

International Patent Classification (IPC)

H04L 5/00 (2006.01)

H04B 7/02 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2014/051152

US	20120281554 A1	08/11/2012	CA	2834080 A1	08/11/2012
			CN	103535001 A	22/01/2014
			EP	2705638 A4	28/01/2015
			KR	20140018357 A	12/02/2014
			WO	2012151063 A2	08/11/2012
US	20130301434 A1	14/11/2013	CN	104285466 A	14/01/2015
			WO	2013173018 A1	21/11/2013

Electronic Acknowledgement Receipt	
EFS ID:	32744065
Application Number:	15863267
International Application Number:	
Confirmation Number:	5504
Title of Invention:	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-188.101
Receipt Date:	29-MAY-2018
Filing Date:	05-JAN-2018
Time Stamp:	15:04:04
Application Type:	Utility under 35 USC 111(a)

Payment information:					
Submitted with Payment			no		
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	1426-188-101-- IDSasFiled05292018.pdf	153333	no	6
			8d8ba3be55f2b6d2686df2fa76a228436bac6b07		
Warnings:			Petitioners' Exhibit 1002, p. 106 AT&T et al v. Asustek Technology & Celerity IPR2024-01121		

Information:					
This is not an USPTO supplied IDS fillable form					
2	Foreign Reference	WO2015080648.pdf	6216845	no	55
			89f0289de2956c2abc3aea2d52cdf22d851a cafc		
Warnings:					
Information:					
3	Non Patent Literature	NPL-R1-1612509.pdf	689210	no	4
			a277788d30e291b9eb6695178d741ce6cf3 526d3		
Warnings:					
Information:					
4	Non Patent Literature	NPL-R1-1609514.pdf	828683	no	4
			2346430342c339eb9bf3a3a6197f1b3db48 52cbd		
Warnings:					
Information:					
5	Non Patent Literature	NPL-EPSearchReport.pdf	1467943	no	8
			b335e141075c64bb447f0fe13155a287858 7a89b		
Warnings:					
Information:					
Total Files Size (in bytes):			9356014		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					



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.
15/863,267	01/05/2018	Ko-Chiang Lin	1426-188.101	5504
106622	7590	05/22/2018	EXAMINER	
Blue Capital Law Firm, P.C. 650 Town Center Drive, Suite 1530 Costa Mesa, CA 92626			JUNG, MIN	
			ART UNIT	PAPER NUMBER
			2472	
			NOTIFICATION DATE	DELIVERY MODE
			05/22/2018	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):

docketing@bluecapitallaw.com

Office Action Summary	Application No. 15/863,267	Applicant(s) LIN ET AL.	
	Examiner MIN JUNG	Art Unit 2472	AIA (First Inventor to File) Status Yes

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

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 1-5-18.
☐ 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) 1-20 is/are pending in the application.
5a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) ____ is/are allowed.
- 7) ☒ Claim(s) 1-20 is/are rejected.
- 8) ☐ Claim(s) ____ is/are objected to.
- 9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on ____ 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) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date ____. | 4) ☐ Other: ____. |

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

DETAILED ACTION

Claim Rejections - 35 USC § 112

2. The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Regarding claims 3, 9 and 17, it seems that a punctuation is missing, and thus the meaning of the limitation is not clear.

Claim Rejections - 35 USC § 102

4. 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.

5. Claim(s) 1-5, 7-13 and 15-19 are rejected under 35 U.S.C. 102(a)(2) as being anticipated by Nagaraja et al., US 2018/0103407 (Nagaraja).

Nagaraja discloses reference beam for event trigger in mobility management.

Regarding claim 1, Nagaraja teaches a method of a base station, comprising: the base station transmits to a UE a control signal associated with a reference signal for beam measurement (transmitting information regarding one or more reference beams and one or more event triggers associated with the one or more reference beams, 1002, Fig. 10, and [0098]), wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement (the reference beam may be based on a beam identification. A BS may indicate or configure a UE with one or more beam IDs which may be used as reference beams by the UE, [[0101]]); and the base station transmits the reference signal for beam measurement to the UE (A BS may signal one or multiple reference beams, [0100]).

Regarding claim 2, Nagaraja teaches that the beam-related information indicates at least a beam on which the reference signal for beam measurement is transmitted (beam identification. A BS may indicate or configure a UE with one or more beam IDs which may be used as reference beams by the UE, [[0101]]).

Regarding claim 3, Nagaraja teaches that the beam-related information indicates a first beam (one or more beam ID) and the reference signal for beam measurement is transmitted on at least a refined beam of the first beam (the reference beam may be based on a beam identification, [0101]; event trigger may be based on relative changes within in a set of measurements associated with the reference beams, [0104]).

Regarding claim 4, Nagaraja teaches that the reference signal for beam measurement is transmitted aperiodically ({as opposed to being periodic} event trigger may be based on relative changes..., [0104], [0105]; relative change may be based on the best and worst signal quality measurement within a set of reference beams.... [0106])

Regarding claim 5, Nagaraja teaches that the control signal is transmitted via a control channel ([0034] and [0035]).

Regarding claims 7-9, and 12-20, Nagaraja is applied in the same manner as above.

Regarding claims 10 and 11, Nagaraja teaches that the UE performs measurement on the reference signal for beam measurement with UE beam(s) associated with the at least a beam indicated by the beam-related information; and that the beam refinement for the UE is performed for the at least a beam indicated by the beam-related information ([0096] and [0100]-[0105]).

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 6, 14 and 20 are rejected under 35 U.S.C. 103 as being unpatentable over Nagaraja.

Regarding claim 6, Nagaraja fails to specifically teach that the control signal indicates how many symbols are used to carry the reference signal for beam measurement. However, Nagaraja teaches encoding and symbol mapping the data and control information to obtain data symbols and control symbols, and generating reference symbols ([0073]). It would have been obvious for one of ordinary skill in the art at the time of the invention to specifically indicate the number of symbols for carrying the reference signal since it provides necessary information for decoding the received information so that it can be utilized.

Conclusion

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The Islam et al. PG Pub., the Guo et al. PG Pub., the Sadiq et al. PG Pub., the Visotsky et al. PG Pub., and Yoo et al. PG Pub., are cited for further references.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MIN JUNG whose telephone number is (571)272-3127. The examiner can normally be reached on Monday through Friday 9:00 - 5:00.

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>.

Art Unit: 2472

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hassan Kizou can be reached on 571-272-3088. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. 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.

/MIN JUNG/

Primary Examiner, Art Unit 2472

Notice of References Cited	Application/Control No. 15/863,267		Applicant(s)/Patent Under Reexamination LIN ET AL.	
	Examiner MIN JUNG		Art Unit 2472	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2018/0103407 A1	04-2018	NAGARAJA; Sumeeth	H04W36/30	1/1
*	B	US-2018/0049177 A1	02-2018	Islam; Muhammad Nazmul	H04W72/046	1/1
*	C	US-2018/0048375 A1	02-2018	Guo; Li	H04B7/0695	1/1
*	D	US-2018/0034531 A1	02-2018	Sadiq; Bilal	H04B7/0408	1/1
*	E	US-2017/0289917 A1	10-2017	VISOTSKY; Eugene	H04W52/143	1/1
*	F	US-2017/0288763 A1	10-2017	YOO; Hyunil	H01Q3/10	1/1
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

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.

Bibliographic Data

Application No: 15/863,267

Foreign Priority claimed: ☐ Yes ☒ No

35 USC 119 (a-d) conditions met: ☐ Yes ☒ No ☐ Met After Allowance

Verified and Acknowledged:

/MIN JUNG/

Examiner's Signature

Initials

Title:

METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
01/05/2018	370	2472	1426-188.101
RULE			

APPLICANTS

ASUSTek Computer Inc., Taipei City, TAIWAN

INVENTORS

Ko-Chiang Lin Taipei City, TAIWAN
Richard Lee-Chee Kuo Taipei City 112, OT, TAIWAN

CONTINUING DATA

This application has PRO of 62443291 01/06/2017

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

01/29/2018

STATE OR COUNTRY

TAIWAN

ADDRESS

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626
UNITED STATES

FILING FEE RECEIVED

\$5,740

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		2018-01-05
	First Named Inventor	LIN, KO-CHIANG	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	1426-188.101	

U.S.PATENTS						
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.

U.S.PATENT APPLICATION PUBLICATIONS						
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	20170195998		2017-07-06	Jian Zhang	

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

FOREIGN PATENT DOCUMENTS								
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	2017067138	WO		2017-04-27	Intel IP Corp.		☐
	2	2017020688	WO		2017-02-09	NTT Docomo Inc.		☐

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

NON-PATENT LITERATURE DOCUMENTS								
---------------------------------	--	--	--	--	--	--	--	--

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		2018-01-05
	First Named Inventor	LIN, KO-CHIANG	
	Art Unit		
	Examiner Name		
		Attorney Docket Number	1426-188.101

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		☐

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

EXAMINER SIGNATURE

Examiner Signature	/MIN JUNG/	Date Considered	05/17/2018
--------------------	------------	-----------------	------------

*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.

<i>Index of Claims</i> 	Application/Control No. 15863267	Applicant(s)/Patent Under Reexamination LIN ET AL.
	Examiner MIN JUNG	Art Unit 2472

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant											☐ CPA		☐ T.D.		☐ R.1.47	
CLAIM		DATE														
Final	Original	05/17/2018														
	1	✓														
	2	✓														
	3	✓														
	4	✓														
	5	✓														
	6	✓														
	7	✓														
	8	✓														
	9	✓														
	10	✓														
	11	✓														
	12	✓														
	13	✓														
	14	✓														
	15	✓														
	16	✓														
	17	✓														
	18	✓														
	19	✓														
	20	✓														

Search Notes 	Application/Control No. 15863267	Applicant(s)/Patent Under Reexamination LIN ET AL.
	Examiner MIN JUNG	Art Unit 2472

CPC- SEARCHED		
Symbol	Date	Examiner
H04L 5/0048	5-17-18	MJ
H04W 72/0406, 72/085, 88/08, 88/02	5-17-18	MJ
H04B 7/0617	5-17-18	MJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

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

SEARCH NOTES		
Search Notes	Date	Examiner
EAST searched - text search combined with H04L 5/0048; H04W 72/0406, 72/085, 88/08, 88/02; H04B 7/0617	5-17-18	MJ

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

--	--

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	0	15/863267	US-PGPUB; USPAT	OR	ON	2018/05/14 14:51
S2	13077	(beam near2 measur\$) same reference	US-PGPUB; USPAT	OR	ON	2018/05/14 14:52
S3	2433	S2.clm.	US-PGPUB; USPAT	OR	ON	2018/05/14 14:52
S4	512	beam adj id	US-PGPUB; USPAT	OR	ON	2018/05/14 14:53
S5	16	S3 and S4	US-PGPUB; USPAT	OR	ON	2018/05/14 14:53
S6	10979	H04L5/0048.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:34
S7	13096	(beam near2 measur\$) same reference	US-PGPUB; USPAT	OR	ON	2018/05/17 12:36
S8	2433	S7.clm.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:36
S9	21	S6 and S8	US-PGPUB; USPAT	OR	ON	2018/05/17 12:39
S10	7416	H04W72/0406.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:43
S11	1	S8 and S10	US-PGPUB; USPAT	OR	ON	2018/05/17 12:44
S12	6319	beam adj measurement	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S13	1432	S12.clm.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S14	1	S10 and S13	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S15	215312	reference adj signal	US-PGPUB; USPAT	OR	ON	2018/05/17 12:45
S16	158	S12 same S15	US-PGPUB; USPAT	OR	ON	2018/05/17 12:46
S17	33	S16.clm.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:46
S18	30	S17 not S9	US-PGPUB; USPAT	OR	ON	2018/05/17 12:46
S19	5748	H04B7/0617.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 12:53
S20	21	S8 and S19	US-PGPUB; USPAT	OR	ON	2018/05/17 12:54
S21	13	S20 not S9	US-PGPUB; USPAT	OR	ON	2018/05/17 12:54
S22	12	S21 not S18	US-PGPUB; USPAT	OR	ON	2018/05/17 12:54

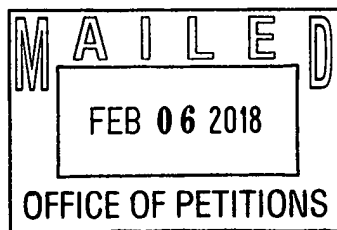
S23	5132	H04W72/085.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 13:50
S24	5	S8 and S23	US-PGPUB; USPAT	OR	ON	2018/05/17 13:51
S25	16287	H04W88/08.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 13:53
S26	4	S8 and S25	US-PGPUB; USPAT	OR	ON	2018/05/17 13:53
S27	17328	H04W88/02.cpc.	US-PGPUB; USPAT	OR	ON	2018/05/17 13:53
S28	7	S8 and S27	US-PGPUB; USPAT	OR	ON	2018/05/17 13:54
S29	12	((("Lin") near3 ("Ko-Chiang"))).INV.	USPAT	OR	OFF	2018/05/17 14:11
S30	56	((("Lin") near3 ("Ko-Chiang"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/05/17 14:12
S31	1	("20170195998").PN.	US-PGPUB; USPAT	OR	OFF	2018/05/17 17:00

5/ 17/ 2018 5:05:56 PM
C:\ Users\ mjung\ Documents\ EAST\ Workspaces\ 15863267.wsp



UNITED STATES PATENT AND TRADEMARK OFFICE

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa CA 92626



Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Doc Code: TRACK1.GRANT

**Decision Granting Request for
Prioritized Examination
(Track I or After RCE)**

Application No.: 15/863,267

1. THE REQUEST FILED January 5, 2018 IS **GRANTED**.

The above-identified application has met the requirements for prioritized examination

- A. ☒ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination.** The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

- A. filing a **petition for extension of time** to extend the time period for filing a reply;
B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims**, or a multiple dependent claim;
C. filing a **request for continued examination**;
D. filing a notice of appeal;
E. filing a request for suspension of action;
F. mailing of a notice of allowance;
G. mailing of a final Office action;
H. completion of examination as defined in 37 CFR 41.102; or
I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to Brian W. Brown at 571-272-5338.

/Brian W. Brown/
[Signature]

Petitions Examiner, Office of Petitions
(Title)



UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
15/863,267	01/05/2018	3737	1600	1426-188.101	20	3

CONFIRMATION NO. 5504

FILING RECEIPT



0000000097005124

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

Date Mailed: 01/31/2018

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**

Inventor(s)

Ko-Chiang Lin, Taipei City, TAIWAN;
Richard Lee-Chee Kuo, Taipei City, TAIWAN;

Applicant(s)

ASUSTek Computer Inc., Taipei City, TAIWAN;

Power of Attorney: The patent practitioners associated with Customer Number 106622

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/443,291 01/06/2017

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

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.

If Required, Foreign Filing License Granted: 01/29/2018

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/863,267**

Projected Publication Date: 07/12/2018

Non-Publication Request: No

Early Publication Request: No

Title

METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

Preliminary Class

600

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 Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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

SelectUSA

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

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 15/863,267				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	660			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760			
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *			OR	x 100 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 460 =	0.00			
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		TOTAL	1720			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	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))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	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))							OR		
	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.										

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		2018-01-05
	First Named Inventor	LIN, KO-CHIANG	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	1426-188.101	

U.S.PATENTS						
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.

U.S.PATENT APPLICATION PUBLICATIONS						
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	20170195998		2017-07-06	Jian Zhang	

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

FOREIGN PATENT DOCUMENTS								
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	2017067138	WO		2017-04-27	Intel IP Corp.		☐
	2	2017020688	WO		2017-02-09	NTT Docomo Inc.		☐

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

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		2018-01-05
	First Named Inventor	LIN, KO-CHIANG	
	Art Unit		
	Examiner Name		
	Attorney Docket Number		1426-188.101

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		☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

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

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

**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	Not Yet Assigned
Filing Date	Not Yet Assigned
First Named Inventor	Ko-Chiang Lin
Title	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	1426-188.101

SIGNATURE of Applicant or Patent Practitioner

Signature	/Sang N. Dang/	Date (Optional)	January 5, 2018
Name	Sang N. Dang	Registration Number	51,186
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

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 _____ 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.**

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:

106622

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):

--



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

MING-HSIU HSU

Date (Optional)

Aug 20, 2015

Name

MING-HSIU HSU

Title

Director of ASUSTek Computer Inc.

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

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Ko-Chiang Lin and Richard Lee-Chee Kuo
Title: METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A
WIRELESS COMMUNICATION SYSTEM
Serial No.: TBD Filed: Herewith
Examiner: TBD Group Art Unit: TBD
Attorney Docket No.: 1426-188.101 (1060022-US)

**CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8**

I hereby certify that the enclosed 1 Page Utility Transmittal Sheet; 1 Page Fee Transmittal; 1 Page Certification and Request for Prioritized Examination (TrackOne Request PTO/AIA/424); 8 Page Application Data Sheet Web-ADS; 24 Page Specification; 12 Page Drawings; 2 Page executed Declaration; 2 Page Information Disclosure Statement by Applicant with 2 foreign reference; and 2 Page Power of Attorney are being transmitted to the United States Patent and Trademark Office via EFS-Web on January 5, 2018.

Date: January 5, 2018

/Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995



(51) International Patent Classification:
H04L 1/16 (2006.01)

(21) International Application Number:
PCT/CN2016/078388

(22) International Filing Date:
1 April 2016 (01.04.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/244,609 21 October 2015 (21.10.2015) US

(71) Applicant: **INTEL IP CORPORATION** [US/US]; 2200 Mission College Blvd., Santa Clara, California 95054 (US).

(72) Inventors; and

(71) Applicants (for BZ only): **CHANG, Wenting** [CN/CN]; 8F, Raycom Infotech Park A, No2, Kexueyuan South Road, Beijing 100190 (CN). **ZHU, Yuan** [CN/CN]; Room 605, Building 16, Mo Li Yuan, Bei Yuan Jia Yuan, Chao Yang District, Beijing 100012 (CN). **NIU, Huaning** [CN/US]; 1308 Knollview Drive, Milpitas, California 95035 (US). **XIONG, Gang** [CN/US]; 16682 NW Arizona Drive, Beaverton, Oregon 97006 (US). **ZHANG, Yushu** [CN/CN]; 8F, Raycom Info Park A, No.2, Kexueyuan South Road, Haidian District, Beijing 100190 (CN).

(74) Agent: **NTD PATENT AND TRADEMARK AGENCY LIMITED**; 10th Floor, Block A, Investment Plaza, 27 Jin-rongdajie, Xicheng District, Beijing 100033 (CN).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD, APPARATUS AND SYSTEM FOR REPORTING BEAM REFERENCE SIGNAL RECEIVING POWER

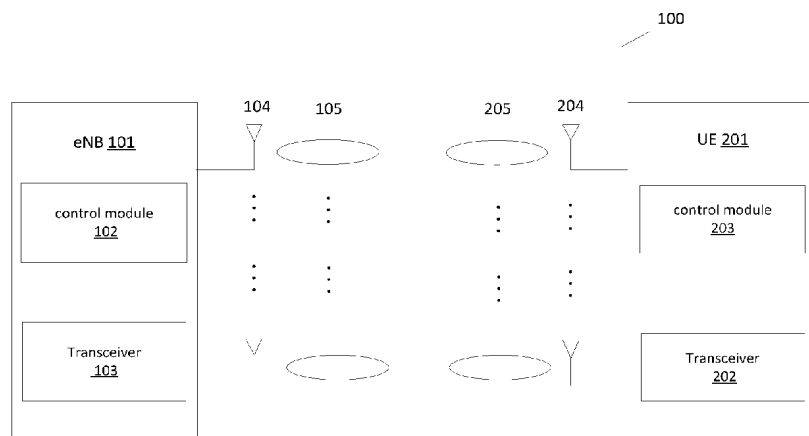


Fig.1

(57) Abstract: Machine-readable media, methods, apparatus and system for beam acquisition in a wireless system are disclosed. In some embodiments, a base station may comprise a transceiver to transmit, to a user equipment (UE), a plurality of beam reference signals (BRSs) via a plurality of transmission beams; and to receive, from the UE, a report to report receiving information associated with at least one of the BRSs on at least one of the transmission beams, wherein the report comprises an antenna identifier to identify a directional antenna panel or an antenna port associated with the directional antenna panel of the UE which receives the at least one of the BRSs on the at least one of the transmission beam.

METHOD, APPARATUS AND SYSTEM FOR REPORTING BEAM REFERENCE SIGNAL RECEIVING POWER

Cross Reference to Related Applications

5 The present application claims priority to U.S. Provisional Patent Application No. 62/244,609, filed October 21, 2015, the entire disclosure of which is hereby incorporated by reference.

Field

10 Embodiments of the present invention relate generally to the field of beam reference signal (BRS) receiving power (BRS-RP) report, and more particularly, to the BRS-RP report in a 5th generation wireless system.

Background Information

15 In a wireless network, e.g., a wireless network operating in accordance with a 5th generation system, an evolved Node B (eNB) may have a large number of transmission beams to support massive multiple-input, multiple-output (MIMO). Beam reference signals (BRSs) mapped on the transmission beams may be transmitted to a user equipment (UE) connected with the eNB via the wireless network.

20

Brief Description of the Drawings

Embodiments of the invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings in which like reference numerals refer to similar elements.

25 **Figure 1** schematically illustrates a wireless system comprising an evolved Node B (eNB) and a user equipment (UE) for beam reference signal receiving power (BRS-RP) report and others, in accordance with various embodiments.

Figure 2 schematically illustrates an example of BRS-RP measurement by the UE having directional antenna panel(s), in accordance with various embodiments.

30 **Figure 3** schematically illustrates an example of a BRS-RP report for a directional antenna panel of the UE, in accordance with various embodiments.

Figure 4 schematically illustrates an example of a BRS-RP report for all directional antenna panel(s) of the UE, in accordance with various embodiments.

Figure 5 schematically illustrates a method of reporting the BRS-RP from the UE to the eNB, in accordance with various embodiments.

5 **Figure 6** schematically illustrates a method of utilizing the BRS-RP for channel control from the eNB to the UE, in accordance with various embodiments.

Figure 7 schematically illustrates an example system in accordance with various embodiments.

10 **Figure 8** schematically illustrates an example of the UE device, in accordance with various embodiments.

Description of the Embodiments

15 Illustrative embodiments of the present disclosure include, but are not limited to, methods, systems, and apparatuses for beam reference signal receiving power (BRS-RP) report in a wireless system, for example, in a 5th generation wireless system.

20 Various embodiments of the illustrative embodiments will be described using terms commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. However, it will be apparent to those skilled in the art that some alternate embodiments may be practiced using with portions of the described embodiments. For purposes of explanation, specific numbers, materials, and configurations are set forth in order to provide a thorough understanding of the illustrative embodiments. However, it will be apparent to one skilled in the art that alternate embodiments may be practiced without the specific details. In other instances, well-known features are omitted or simplified in order to not obscure the illustrative
25 embodiments.

30 Further, various operations will be described as multiple discrete operations, in turn, in a manner that is most helpful in understanding the illustrative embodiments; however, the order of description should not be construed as to imply that these operations are necessarily order dependent. In particular, these operations need not be performed in the order of presentation.

The phrase “in one embodiment” is used repeatedly. The phrase generally does not refer to the same embodiment; however, it may. The terms “comprising,” “having,” and “including” are synonymous, unless the context dictates otherwise. The phrase “A/B”

means “A or B”. The phrase “A and/or B” means “(A), (B), or (A and B)”. The phrase “at least one of A, B and C” means “(A), (B), (C), (A and B), (A and C), (B and C) or (A, B and C)”. The phrase “(A) B” means “(B) or (A B)”, that is, A is optional.

Although specific embodiments have been illustrated and described herein, it will
5 be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent implementations may be substituted for the specific embodiments shown and described, without departing from the scope of the embodiments of the present disclosure. This application is intended to cover any adaptations or variations of the embodiments discussed herein. Therefore, it is manifestly intended that the embodiments of the present
10 disclosure be limited only by the claims and the equivalents thereof.

As used herein, the term “module” may refer to, be part of, or include an Application Specific Integrated Circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group) and/or memory (shared, dedicated, or group) that execute one or more software or firmware programs, a combinational logic circuit, and/or other suitable
15 components that provide the described functionality.

Figure 1 schematically illustrates a wireless system 100 comprising an evolved Node B (eNB) 101 and a user equipment (UE) 201 for BRS-RP report and others, in accordance with various embodiments. In some embodiments, eNB 101 may comprise a control module 102, a transceiver 103, a plurality of antennas 104, and others. Control
20 module 102 may generate a plurality of beam reference signals (BRSs) which may be used to measure channel state and quality for each of transmission beams 105 generated by antennas 104. Control module 102 may further map the BRSs onto transmission beams 105 before transceiver 103 transmit the BRSs via the transmission beams to UE 201. In some embodiments, transceiver 103 may further receive, from UE 201, a BRS-RP report
25 to report power of receiving at least one of the BRSs on at least one of the transmission beams by at least one directional antenna panel of UE 201.

In some embodiments, besides the receiving power, the BRS-RP report may comprise a BRS identifier to identify the BRS associated with the receiving power, a transmission beam identifier to identify the transmission beam that the BRS may be
30 mapped on, a receiving antenna panel identifier to identify a directional antenna panel of UE 201 that may receive the BRS on the transmission beam, and/or others. In a case that UE 201 comprises more than one directional antenna panels, the receiving power in the BRS-RP report may be the highest receiving power for each of the at least one of the

BRSs on each of the at least one of the transmission beams across the directional antenna panels. In some embodiments, the receiving power in the BRS-RP report may be higher than a threshold. In some embodiments, the number for the reported transmission beams associated with the BRS-RP may be pre-determined. In some embodiments, the number of the reported receiving antenna panel associated with the BRS-RP may be predetermined. In some embodiments, the receiving antenna panel identifier may comprise 1 bit flag to identify whether the receiving antenna panel is a default panel or not. In some embodiments, the directional antenna panel of UE 201 may comprise an antenna array of multiple antenna elements, which may point to a spatial direction based on at least one polarization direction through beamforming. In view of this, the receiving antenna panel identifier may be alternatively used to identify the antenna port(s) that receive the BRS on the transmission beams.

With the above-stated scheme of BRS-RP reporting, the overhead for UE 201 to transmit the BRS-RP report may be reduced. More details for the BRS-RP report may be described in the below with reference to Figures 2-4.

In some embodiment, control module 102 of eNB 101 may select transmission beam candidates from the BRS-RP report. For example, control module 102 may select N transmission beam candidates having highest receiving power from the BRS-RP report. Control module 102 may then use the transmission beam candidates to configure channel control information, such as a channel state information-reference signal (CSI-RS), an enhanced physical downlink control channel (EPDCCH), and/or others. For example, control module 102 may include the receiving antenna panel identifier associated with the transmission beam candidates in the CSI-RS configuration information, the EPDCCH configuration information, and/or others.

For another example, control module 102 may determine whether one or more transmission antenna panels (or transmission antenna ports) should be used for the transmissions between eNB 101 and UE 201, at least in part based on whether the receiving antenna panel identifier associated with the transmission beam candidates identifies one or more receiving antenna panels. More specifically, if the receiving antenna panel identifier identifies that the transmission beam candidates are associated with one receiving antenna panel, control module 102 may determine to use single transmission antenna panel (or related transmission antenna ports) for the transmission between eNB 101 and UE 201. If the receiving antenna panel identifier identifies that the

transmission beam candidates are associated with more than one receiving antenna panel, for example, to a default antenna panel as well as an alternative antenna panel, control module 102 may determine to use dual or more transmission antenna panels (or related transmission antenna ports) for the transmission between eNB 101 and UE 201. This way
5 may help eNB 101 to more efficiently navigate transmission resource to serve the UE(s). In some embodiments, eNB 101 may select a transmission beam with a highest BRS-RP value for further communication between eNB 101 and UE 201.

In some embodiments, UE 201 may comprise a transceiver 202, a control module 203, a plurality of antennas 204, and/or others. Transceiver 202 may receive the plurality
10 of BRSs mapped on the plurality of transmission beams 105 via receiving beams 205 generated by antennas 204. In some embodiments, the receiving beam may comprise an optimized receiving beam of each receiving antenna panel which may be obtained from a previous beam acquisition process. The receiving antenna panel may comprise the directional antenna panel having an antenna array of multiple antenna elements, which
15 may point to a spatial direction based on at least one polarization direction through beamforming.

Control module 203 may calculate the power of receiving each BRS mapped on each transmission beam 105 by each of the receiving antenna panel(s). In some embodiments, UE 201 may comprise one or more receiving antenna panels, for example, a
20 default antenna panel and an alternative antenna panel. Control module 203 may then generate the BRS-RP report comprising the receiving power, a BRS identifier to identify the BRS associated with the receiving power, a transmission beam identifier to identify the transmission beam that the BRS may be mapped on, a receiving antenna panel identifier to identify the directional antenna panel or a receiving antenna port identifier to identify a
25 receiving antenna port associated with the directional antenna panel that may receive the BRS on the transmission beam, and/or others. In some embodiments, if UE 201 comprises more than one directional antenna panels, the receiving power in the BRS-RP report may be the highest receiving power for each of the at least one of the BRSs on each of the at least one of the transmission beams across the directional antenna panels. In some
30 embodiments, the receiving power in the BRS-RP report may be higher than a threshold. In some embodiments, the number for the reported transmission beams associated with the BRS-RP may be pre-determined. In some embodiments, the number of the reported receiving antenna panel associated with the BRS-RP may be predetermined. In some

embodiments, the receiving antenna panel identifier (or the receiving antenna port identifier) may comprise 1 bit flag to identify whether the receiving antenna panel (or the receiving antenna port) is a default panel (or a default antenna port) or not.

With the above-stated scheme of BRS-RP reporting, the overhead for UE 201 to transmit the BRS-RP report may be reduced. More details for the BRS-RP report may be described in the below with reference to Figures 2-4.

It should be understood that other embodiments may implement other technologies for the wireless system 100 of Figure 1. In some embodiments, besides the 5th generation wireless technology, the wireless system 100 may use a variety of other wireless access technologies such as Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Orthogonal Frequency Division Multiple Access (OFDMA), Single Carrier Frequency Division Multiple Access (SC-FDMA), and/or others in compliance with an Institute of Electrical and Electronics Engineers (IEEE) 802 system, a 3rd Generation Project Partnership (3GPP) system, a 3GPP Long Term Evolution (LTE) system, and/or a 3GPP2 system.

In some embodiments, the BRS-RP report may be replaced by a BRS receiving quality (BRS-RQ) report which may report BRS receiving quality, or other reports which may report BRS receiving information and help eNB 101 to configure transmission channels between eNB 101 and UE 201.

Figure 2 schematically illustrates an example of BRS-RP measurement by the UE having directional antenna panel(s), in accordance with various embodiments. As illustrated in Figure 2, the BRS-RP measurement result by the directional antenna panel(s) of UE 201 may include BRS-RP measurement values as well as indications of the directional antenna panel(s), transmission beams and/or others that may be associated with the BRS-RP measurement. For example, the receiving power of the BRS mapped on the transmission beam # N_{Tx-1} may be measured as $x_{0,N_{Tx-1}}$ dBm by the directional antenna panel #0 of UE 201, wherein N_{Tx-1} may represent the number of transmission beams carrying the BRSs whose receiving power may be measured.

It should be understood that other embodiments may implement other technologies for BRS receiving information measurement by UE 201. For example, the BRS-RP report may be replaced by a BRS receiving quality (BRS-RQ) report which may report BRS receiving quality, or other reports which may report BRS receiving information and help eNB 101 to configure transmission channels between eNB 101 and UE 201. For another

example, UE 201 may comprise one directional antenna panel and the panel index as shown in Figure 2 may be omitted. For yet another embodiment, the panel index may be replaced by receiving antenna port index, such as ports (A, B) to replace panel #0, ports (C, D) to replace panel #1, and so on.

5 Figure 3 schematically illustrates an example of a BRS-RP report for a directional antenna panel of UE 201, in accordance with various embodiments. As illustrated in Figure 3, besides the measured BRS-RP, the BRS-RP report may comprise an antenna panel identifier, a BRS identifier and a transmission beam identifier to identify the receiving antenna panel, the BRS and the transmission beam associated with the measured BRS-RP.

10 In some embodiments, the BRS-RP report may further comprise a cell identifier to identify a serving cell from which the identified transmission beam may be served.

In some embodiments, the BRS-RP report as illustrated in Figure 3 may comprise a predetermined highest BRS-RP values, rather than all measured BRS-RP values in order to save the BRS-RP report overhead. In some embodiments, the BRS-RP report may

15 comprise the BRS-RP values which are higher than a threshold. For example, if UE 201 comprises two or more receiving antenna panels, the BRS-RP report for a secondary or other subsequent antenna panel may comprise a BRS-RP value meeting the following condition:

$$\gamma' - \gamma_j < \Delta$$

20 wherein, γ' may represent the maximum BRS-RP value measured by the previous receiving antenna panel, such as the antenna panel #0, γ_j may represent a BRS-RP value measured by a subsequent receiving antenna panel, such as the antenna panel #1, Δ may represent a difference threshold.

In some embodiments, eNB 101 may request UE 201 to report the BRS-RP values

25 measured by a specific receiving antenna panel. ENB 101 may know the number of directional antennal panel(s) that UE 201 may have and their capacities through the UE capability reporting, when UE 201 accesses the wireless system 100. The specific receiving antenna panel may be obtained through a previous BRS-RP report process.

It should be understood that other embodiments may implement other technologies

30 for BRS-RP report of Figure 3. For example, the BRS-RP report may be replaced by a BRS receiving quality (BRS-RQ) report which may report BRS receiving quality, or other reports which may report BRS receiving information and help eNB 101 to configure transmission channels between eNB 101 and UE 201. For another example, UE 201 may

comprise one directional antenna panel and the panel index as shown in Figure 3 may be omitted. For yet another embodiment, the panel index may be replaced by receiving antenna port index, such as ports (A, B) to replace panel #0, ports (C, D) to replace panel #1, and so on.

5 Figure 4 schematically illustrates an example of a BRS-RP report for all directional antenna panel(s) of the UE, in accordance with various embodiments. As illustrated by Figure 4, the BRS-RP report may comprise a highest BRS-RP value measure by all receiving antenna panel(s) of UE 201 for a BRS on a transmission beam. For example, if UE 201 comprises two or more directional antenna panels, the BRS-RP value in the BRS-
10 RP report as illustrated in Figure 4 may represent the highest BRS-RP value measured across all of the directional antenna panels for a specific transmission beam. In this way, UE 201 may not need to report the BRS-RP values measured by each of the directional antenna panels.

 The BRS-RP report may further comprise an antenna identifier to identify the
15 directional antenna panel which measures the highest BRS-RP. In some embodiments, the antenna identifier may comprise 1 bit flag to identify whether the directional antenna panel is a default panel or not. In a case that the BRS-RP report may report antenna port(s) rather than the antenna panel(s), the antenna identifier may identify whether the antenna port(s) which may receive the BRS on the transmission beam with the highest receiving
20 power is a default antenna port(s) or not.

 It should be understood that other embodiments may implement other technologies for BRS-RP report of Figure 4. For example, the BRS-RP report may be replaced by a BRS receiving quality (BRS-RQ) report which may report BRS receiving quality, or other reports which may report BRS receiving information and help eNB 101 to configure
25 transmission channels between eNB 101 and UE 201.

 Figure 5 schematically illustrates a method of reporting the BRS-RP from the UE to the eNB, in accordance with various embodiments. As illustrated in Figure 5, in some embodiments, transceiver 202 or other devices of UE 201 may receive BRSs mapped on transmission beams 105 from eNB 101, through one or more directional antenna panels of
30 UE 201 in block 501. In some embodiments, the optimized receiving beam from each directional antenna panel which may be obtained via a previous beam acquisition process may receive the BRSs. The directional antenna panel may comprise an antenna array

having multiple antenna elements, which may point to a spatial direction based on at least one polarization direction through beamforming.

In block 502, control module 203 or other devices of UE 201 may measure BRS-RP values for receiving the at least one BRS on the at least one transmission beam.

5 Examples of the BRS-RP measurement may be illustrated in Figure 2, which may comprise BRS-RP values and identifiers of the directional antenna panel(s), BRSs, transmission beams and others that may be associated with the BRS-RP values.

In block 503, control module 203 or other devices of UE 201 may generate the BRS-RP report to report the BRS-RP value(s) for the at least one BRS on the at least one
10 transmission beam. Examples of the BRS-RP report may be illustrated in Figures 3 and 4, which may include BRS-RP values for each directional antenna panel or for all directional antenna panel(s) through, for example, reporting the highest BRS-RP values for the at least one BRS on the at least one transmission beam across all of the directional antenna panel(s). For other example, the BRS-RP report may comprise the BRS-RP values which
15 are higher than a threshold. For other example, the number for the reported transmission beams associated with the BRS-RP may be pre-determined. For other example, the number of the reported receiving antenna panel associated with the BRS-RP may be predetermined. For other example, the receiving antenna panel identifier (or the receiving antenna port identifier) may comprise 1 bit flag to identify whether the directional antenna
20 panel is a default panel or not. In block 504, transceiver 202 or other devices of UE 201 may transmit the BRS-RP report to the eNB.

It should be understood that other embodiments may implement other technologies for BRS receiving information measurement by UE 201. For example, the BRS-RP report may be replaced by a BRS receiving quality (BRS-RQ) report which may report BRS
25 receiving quality, or other reports which may report BRS receiving information and help eNB 101 to configure transmission channels between eNB 101 and UE 201. For another example, UE 201 may comprise one directional antenna panel and the panel index as shown in Figure 2 may be omitted. For yet another embodiment, the panel index may be replaced by receiving antenna port index, such as ports (A, B) to replace panel #0, ports (C,
30 D) to replace panel #1, and so on.

Figure 6 schematically illustrates a method of utilizing the BRS-RP for channel control from the eNB to the UE, in accordance with various embodiments. As illustrated in Figure 6, in some embodiments, transceiver 103 or other devices of eNB 101 may

transmit the BRSs via transmission beams 105 to UE 201, in block 601. In block 602, transceiver 103 or other devices of eNB 101 may receive the BRS-RP report from UE 201, wherein the BRS-RP report may report the receiving power associated with the as least one BRS on the at least one transmission beam which may be measured by the directional antenna panel(s) of UE 201.

Examples of the BRS-RP report may be illustrated in Figures 3 and 4, which may include BRS-RP values for each directional antenna panel or for all directional antenna panel(s) through, for example, reporting the highest BRS-RP values for the at least one BRS on the at least one transmission beam across all of the directional antenna panel(s). For other example, the BRS-RP report may comprise the BRS-RP values which are higher than a threshold. For other example, the number for the reported transmission beams associated with the BRS-RP may be pre-determined. For other example, the number of the reported receiving antenna panel associated with the BRS-RP may be predetermined. For other example, the antenna identifier associated with the BRS-RP may comprise 1 bit flag to identify whether the directional antenna panel of UE 201 is a default panel or not.

In block 603, control module 102 or other devices of eNB 101 may select the select transmission beam candidates at least in part based on the BRS-RP report. For example, control module 102 or other devices of eNB 101 may select N transmission beam candidates having highest receiving power from the BRS-RP report. In block 603, control module 102 may then utilize the selected transmission beams and/or other information associated with the selected transmission beams to configure channel control information, such as a channel state information-reference signal (CSI-RS), an enhanced physical download control channel (EPDCCH), and/or others. For example, control module 102 may select include the receiving antenna panel identifier associated with the transmission beam candidates in the CSI-RS configuration information, the EPDCCH configuration information, and/or others. For other example, control module 102 may determine whether one or more transmission antenna panels should be used for the transmissions between eNB 101 and UE 201, at least in part based on whether the receiving antenna panel identifier associated with the transmission beam candidates identifies one or more receiving antenna panels. More specifically, if the receiving antennal panel identifier identifiers that the transmission beam candidates are associated with one receiving antenna panel, control module 102 or other devices of eNB 101 may determine to use single transmission antenna panel (or related transmission antenna ports)

for the transmission between eNB 101 and UE 201. If the receiving antennal panel identifier identifies that the transmission beam candidates are associated with more than one receiving antenna panel, for example, to a default antenna panel as well as an alternative antenna panel, control module 102 or other devices of eNB 101 may determine
5 to use dual or more transmission antenna panels for the transmission between eNB 101 and UE 201. This way may help eNB 101 to more efficiently navigate transmission resource to serve the UE(s).

It should be understood that other embodiments may implement other technologies for BRS receiving information measurement by UE 201. For example, the BRS-RP report
10 may be replaced by a BRS receiving quality (BRS-RQ) report which may report BRS receiving quality, or other reports which may report BRS receiving information and help eNB 101 to configure transmission channels between eNB 101 and UE 201. For another example, UE 201 may comprise one directional antenna panel and the panel index as shown in Figure 2 may be omitted. For yet another embodiment, the panel index may be
15 replaced by receiving antenna port index, such as ports (A, B) to replace panel #0, ports (C, D) to replace panel #1, and so on.

Figure 7 schematically illustrates an example system in accordance with various embodiments. In some embodiments, the system 700 may comprise one or more processor(s) 704, system control logic 708 coupled with at least one of the processor(s)
20 704, system memory 712 coupled with system control logic 708, non-volatile memory (NVM)/storage 716 coupled with system control logic 708, and a network interface 720 coupled with system control logic 708.

Processor(s) 704 may include one or more single-core or multi-core processors. Processor(s) 704 may include any combination of general-purpose processors and
25 dedicated processors (e.g., graphics processors, application processors, baseband processors, etc.). In an embodiment in which the system 700 implements eNB 101, processor(s) 704 may be configured to execute one or more embodiment(s) as illustrated in Figures 1-4 and 6 in accordance with various embodiments. In an embodiment in which the system 700 implements UE 201, processor(s) 704 may be configured to execute one
30 or more embodiment(s) as illustrated in Figures 1-5 in accordance with various embodiments.

System control logic 708 for one embodiment may include any suitable interface controllers to provide for any suitable interface to at least one of the processor(s) 704

and/or to any suitable device or component in communication with system control logic 708.

System control logic 708 for one embodiment may include one or more memory controller(s) to provide an interface to system memory 712. System memory 712 may be used to load and store data and/or instructions, for example, for system 700. System memory 712 for one embodiment may include any suitable volatile memory, such as suitable dynamic random access memory (DRAM), for example.

NVM/storage 716 may include one or more tangible, non-transitory computer-readable media used to store data and/or instructions, for example. NVM/storage 716 may include any suitable non-volatile memory, such as flash memory, for example, and/or may include any suitable non-volatile storage device(s), such as one or more hard disk drive(s) (HDD(s)), one or more compact disk (CD) drive(s), and/or one or more digital versatile disk (DVD) drive(s), for example.

The NVM/storage 716 may include a storage resource physically part of a device on which the system 700 is installed or it may be accessible by, but not necessarily a part of, the device. For example, the NVM/storage 716 may be accessed over a network via the network interface 720.

System memory 712 and NVM/storage 716 may respectively include, in particular, temporal and persistent copies of instructions 724. Instructions 724 may include instructions that when executed by at least one of the processor(s) 704 result in the system 700 implementing the method as described with reference to Figure 5 and/or 6. In various embodiments, instructions 724, or hardware, firmware, and/or software components thereof, may additionally/alternatively be located in the system control logic 708, the network interface 720, and/or the processor(s) 704.

In some embodiments in which the system 700 may implement eNB 101, network interface 720 may include control module 102, transceiver 103 and/or others as illustrated in Figure 1, to provide a radio interface for system 700 to communicate over one or more network(s) and/or with any other suitable device. In some embodiments in which the system 700 may implement UE 201, network interface 720 may include transceiver 202, control module 203 and/or others as illustrated in Figure 1, to provide a radio interface for system 700 to communicate over one or more network(s) and/or with any other suitable device. In various embodiments, the network interface 720 may be integrated with other components of system 700. For example, the network interface may include a processor

of the processor(s) 704, memory of the system memory 712, NVM/Storage of NVM/Storage 716, and/or a firmware device (not being illustrated) having instructions that when executed by at least one of the processor(s) 704 result in the system 700 implementing the method as described with reference to Figure 5 or Figure 6.

5 Network interface 720 may further include any suitable hardware and/or firmware, such as a plurality of antennas (e.g., antenna 104 of eNB 101 or antenna 204 of UE 201) to provide a multiple input, multiple output radio interface. Network interface 720 for one embodiment may be, for example, a network adapter, a wireless network adapter, a telephone modem, and/or a wireless modem.

10 For one embodiment, at least one of the processor(s) 704 may be packaged together with logic for one or more controller(s) of system control logic 708. For one embodiment, at least one of the processor(s) 704 may be packaged together with logic for one or more controllers of system control logic 708 to form a System in Package (SiP). For one embodiment, at least one of the processor(s) 704 may be integrated on the same
15 die with logic for one or more controller(s) of system control logic 708. For one embodiment, at least one of the processor(s) 704 may be integrated on the same die with logic for one or more controller(s) of system control logic 708 to form a System on Chip (SoC).

 The system 700 may further include input/output (I/O) devices 732. The I/O
20 devices 732 may include user interfaces designed to enable user interaction with the system 700, peripheral component interfaces designed to enable peripheral component interaction with the system 700, and/or sensors designed to determine environmental conditions and/or location information related to the system 700.

 In various embodiments, the user interfaces could include, but are not limited to, a
25 display (e.g., a liquid crystal display, a touch screen display, etc.), a speaker, a microphone, one or more cameras (e.g., a still camera and/or a video camera), a flashlight (e.g., a light emitting diode flash), and a keyboard.

 In various embodiments, the peripheral component interfaces may include, but are not limited to, a non-volatile memory port, an audio jack, and a power supply interface.

30 In various embodiments, the sensors may include, but are not limited to, a gyro sensor, an accelerometer, a proximity sensor, an ambient light sensor, and a positioning unit. The positioning unit may also be part of, or interact with, the network interface 720

to communicate with components of a positioning network, e.g., a global positioning system (GPS) satellite.

In various embodiments, the system 700 may be an eNB (e.g., eNB 101) and/or a UE (e.g., UE 201). In various embodiments, the system 700 may have more or less
5 components, and/or different architectures.

FIG. 8 illustrates, for one embodiment, example components of a UE device 800 in accordance with some embodiments. In some embodiments, the UE device 800 may include application circuitry 802, baseband circuitry 804, Radio Frequency (RF) circuitry 806, front-end module (FEM) circuitry 808, and one or more antennas 810, coupled
10 together at least as shown. In some embodiments, the UE device 800 may include additional elements such as, for example, memory/storage, display, camera, sensor, and/or input/output (I/O) interface.

The application circuitry 802 may include one or more application processors. For example, the application circuitry 802 may include circuitry such as, but not limited to,
15 one or more single-core or multi-core processors. The processor(s) may include any combination of general-purpose processors and dedicated processors (e.g., graphics processors, application processors, etc.). The processors may be coupled with and/or may include memory/storage and may be configured to execute instructions stored in the memory/storage to enable various applications and/or operating systems to run on the
20 system.

The baseband circuitry 804 may include circuitry such as, but not limited to, one or more single-core or multi-core processors. The baseband circuitry 804 may include one or more baseband processors and/or control logic to process baseband signals received from a receive signal path of the RF circuitry 806 and to generate baseband signals for a
25 transmit signal path of the RF circuitry 806. Baseband processing circuitry 804 may interface with the application circuitry 802 for generation and processing of the baseband signals and for controlling operations of the RF circuitry 806. For example, in some embodiments, the baseband circuitry 804 may include a second generation (2G) baseband processor 804a, third generation (3G) baseband processor 804b, fourth generation (4G)
30 baseband processor 804c, and/or other baseband processor(s) 804d for other existing generations, generations in development or to be developed in the future (e.g., fifth generation (5G), 6G, etc.). The baseband circuitry 804 (e.g., one or more of baseband processors 804a-d) may handle various radio control functions that enable communication

with one or more radio networks via the RF circuitry 806. The radio control functions may include, but are not limited to, signal modulation/demodulation, encoding/decoding, radio frequency shifting, etc. In some embodiments, modulation/demodulation circuitry of the baseband circuitry 804 may include Fast-Fourier Transform (FFT), precoding, and/or
5 constellation mapping/demapping functionality. In some embodiments, encoding/decoding circuitry of the baseband circuitry 804 may include convolution, tail-biting convolution, turbo, Viterbi, and/or Low Density Parity Check (LDPC) encoder/decoder functionality. Embodiments of modulation/demodulation and encoder/decoder functionality are not limited to these examples and may include other
10 suitable functionality in other embodiments.

In some embodiments, the baseband circuitry 804 may include elements of a protocol stack such as, for example, elements of an EUTRAN protocol including, for example, physical (PHY), media access control (MAC), radio link control (RLC), packet data convergence protocol (PDCP), and/or RRC elements. A central processing unit (CPU)
15 804e of the baseband circuitry 804 may be configured to run elements of the protocol stack for signaling of the PHY, MAC, RLC, PDCP and/or RRC layers. In some embodiments, the baseband circuitry may include one or more audio digital signal processor(s) (DSP) 804f. The audio DSP(s) 804f may include elements for compression/decompression and echo cancellation and may include other suitable
20 processing elements in other embodiments. Components of the baseband circuitry may be suitably combined in a single chip, a single chipset, or disposed on a same circuit board in some embodiments. In some embodiments, some or all of the constituent components of the baseband circuitry 804 and the application circuitry 802 may be implemented together such as, for example, on a system on a chip (SOC).

In some embodiments, the baseband circuitry 804 may provide for communication compatible with one or more radio technologies. For example, in some embodiments, the baseband circuitry 804 may support communication with an evolved universal terrestrial radio access network (EUTRAN) and/or other wireless metropolitan area networks (WMAN), a wireless local area network (WLAN), a wireless personal area network
30 (WPAN). Embodiments in which the baseband circuitry 804 is configured to support radio communications of more than one wireless protocol may be referred to as multi-mode baseband circuitry.

RF circuitry 806 may enable communication with wireless networks using modulated electromagnetic radiation through a non-solid medium. In various embodiments, the RF circuitry 806 may include switches, filters, amplifiers, etc. to facilitate the communication with the wireless network. RF circuitry 806 may include a receive signal path which may include circuitry to down-convert RF signals received from the FEM circuitry 808 and provide baseband signals to the baseband circuitry 804. RF circuitry 806 may also include a transmit signal path which may include circuitry to up-convert baseband signals provided by the baseband circuitry 804 and provide RF output signals to the FEM circuitry 808 for transmission.

In some embodiments, the RF circuitry 806 may include a receive signal path and a transmit signal path. The receive signal path of the RF circuitry 806 may include mixer circuitry 806a, amplifier circuitry 806b and filter circuitry 806c. The transmit signal path of the RF circuitry 806 may include filter circuitry 806c and mixer circuitry 806a. RF circuitry 806 may also include synthesizer circuitry 806d for synthesizing a frequency for use by the mixer circuitry 806a of the receive signal path and the transmit signal path. In some embodiments, the mixer circuitry 806a of the receive signal path may be configured to down-convert RF signals received from the FEM circuitry 808 based on the synthesized frequency provided by synthesizer circuitry 806d. The amplifier circuitry 806b may be configured to amplify the down-converted signals and the filter circuitry 806c may be a low-pass filter (LPF) or band-pass filter (BPF) configured to remove unwanted signals from the down-converted signals to generate output baseband signals. Output baseband signals may be provided to the baseband circuitry 804 for further processing. In some embodiments, the output baseband signals may be zero-frequency baseband signals, although this is not a requirement. In some embodiments, mixer circuitry 806a of the receive signal path may comprise passive mixers, although the scope of the embodiments is not limited in this respect.

In some embodiments, the mixer circuitry 806a of the transmit signal path may be configured to up-convert input baseband signals based on the synthesized frequency provided by the synthesizer circuitry 806d to generate RF output signals for the FEM circuitry 808. The baseband signals may be provided by the baseband circuitry 804 and may be filtered by filter circuitry 806c. The filter circuitry 806c may include a low-pass filter (LPF), although the scope of the embodiments is not limited in this respect.

In some embodiments, the mixer circuitry 806a of the receive signal path and the mixer circuitry 806a of the transmit signal path may include two or more mixers and may be arranged for quadrature downconversion and/or upconversion respectively. In some embodiments, the mixer circuitry 806a of the receive signal path and the mixer circuitry 806a of the transmit signal path may include two or more mixers and may be arranged for image rejection (e.g., Hartley image rejection). In some embodiments, the mixer circuitry 806a of the receive signal path and the mixer circuitry 806a may be arranged for direct downconversion and/or direct upconversion, respectively. In some embodiments, the mixer circuitry 806a of the receive signal path and the mixer circuitry 806a of the transmit signal path may be configured for super-heterodyne operation.

In some embodiments, the output baseband signals and the input baseband signals may be analog baseband signals, although the scope of the embodiments is not limited in this respect. In some alternate embodiments, the output baseband signals and the input baseband signals may be digital baseband signals. In these alternate embodiments, the RF circuitry 806 may include analog-to-digital converter (ADC) and digital-to-analog converter (DAC) circuitry and the baseband circuitry 804 may include a digital baseband interface to communicate with the RF circuitry 806.

In some dual-mode embodiments, a separate radio IC circuitry may be provided for processing signals for each spectrum, although the scope of the embodiments is not limited in this respect.

In some embodiments, the synthesizer circuitry 806d may be a fractional-N synthesizer or a fractional $N/N+1$ synthesizer, although the scope of the embodiments is not limited in this respect as other types of frequency synthesizers may be suitable. For example, synthesizer circuitry 806d may be a delta-sigma synthesizer, a frequency multiplier, or a synthesizer comprising a phase-locked loop with a frequency divider.

The synthesizer circuitry 806d may be configured to synthesize an output frequency for use by the mixer circuitry 806a of the RF circuitry 806 based on a frequency input and a divider control input. In some embodiments, the synthesizer circuitry 806d may be a fractional $N/N+1$ synthesizer.

In some embodiments, frequency input may be provided by a voltage controlled oscillator (VCO), although that is not a requirement. Divider control input may be provided by either the baseband circuitry 804 or the applications processor 802 depending on the desired output frequency. In some embodiments, a divider control input (e.g., N)

may be determined from a look-up table based on a channel indicated by the applications processor 802.

Synthesizer circuitry 806d of the RF circuitry 806 may include a divider, a delay-locked loop (DLL), a multiplexer and a phase accumulator. In some embodiments, the divider may be a dual modulus divider (DMD) and the phase accumulator may be a digital phase accumulator (DPA). In some embodiments, the DMD may be configured to divide the input signal by either N or $N+1$ (e.g., based on a carry out) to provide a fractional division ratio. In some example embodiments, the DLL may include a set of cascaded, tunable, delay elements, a phase detector, a charge pump and a D-type flip-flop. In these embodiments, the delay elements may be configured to break a VCO period up into N_d equal packets of phase, where N_d is the number of delay elements in the delay line. In this way, the DLL provides negative feedback to help ensure that the total delay through the delay line is one VCO cycle.

In some embodiments, synthesizer circuitry 806d may be configured to generate a carrier frequency as the output frequency, while in other embodiments, the output frequency may be a multiple of the carrier frequency (e.g., twice the carrier frequency, four times the carrier frequency) and used in conjunction with quadrature generator and divider circuitry to generate multiple signals at the carrier frequency with multiple different phases with respect to each other. In some embodiments, the output frequency may be a LO frequency (fLO). In some embodiments, the RF circuitry 806 may include an IQ/polar converter.

FEM circuitry 808 may include a receive signal path which may include circuitry configured to operate on RF signals received from one or more antennas 810, amplify the received signals and provide the amplified versions of the received signals to the RF circuitry 806 for further processing. FEM circuitry 808 may also include a transmit signal path which may include circuitry configured to amplify signals for transmission provided by the RF circuitry 806 for transmission by one or more of the one or more antennas 810.

In some embodiments, the FEM circuitry 808 may include a TX/RX switch to switch between transmit mode and receive mode operation. The FEM circuitry may include a receive signal path and a transmit signal path. The receive signal path of the FEM circuitry may include a low-noise amplifier (LNA) to amplify received RF signals and provide the amplified received RF signals as an output (e.g., to the RF circuitry 806). The transmit signal path of the FEM circuitry 808 may include a power amplifier (PA) to

amplify input RF signals (e.g., provided by RF circuitry 806), and one or more filters to generate RF signals for subsequent transmission (e.g., by one or more of the one or more antennas 810).

5 In some embodiments, the UE 800 comprises a plurality of power saving mechanisms. If the UE 800 is in an RRC_Connected state, where it is still connected to the eNB as it expects to receive traffic shortly, then it may enter a state known as Discontinuous Reception Mode (DRX) after a period of inactivity. During this state, the device may power down for brief intervals of time and thus save power.

10 If there is no data traffic activity for an extended period of time, then the UE 800 may transition off to an RRC_Idle state, where it disconnects from the network and does not perform operations such as channel quality feedback, handover, etc. The UE 800 goes into a very low power state and it performs paging where again it periodically wakes up to listen to the network and then powers down again. The device cannot receive data in this state, in order to receive data, it must transition back to RRC_Connected state.

15 An additional power saving mode may allow a device to be unavailable to the network for periods longer than a paging interval (ranging from seconds to a few hours). During this time, the device is totally unreachable to the network and may power down completely. Any data sent during this time incurs a large delay and it is assumed the delay is acceptable.

20 The disclosure may include various example embodiments disclosed below.

Example 1 may include a user equipment (UE), comprising: a transceiver to receive a plurality of beam reference signals (BRSs) mapped on a plurality of transmission beams via at least one directional antenna panel; and a control module to generate a report to report receiving information associated with at least one of the BRSs on at least one of
25 the transmission beams, wherein the report is further to comprise an antenna identifier to identify the directional antenna panel or an antenna port associated with the directional antenna panel which receives the at least one of the BRSs on the at least one of the transmission beam; wherein, the transceiver is further to transmit the report to a base station.

30 Example 2 may include the subject matter of Example 1, and optionally, wherein the antenna identifier is a 1 bit flag to indicate whether the direction antenna panel is a default antenna panel or whether the antenna port is a default antenna port.

Example 3 may include the subject matter of any of Examples 1-2, and optionally, wherein the report further comprises a BRS identifier to identify each of the at least one of the BRSs.

5 Example 4 may include the subject matter of any of Examples 1-3, and optionally, wherein the report further comprises a transmission beam identifier to identify each of the at least one of the transmission beams.

Example 5 may include the subject matter of any of Examples 1-4, and optionally, wherein the receiving information comprises receiving power or receiving quality of receiving the at least one of the BRSs on the at least one of the transmission beams.

10 Example 6 may include the subject matter of any of Examples 1-5, and optionally, wherein the receiving power is higher than a threshold.

Example 7 may include the subject matter of any of Examples 1-6, and optionally, wherein if the UE comprises more than one directional antenna panels, the receiving power in the report is the highest receiving power for each of the at least one of the BRSs on each of the at least one of the transmission beams across the directional antenna panels.

Example 8 may include the subject matter of any of Examples 1-7, and optionally, wherein the directional antenna panel comprises an antenna array of multiple antenna elements, which may point to a spatial direction based on at least one polarization direction through beamforming.

20 Example 9 may include the subject matter of any of Examples 1-8, and optionally, wherein the report further comprises a cell identifier to identify a serving cell that the at least one of the transmission beam is served.

Example 10 may include the subject matter of any of Examples 1-9, and optionally, wherein the base station is an evolved Node B.

25 Example 11 may include a base station, comprising: a transceiver to transmit, to a user equipment (UE), a plurality of beam reference signals (BRSs) via a plurality of transmission beams; and to receive, from the UE, a report to report receiving information associated with at least one of the BRSs on at least one of the transmission beams, wherein the report comprises an antenna identifier to identify a directional antenna panel or an antenna port associated with the directional antenna panel of the UE which receives the at least one of the BRSs on the at least one of the transmission beam.

30 Example 12 may include the subject matter of Example 11, and optionally, further comprising: a control module to utilize the report to configure channel control information;

and wherein the transceiver is further to transmit the channel control information to the UE.

Example 13 may include the subject matter of any of Examples 11-12, and optionally, wherein that the control module utilizes the report further comprises to select
5 one or more transmission beam candidates at least in part based on the receiving information in the report; and to configure the channel control information to include the antenna identifier of the directional antenna panel or the antenna port associated with the transmission beam candidates as least in part based on the report.

Example 14 may include the subject matter of any of Examples 11-13, and
10 optionally, wherein that the control module utilizes the report further comprises to: select one or more transmission beam candidate at least in part based on the receiving information in the report; and determine one or more transmission antenna panels for transmission between the eNB and the UE at least in part based on a determination of whether the UE uses one or more directional antenna panel to receive the BRS on the
15 transmission beam candidates.

Example 15 may include the subject matter of any of Examples 11-14, and optionally, wherein the channel control information is associated with a channel state information-reference signal (CSI-RS) and/or a second set of an enhanced physical control channel (EPDCCH).

Example 16 may include the subject matter of any of Examples 11-15, and
20 optionally, wherein the antenna identifier is a 1 bit flag to indicate whether the direction antenna panel is a default antenna panel or whether the antenna port is the default antenna port.

Example 17 may include the subject matter of any of Examples 11-16, and
25 optionally, wherein the report further comprises a BRS identifier to identify each of the at least one of the BRSs.

Example 18 may include the subject matter of any of Examples 11-17, and optionally, wherein the report further comprises a transmission beam identifier to identify each of the at least one of the transmission beams.

Example 19 may include the subject matter of any of Examples 11-18, and
30 optionally, wherein the receiving information comprises receiving power or receiving quality of receiving the at least one of the BRSs on the at least one of the transmission beams.

Example 20 may include the subject matter of any of Examples 11-19, and optionally, wherein the receiving power is higher than a threshold.

Example 21 may include the subject matter of any of Examples 11-20, and optionally, wherein if the UE comprises more than one directional antenna panels, the receiving power in the report is the highest receiving power for each of the at least one of the BRSs on each of the at least one of the transmission beams across the directional antenna panels.

Example 22 may include the subject matter of any of Examples 11-21, and optionally, wherein the base station is an evolved Node B.

Example 23 may include a method, to be employed by a user equipment (UE), comprising: receiving a plurality of beam reference signals (BRSs) mapped on a plurality of transmission beams via at least one directional antenna panel; generating a report to report receiving information associated with at least one of the BRSs on at least one of the transmission beams, wherein the report is further to comprise an antenna identifier to identify the directional antenna panel or an antenna port associated with the directional antenna panel which receives the at least one of the BRSs on the at least one of the transmission beam; and transmitting the report to a base station.

Example 24 may include the subject matter of Example 23, and optionally, the antenna identifier is a 1 bit flag to indicate whether the direction antenna panel is a default antenna panel or whether the antenna port is a default antenna port.

Example 25 may include the subject matter of any of Examples 23-24, and optionally, wherein the report further comprises a BRS identifier to identify each of the at least one of the BRSs.

Example 26 may include the subject matter of any of Examples 23-25, and optionally, wherein the report further comprises a transmission beam identifier to identify each of the at least one of the transmission beams.

Example 27 may include the subject matter of any of Examples 23-26, and optionally, wherein the receiving information comprises receiving power or receiving quality of receiving the at least one of the BRSs on the at least one of the transmission beams.

Example 28 may include the subject matter of any of Examples 23-27, and optionally, wherein the receiving power is higher than a threshold.

Example 29 may include the subject matter of any of Examples 23-28, and optionally, wherein if the UE comprises more than one directional antenna panels, the receiving power in the report is the highest receiving power for each of the at least one of the BRSs on each of the at least one of the transmission beams across the directional
5 antenna panels.

Example 30 may include the subject matter of any of Examples 23-29, and optionally, wherein the directional antenna panel comprises an antenna array of multiple antenna elements, which may point to a spatial direction based on at least one polarization direction through beamforming.

10 Example 31 may include the subject matter of any of Examples 23-30, and optionally, wherein the report further comprises a cell identifier to identify a serving cell that the at least one of the transmission beam is served.

Example 32 may include the subject matter of any of Examples 23-31, and optionally, wherein the base station is an evolved Node B.

15 Example 33 may include a method, to be employed by a base station, comprising: transmitting, to a user equipment (UE), a plurality of beam reference signals (BRSs) via a plurality of transmission beams; and receiving, from the UE, a report to report receiving information associated with at least one of the BRSs on at least one of the transmission beams, wherein the report comprises an antenna identifier to identify a directional antenna
20 panel or an antenna port associated with the directional antenna panel of the UE which receives the at least one of the BRSs on the at least one of the transmission beam.

Example 34 may include the subject matter of Example 33, and optionally, further comprising: utilizing the report to configure channel control information; and transmitting the channel control information to the UE.

25 Example 35 may include the subject matter of any of Examples 33-34, and optionally, wherein the utilizing further comprises: selecting one or more transmission beam candidates at least in part based on the receiving information in the report; and configuring the channel control information to include the antenna identifier of the directional antenna panel or the antenna port associated with the transmission beam
30 candidates as least in part based on the report.

Example 36 may include the subject matter of any of Examples 33-35, and optionally, wherein the channel control information is associated with a channel state

information-reference signal (CSI-RS) and/or a second set of an enhanced physical control channel (EPDCCH).

Example 37 may include the subject matter of any of Examples 33-36, and optionally, wherein the utilizing further comprises: selecting one or more transmission
5 beam candidate at least in part based on the receiving information in the report; and determining one or more transmission antenna panels for transmission between the eNB and the UE at least in part based on a determination of whether the UE uses one or more directional antenna panel to receive the BRS on the transmission beam candidates.

Example 38 may include the subject matter of any of Examples 33-37, and
10 optionally, wherein the antenna identifier is a 1 bit flag to indicate whether the direction antenna panel is a default antenna panel or whether the antenna port is the default antenna port.

Example 39 may include the subject matter of any of Examples 33-38, and optionally, wherein the report is further to comprise a BRS identifier to identify each of
15 the at least one of the BRSs.

Example 40 may include the subject matter of any of Examples 33-39, and optionally, wherein the report is further to comprise a transmission beam identifier to identify each of the at least one of the transmission beams.

Example 41 may include the subject matter of any of Examples 33-40, and
20 optionally, wherein the receiving information comprises receiving power or receiving quality of receiving the at least one of the BRSs on the at least one of the transmission beams.

Example 42 may include the subject matter of any of Examples 33-41, and optionally, wherein the receiving power is higher than a threshold.

Example 43 may include the subject matter of any of Examples 33-42, and
25 optionally, wherein if the UE comprises more than one directional antenna panels, the receiving power in the report is the highest receiving power for each of the at least one of the BRSs on each of the at least one of the transmission beams across the directional antenna panels.

Example 44 may include the subject matter of any of Examples 33-43, and
30 optionally, wherein the base station is an evolved Node B.

Example 45 may comprise a computer-readable storage medium that stores instructions for execution by a processor to perform operations of a UE or a base station,

the operations, when executed by the processor to execute any of the operations discussed above in any combination.

Example 46 may comprise an apparatus for a UE or a base station comprising means for executing any of the operations discussed above in any combination.

5 Although certain embodiments have been illustrated and described herein for purposes of description, a wide variety of alternate and/or equivalent embodiments or implementations calculated to achieve the same purposes may be substituted for the embodiments shown and described without departing from the scope of the present disclosure. This application is intended to cover any adaptations or variations of the
10 embodiments discussed herein. Therefore, it is manifestly intended that embodiments described herein be limited only by the claims and the equivalents thereof.

CLAIMS:

What is claimed is:

1. A user equipment (UE), comprising:
a transceiver to receive a plurality of beam reference signals (BRSs) mapped on a
5 plurality of transmission beams via at least one directional antenna panel; and
a control module to generate a report to report receiving information associated
with at least one of the BRSs on at least one of the transmission beams, wherein the report
comprises an antenna identifier to identify the directional antenna panel or an antenna port
associated with the directional antenna panel which receives the at least one of the BRSs
10 on the at least one of the transmission beam;
wherein, the transceiver is further to transmit the report to a base station.
2. The UE of claim 1, wherein the antenna identifier is a 1 bit flag to indicate whether
the direction antenna panel is a default antenna panel or whether the antenna port is a
15 default antenna port.
3. The UE of claim 1 or 2, wherein the report further comprises a BRS identifier to
identify each of the at least one of the BRSs.
- 20 4. The UE of any of claims 1-3, wherein the report further comprises a transmission
beam identifier to identify each of the at least one of the transmission beams.
5. The UE of any of claims 1-3, wherein the receiving information comprises
receiving power or receiving quality of receiving the at least one of the BRSs on the at
25 least one of the transmission beams.
6. The UE of claim 5, wherein the receiving power is higher than a threshold and
wherein if the UE comprises more than one directional antenna panels, the receiving
power in the report is the highest receiving power for each of the at least one of the BRSs
30 on each of the at least one of the transmission beams across the directional antenna panels.

7. The UE of any of claims 1-6, wherein the directional antenna panel comprises an antenna array of multiple antenna elements, which points to a spatial direction based on at least one polarization direction through beamforming.

5 8. The UE of any of claims 1-7, wherein the report further comprises a cell identifier to identify a serving cell that the at least one of the transmission beam is served.

9. An apparatus of a base station, comprising:

10 a transceiver to transmit, to a user equipment (UE), a plurality of beam reference signals (BRSs) via a plurality of transmission beams; and to receive, from the UE, a report to report receiving information associated with at least one of the BRSs on at least one of the transmission beams, wherein the report comprises an antenna identifier to identify a directional antenna panel or an antenna port associated with the directional antenna panel of the UE which receives the at least one of the BRSs on the at least one of the
15 transmission beam.

10. The apparatus of claim 9, further comprising:

a control module to utilize the report to configure channel control information; and wherein the transceiver is further to transmit the channel control information to the UE.
20

11. The apparatus of claim 10, wherein that the control module utilizes the report further comprises to select one or more transmission beam candidates at least in part based on the receiving information in the report; and to configure the channel control information to include the antenna identifier of the directional antenna panel or the
25 antenna port associated with the transmission beam candidates as least in part based on the report.

12. The apparatus of claim 10 or 11, wherein that the control module utilizes the report further comprises to:

30 select one or more transmission beam candidate at least in part based on the receiving information in the report; and

determine one or more transmission antenna panels for transmission between the eNB and the UE at least in part based on a determination of whether the UE uses one or more directional antenna panel to receive the BRS on the transmission beam candidates.

5 13. The apparatus of any of claims 10-12, wherein the channel control information is associated with a channel state information-reference signal (CSI-RS) and/or a second set of an enhanced physical control channel (EPDCCH).

10 14. The apparatus of any of claims 9-13, wherein the antenna identifier is a 1 bit flag to indicate whether the direction antenna panel is a default antenna panel or whether the antenna port is the default antenna port.

15 15. The apparatus of any of claims 9-15, wherein the report further comprises a transmission beam identifier to identify each of the at least one of the transmission beams.

16. The apparatus of any of claims 11-18, wherein the receiving information comprises receiving power or receiving quality of receiving the at least one of the BRSs on the at least one of the transmission beams.

20 17. The apparatus of claim 19, wherein if the UE comprises more than one directional antenna panels, the receiving power in the report is the highest receiving power for each of the at least one of the BRSs on each of the at least one of the transmission beams across the directional antenna panels.

25 18. An apparatus of a user equipment (UE), comprising:
a control module to generate a report to report receiving information associated with at least one of a plurality of beam reference signals (BRSs) mapped on at least one of a plurality of transmission beams, wherein the BRSs are received from a base station via at least one directional antenna panel of the UE, and wherein the report comprises an antenna
30 identifier to identify the directional antenna panel or an antenna port associated with the directional antenna panel.

19. The apparatus of claim 18, further comprising:

a transceiver to receive the beam reference signals (BRSs) mapped on the transmission beams via the at least one directional antenna panel; and to transmit the report to the base station.

5 20. The apparatus of claim 18 or 19, wherein the antenna identifier is a 1 bit flag to indicate whether the direction antenna panel is a default antenna panel or whether the antenna port is a default antenna port.

10 21. The apparatus of any of claims 18-20, wherein the report further comprises a BRS identifier to identify each of the at least one of the BRSs.

15 22. The apparatus of any of claims 18-21, wherein the receiving information comprises receiving power or receiving quality of receiving the at least one of the BRSs on the at least one of the transmission beams.

20 23. The apparatus of claim 22, wherein if the UE comprises more than one directional antenna panels, the receiving power in the report is the highest receiving power for each of the at least one of the BRSs on each of the at least one of the transmission beams across the directional antenna panels.

24. The apparatus of any of claims 18-23, wherein the directional antenna panel comprises an antenna array of multiple antenna elements, which points to a spatial direction based on at least one polarization direction through beamforming.

25 25. The apparatus of any of claims 18-24, wherein the report further comprises a cell identifier to identify a serving cell that the at least one of the transmission beam is served.

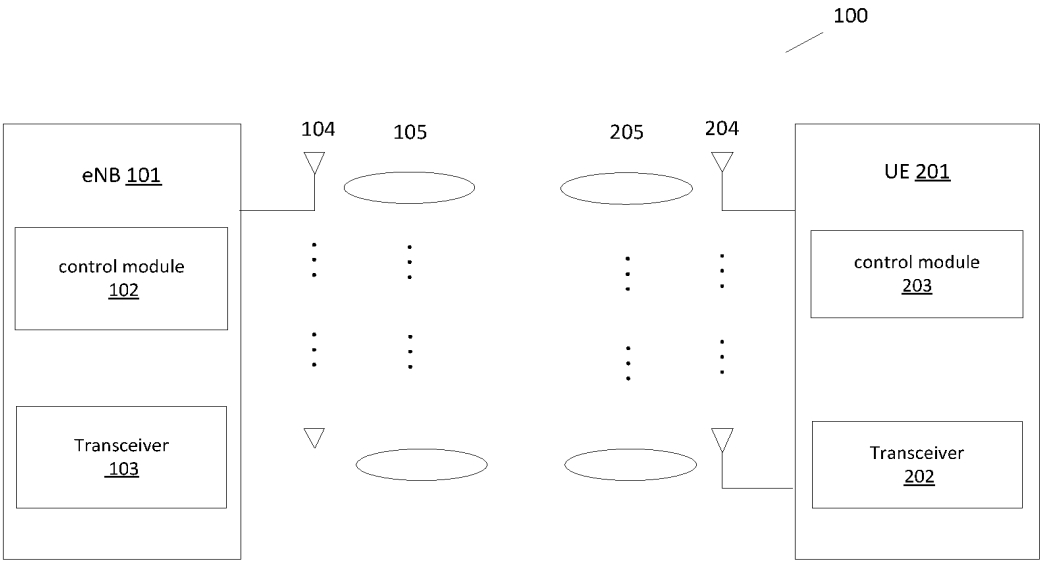


Fig.1

Panel index	TX beam index	BRS-RP value
Panel #0 or Rx antenna ports {A, B}	#0	$x_{0,0}$ dBm
	#1	$x_{0,1}$ dBm
	$\vdots$	$\vdots$
	$\# N_{Tx}-1$	$x_{0,N_{Tx}-1}$ dBm
Panel #1 or Rx antenna ports {C, D}	#0	$x_{1,0}$ dBm
	#1	$x_{1,1}$ dBm
	$\vdots$	$\vdots$
	$\# N_{Tx}-1$	$x_{1,N_{Tx}-1}$ dBm

Fig.2

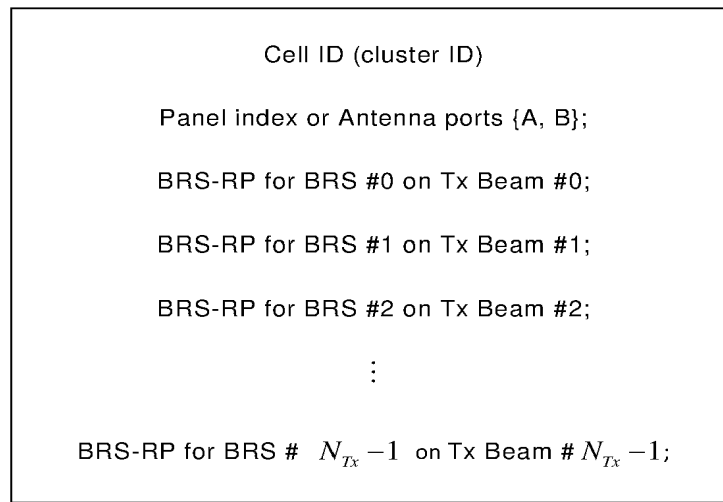


Fig.3

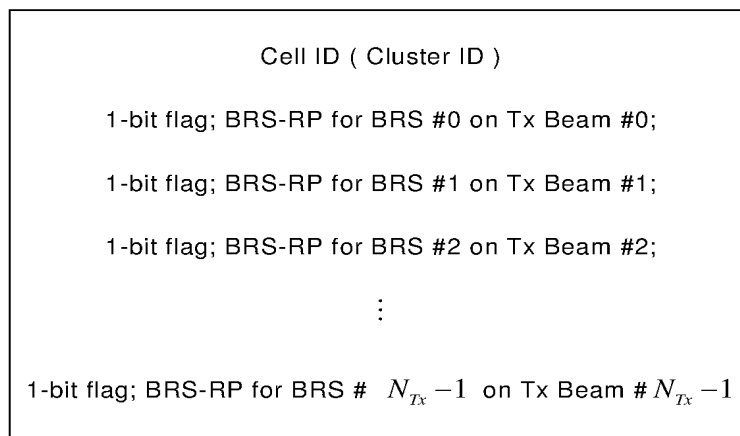


Fig.4

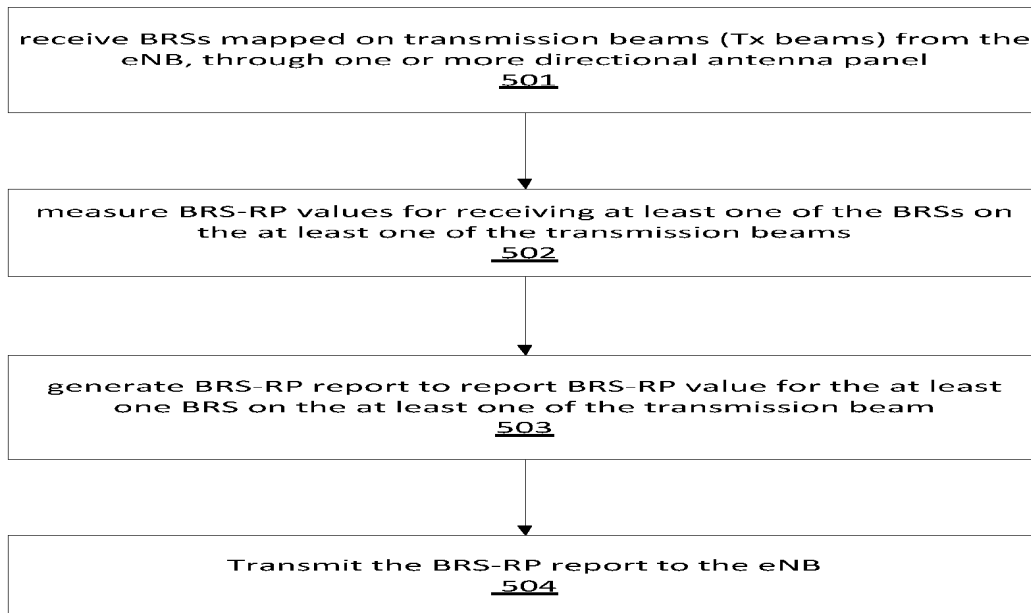


Fig. 5

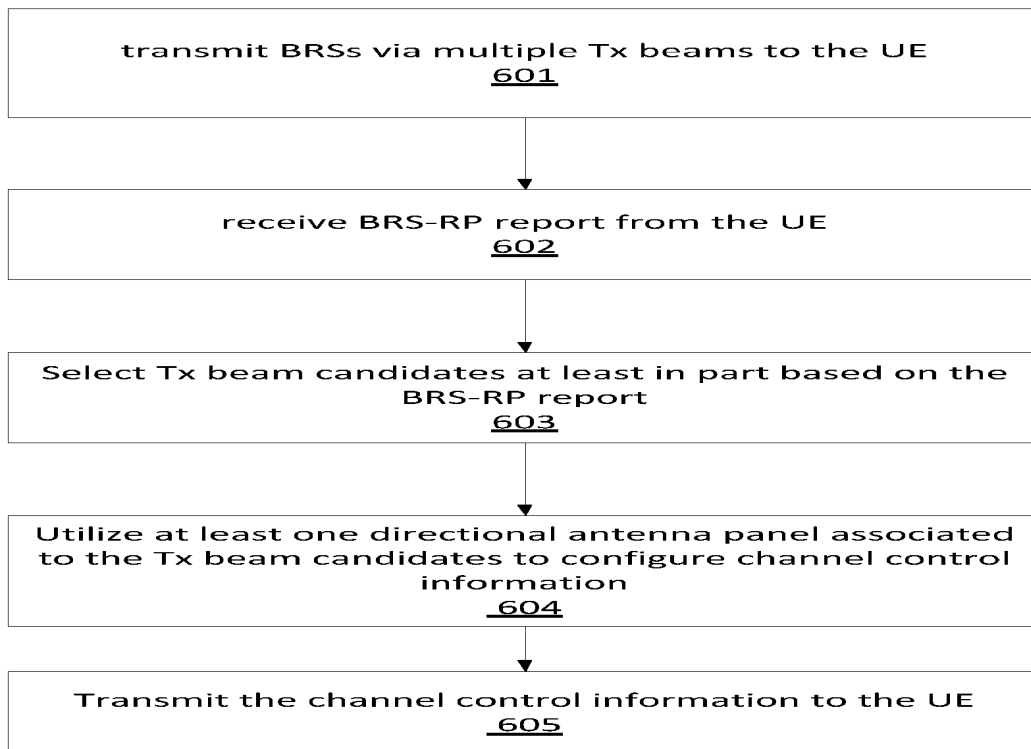


Fig. 6

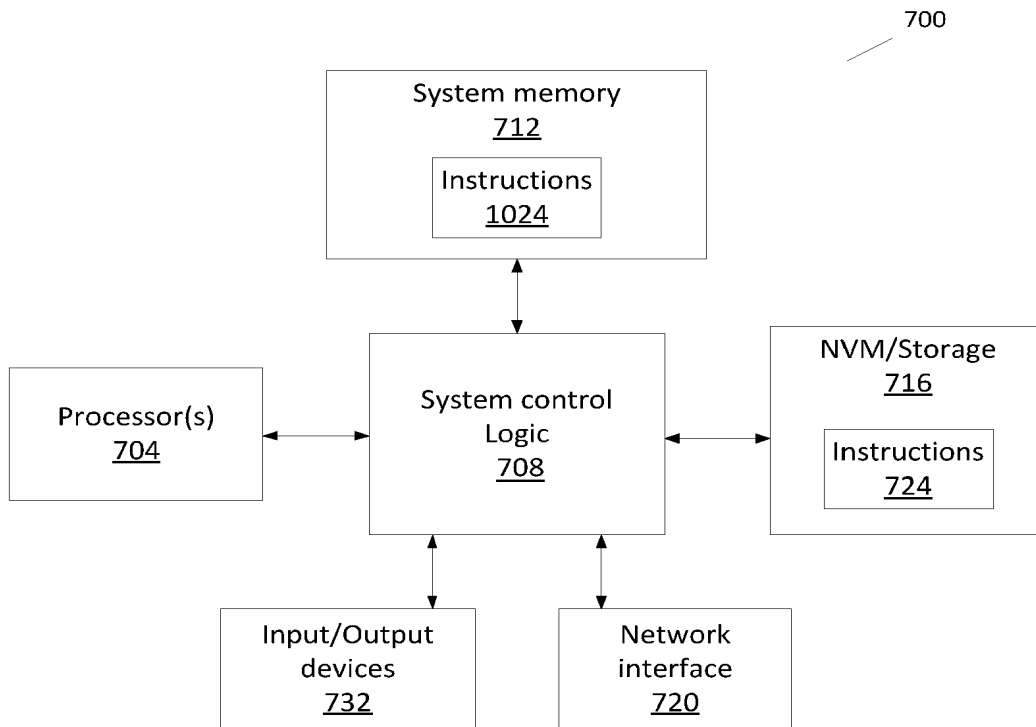


Fig. 7

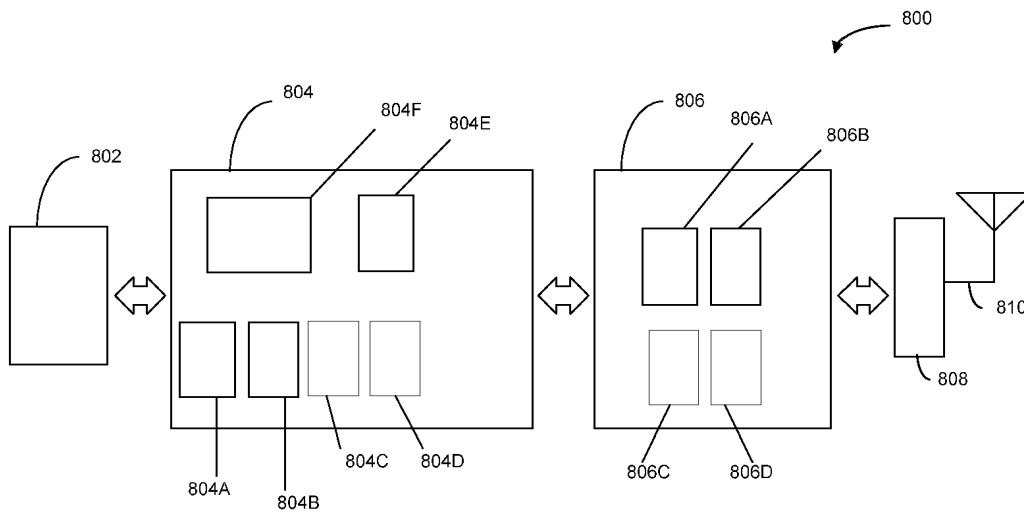


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/078388

A. CLASSIFICATION OF SUBJECT MATTER H04L 1/16(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H04L,H04Q,H04W,H04B Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNPAT,CNKI,EPODOC,WPI,IEEE,3GPP:BRS, reference, beam, select, report, feedback, antenna, massive MIMO, pilot.		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 104184561 A (ZTE CORP.) 03 December 2014 (2014-12-03) description, paragraphs [0008]-[0013], [0235]-[0251]	1-25
X	CN 104205911 A (SAMSUNG ELECTRONICS CO., LTD.) 10 December 2014 (2014-12-10) description, paragraphs [0043]-[0098]	1-25
X	WO 2015020404 A1 (SAMSUNG ELECTRONICS CO., LTD.) 12 February 2015 (2015-02-12) description, paragraphs [0038]-[0078]	1-25
A	CN 104734805 A (ZTE CORP.) 24 June 2015 (2015-06-24) the whole document	1-25
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 25 June 2016		Date of mailing of the international search report 15 July 2016
Name and mailing address of the ISA/CN STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China		Authorized officer SUN,Lili
Facsimile No. (86-10)62019451		Telephone No. (86-10)62413850

Petitioners' Exhibit 1002, p. 167

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/078388

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	104184561	A	03 December 2014	None			
CN	104205911	A	10 December 2014	KR	20130110078	A	08 October 2013
				EP	2832133	A1	04 February 2015
				US	2013258885	A1	03 October 2013
				WO	2013147505	A1	03 October 2013
WO	2015020404	A1	12 February 2015	KR	20150016913	A	13 February 2015
				CN	105453629	A	30 March 2016
CN	104734805	A	24 June 2015	WO	2015090021	A1	25 June 2015

(12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织
国际局

(43) 国际公布日
2017 年 2 月 9 日 (09.02.2017)



(10) 国际公布号
WO 2017/020688 A1

- (51) 国际专利分类号:
H04B 7/06 (2006.01)
- (21) 国际申请号: PCT/CN2016/089766
- (22) 国际申请日: 2016 年 7 月 12 日 (12.07.2016)
- (25) 申请语言: 中文
- (26) 公布语言: 中文
- (30) 优先权:
201510462905.5 2015 年 7 月 31 日 (31.07.2015) CN
- (71) 申请人: 株式会社 NTT 都科摩 (NTT DOCOMO, INC.) [JP/JP]; 日本东京都千代田区永田町 2-11-1 山王 ParkTower, Tokyo (JP)。
- (71) 申请人 (仅对博茨瓦纳): 都科摩 (北京) 通信技术研究中心有限公司 (DOCOMO BEIJING COMMUNICATIONS LABORATORIES CO., LTD.) [CN/CN]; 中国北京市海淀区科学院南路 2 号融科资讯中心 A 座 7 层, Beijing 100190 (CN)。
- (72) 发明人: 侯晓林 (HOU, Xiaolin); 中国北京市海淀区科学院南路 2 号融科资讯中心 A 座 7 层, Beijing 100190 (CN)。 邵伟 (XU, Wei); 中国北京市海淀区

科学院南路 2 号融科资讯中心 A 座 7 层, Beijing 100190 (CN)。 那崇宁 (NA, Chongning); 中国北京市海淀区科学院南路 2 号融科资讯中心 A 座 7 层, Beijing 100190 (CN)。 蒋惠玲 (JIANG, Huiling); 中国北京市海淀区科学院南路 2 号融科资讯中心 A 座 7 层, Beijing 100190 (CN)。 加山英俊 (KAYAMA, Hidetoshi); 中国北京市海淀区科学院南路 2 号融科资讯中心 A 座 7 层, Beijing 100190 (CN)。

(74) 代理人: 北京德琦知识产权代理有限公司 (DEQI INTELLECTUAL PROPERTY LAW CORPORATION); 中国北京市海淀区知春路 1 号学院国际大厦 7 层, Beijing 100083 (CN)。

(81) 指定国 (除另有指明, 要求每一种可提供的国家保护): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST,

[见续页]

(54) Title: SENDING METHOD FOR BEAM REFERENCE SIGNAL, BEAM SELECTION METHOD, BASE STATION, AND USER EQUIPMENT

(54) 发明名称: 波束参考信号的发送方法、波束选择方法、基站及用户终端

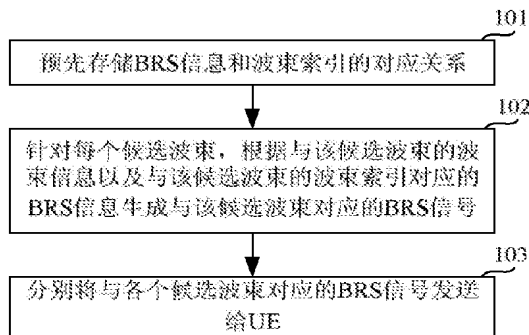


图 1

- 101 Pre-store a corresponding relation between BRS information and a beam index
- 102 For each candidate beam, generate, according to beam information about this candidate beam and BRS information corresponding to a beam index of this candidate beam, a BRS corresponding to this candidate beam
- 103 Send the BRS corresponding to each candidate beam to a UE

(57) Abstract: The present invention provides a sending method for a beam reference signal (BRS), a beam selection method, and a base station and a user equipment (UE) executing the method. The sending method for a BRS comprises: pre-storing a corresponding relation between BRS information and a beam index; for each candidate beam, generating, according to beam information about this candidate beam and BRS information corresponding to a beam index of this candidate beam, a BRS corresponding to this candidate beam; and sending the BRS corresponding to each candidate beam to a UE. By means of the solution, the base station can send a BRS bearing a beam index to the UE to allow the UE to perform beam selection.

(57) 摘要: 本发明提供了波束参考信号(BRS)的发送方法、波束选择方法以及执行上述方法的基站和用户终端(UE)。其中, BRS的发送方法包括: 预先存储 BRS 信息和波束索引的对应关系; 针对每个候选波束, 根据该候选波束的波束信息以及与该候选波束的波束索引对应的 BRS 信息生成与该候选波束对应的 BRS 信号; 以及分别将与各个候选波束对应的 BRS 信号发送给用户终端 UE。通过上述方案, 基站可将承载波束索引的 BRS 发送到 UE, 供 UE 进行波束选择。

WO 2017/020688 A1



SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)。

(84) **指定国** (除另有指明，要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ,

根据细则 4.17 的声明:

— 关于申请人有权要求在先申请的优先权(细则 4.17(iii))

本国际公布:

— 包括国际检索报告(条约第 21 条(3))。

波束参考信号的发送方法、波束选择方法、基站及用户终端

本申请要求于 2015 年 7 月 31 日提交中国专利局、申请号为 201510462905.5、申请名称为“波束参考信号的发送方法、波束选择方法、基站及用户终端”的中国专利申请的优先权,其全部内容通过引用结合在
5 本申请中。

技术领域

本发明涉及无线通信技术,特别涉及波束参考信号(Beamformed Reference Signal, BRS)的发送方法、波束选择方法、基站以及用户终端(User Equipment, UE)。

10 发明背景

当前,随着第四代移动通信(4G)进入规模商用阶段,未来的第五代移动通信(5G)已成为全球研发的热点。

大规模多输入多输出(Massive MIMO)技术已经成为 5G 的关键技术以及研究热点之一。目前,MIMO 技术已经广泛应用于长期演进系统
15 (LTE)、无线保真(Wireless-Fidelity, WIFI)等各个领域。理论上,天线越多,系统的频谱效率和传输可靠性就越高。大规模 MIMO 技术可以由一些并不昂贵的低功耗的天线组件来实现,为在高频段上进行移动通信提供了广阔的前景,它可以成倍提升无线频谱效率,增强网络覆盖和系统容量,帮助运营商最大限度利用已有站址和频谱资源。此外,有源
20 天线系统(AAS)的引入一方面使基站能在三维空间中控制信号的空间分布特性,另一方面将支持天线阵列向二维方向发展,推动大规模 MIMO 技术的发展,大幅提升系统性能。在实际应用中,特别是在高频频段,结合 AAS 和大规模 MIMO 技术的基站在波束赋形时可以产生更多且宽

度更窄的波束,从而可以大幅提高目标 UE 处的信号干扰噪声比(SINR)以及数据吞吐量。

如此,在使用大规模 MIMO 以及 AAS 技术的情况下,UE 如何从众多候选波束中选择质量较好的波束已经成为实现波束赋形需要解决的关键问题。

发明内容

为了解决上述问题,本发明的实施例提供了波束参考信号(BRS)的发送方法以及波束选择方法。

本发明实施例所述的 BRS 发送方法包括:预先存储 BRS 信息和波束索引的对应关系;针对每个候选波束,根据所述候选波束的波束信息以及与所述候选波束的波束索引对应的 BRS 信息生成与所述候选波束对应的 BRS 信号;以及分别将与各个候选波束对应的 BRS 信号发送给 UE。

其中,BRS 信息包括:基序列构造和传输 BRS 信息的时频资源的位置;所述波束信息为波束索引与波束赋形参数的对应关系。

其中,生成与所述候选波束对应的 BRS 信号包括:确定所述候选波束的波束信息;根据预先存储的 BRS 信息和波束索引的对应关系,确定与所述候选波束对应的 BRS 信息;根据确定的 BRS 信息中的基序列构造生成基序列;根据所述基序列确定与该候选波束对应的参考信号的序列;根据确定的波束信息中的波束赋形参数对所述参考信号的序列进行波束赋形,得到与候选波束对应的 BRS 序列;以及根据确定的 BRS 信息中的传输 BRS 信号的时频资源的位置将得到的 BRS 序列进行资源映射,得到对应所述候选波束的 BRS 信号。

上述 BRS 信息进一步包括:基序列的循环移位(CS)值;

所述根据所述基序列确定所述候选波束的参考信号的序列包括:

根据 BRS 信息中的 CS 值对生成的基序列进行相位旋转得到与所述候选波束对应的参考信号。

上述方法进一步包括: 通过下行的信令通知 UE BRS 信息中包括 CS
5 操作以及 CS 操作的参数。

所述波束赋形包括模拟波束赋形、数字波束赋形以及混合波束赋形中的任一项; 和/或,

所述资源映射为块状映射方式或梳状映射方式。

本发明实施例所述的波束选择方法包括: 在系统配置的基站发送
10 BRS 的时频资源位置, 从接收的信号中提取各个候选波束对应的 BRS 信号; 对提取的各个候选波束对应的 BRS 信号进行处理, 得到各个候选波束所对应 BRS 信号的质量参数; 根据各个候选波束所对应 BRS 信号的质量参数从所提取的 BRS 信号中选择 N 个 BRS 信号, 其中, N 为自然数; 确定所选择的 N 个 BRS 信号对应的 BRS 信息, 并根据预先配置
15 的 BRS 信息与波束索引之间的关系, 确定上述所选择的 N 个 BRS 信号对应的 N 个波束索引; 以及将确定的 N 个波束索引反馈给基站。

上述 BRS 信号的质量参数为 BRS 信号的信道质量信息 (CSI); 上述对提取的各个候选波束对应的 BRS 信号进行处理包括: 将提取的 BRS 信号进行信道估计, 得到 BRS 信号的 CSI; 以及所述从所提取的 BRS
20 信号中选择 N 个 BRS 信号包括: 从所提取的 BRS 信号中选择幅度最大的 N 个 BRS 信号。

上述 BRS 信号的质量参数为 BRS 信号的参考信号接收功率 (RSRP); 上述对提取的各个候选波束对应的 BRS 信号进行处理包括: 将提取的 BRS 信号进行功率测量, 得到 BRS 信号的 RSRP; 以及所述
25 从所提取的 BRS 信号中选择 N 个 BRS 信号包括: 从所提取的 BRS 信号

中选择功率最大的 N 个 BRS 信号。

上述将确定的 N 个波束索引反馈给基站包括: 对 N 个波束索引进行编码, 得到一个二进制序列, 再通过波束位图的方式将所述二进制序列反馈给基站。

5 本发明实施例所述的基站包括:

配置单元, 预先存储各个候选波束的波束信息以及 BRS 信息和波束索引的对应关系;

BRS 信号生成单元, 针对每个候选波束, 用于根据与该候选波束的波束信息以及与该候选波束的波束索引对应的 BRS 信息生成与该候选
10 波束对应的 BRS 信号; 以及

发送单元, 分别将与各个候选波束对应的 BRS 信号发送给用户终端 UE。

上述 BRS 信号生成单元包括:

信息确定模块, 用于确定该候选波束的波束信息以及根据预先存储
15 的 BRS 信息和波束索引的对应关系, 确定与该候选波束对应的 BRS 信息;

基序列生成模块, 用于根据确定的 BRS 信息中的基序列构造生成基序列;

参考信号的序列确定模块, 用于根据所述基序列确定参考信号的序
20 列;

波束赋形模块, 用于根据确定的波束信息中的波束赋形参数对参考信号的序列进行波束赋形, 得到该候选波束对应的 BRS 序列;

资源映射模块, 用于根据确定的 BRS 信息中的传输 BRS 信号的时频资源的位置将生成的 BRS 序列进行资源映射, 得到对应该候选波束的
25 BRS 信号。

所述 BRS 信息进一步包括：循环移位 CS 值；

所述参考信号的序列确定模块用于，根据 BRS 信息中的 CS 值对所述基序列进行相位旋转，得到与所述候选波束对应的参考信号的序列。

上述基站进一步包括：通知单元，用于通过下行的信令通知 UE BRS
5 信息中包括 CS 操作以及 CS 操作的参数。

本发明实施例所述的 UE 包括：

接收单元，用于在系统配置的基站发送 BRS 信号的时频资源位置，
从接收的信号中提取各个候选波束对应的 BRS 信号；

信号质量检测单元，用于对提取的各个候选波束对应的 BRS 信号进
10 行处理，得到各个候选波束所对应 BRS 信号的质量参数；

波束选择单元，用于根据各个候选波束所对应 BRS 信号的质量参数
从所提取的 BRS 信号中选择 N 个 BRS 信号，确定所选择的 N 个 BRS
信号对应的 BRS 信息，并根据预先配置的 BRS 信息与波束索引之间的
关系，确定上述所选择的 N 个 BRS 信号对应的 N 个波束索引；以及

15 反馈单元，用于将确定的 N 个波束索引反馈给基站。

附图简要说明

图 1 为本发明实施例所述的波束参考信号的发送方法流程图；

图 2 为本发明实施例所述的生成与每个候选波束对应的 BRS 信号的
方法流程图；

20 图 3 为本发明实施例所述的波束选择方法流程图；

图 4 为本发明实施例所述的基站的内部结构示意图；

图 5 为本发明实施例所述的 BRS 信号生成单元的内部结构示意图；
以及

图 6 为本发明实施例所述的 UE 的内部结构示意图；

图 7 为本发明实施例所述的基站的内部结构示意图；

图 8 为本发明实施例所述的 UE 的内部结构示意图。

实施本发明的方式

为了使本发明的目的、技术方案及优点更加清楚明白，以下结合附图及实施例，对本发明进行进一步详细说明。应当理解，此处所描述的具体实施例仅仅用以解释本发明，并不用于限定本发明。

如前所述，通过结合 AAS 以及大规模 MIMO 技术，基站在波束赋形时可以产生数量更多、宽度更窄的波束。由于这些波束方向性更好，可以大大提高 UE 处的 SINR，从而提高 UE 的数据吞吐量。而为了帮助 UE 从众多候选波束中选择质量较好的波束，完成有效的波束赋形，基站首先需要发送承载各个波束相关信息的波束参考信号（Beamformed Reference Signal, BRS）给 UE，供 UE 进行波束选择。为此，本发明的实施例提供了波束参考信号的发送方法。

首先，为了标识各个候选波束，系统为每个候选波束设置了一个索引，称为波束索引（Beam Index）。其中，波束索引和候选波束是一一对应的。一组波束赋形参数可以唯一确定一个波束，因此，每个候选波束还和一组波束赋形参数是一一对应的。在本发明的实施例中，将一个候选波束的波束索引与该候选波束的波束赋形参数之间的对应关系称为该候选波束的波束信息。为了完成波束赋形，每个基站都应该预先存储有每个候选波束的波束信息。例如，可以在系统初始配置时预先在基站侧配置候选波束的波束信息。

此外，如前所述，为了帮助 UE 进行波束选择，基站需要通过每个候选波束发一些信号给 UE 供其进行测量和选择。为了实现这一目标，在本发明的实施例中，每个候选波束的波束索引具体是通过与每个候选

波束对应的 BRS 信息来承载并发送给 UE 的。具体而言, 上述 BRS 信息是指与 BRS 自身承载的内容以及发送方式有关的信息, 至少包括 BRS 自身承载的基序列的构造以及在发送该 BRS 信号时所占用的时频资源的位置等等。更进一步, 为了扩展 BRS 信息可以承载的波束索引的数量, 5 上述 BRS 信息还可以包括自身所承载基序列的循环移位 (Cyclic Shift, CS) 值。其中, 基序列为一基础序列, 通过对该基序列进行不同的循环移位可以得到多个不同的参考信号的序列。

为了承载每个候选波束的波束索引, 需要预先定义 BRS 信息与波束索引之间的一一对应关系, 即保证每种 BRS 信息唯一对应一个波束索引。为了进行波束选择, 基站侧和 UE 侧都应当预先存储上述 BRS 信息 10 与波束索引的对应关系。对于基站侧, 可以在系统初始配置时进行相关配置。对于 UE 侧, 也可以在系统初始配置时进行相关配置, 或者还可以在系统启动运行后, 由基站通过准静态的信令将 BRS 信息与波束索引的对应关系发送给 UE。UE 在收到 BRS 信息与波束索引的对应关系后 15 存储这一对应关系。

下面将通过举例详细说明在不同情况下 BRS 信息与波束索引的对应关系。

如前所述, BRS 信息可以包括自身承载的基序列的构造、对该基序列进行 CS 操作的 CS 值以及在发送该 BRS 时所占用的时频资源的位置。 20 如此, 在建立 BRS 信息与波束索引的对应关系时, 不同的基序列、不同 CS 值以及不同时频资源位置的组合将分别对应于不同的波束索引。例如, 假设当前使用的基序列有 2 个, CS 值有 4 个, 可用于传输 BRS 的不同的时频资源有 8 个, 则可共有 $2 \times 4 \times 8 = 64$ 个 BRS 信息。这 64 个 BRS 信息将分别一一对应于 64 个候选波束的波束索引。假设当前使用的基 25 序列只有 1 个, 但 CS 值有 4 个, 可用于传输 BRS 的不同的时频资源有

8 个，则可共有 $4 \times 8 = 32$ 个 BRS 信息。这 32 个 BRS 信息将分别一一对应于 32 个候选波束的波束索引。

若 BRS 信息仅包括基序列的构造以及在发送该 BRS 时所占用的时频资源，而不包括对基序列进行 CS 操作的 CS 值，也即不对基序列进行 CS 操作。则在建立 BRS 信息与波束信息的对应关系时，不同的基序列以及不同时频资源的组合将分别对应于不同的波束索引。例如，假设当前使用的基序列有 2 个，而且没有循环移位，可以用于传输 BRS 的时频资源有 8 个。则在这种情况下只有 $2 \times 8 = 16$ 个 BRS 信息，仅可以分别一一对应于 16 个候选波束的波束索引。

从上述对应关系可以看出，为了承载不同候选波束的波束索引，对应不同候选波束的 BRS 信息是不同的。也即，如果 BRS 信息中基序列构造相同且不对基序列进行 CS 操作，则不同候选波束对应的 BRS 序列应当被映射到不同的时频资源（即正交的时频资源）上。例如，在这种情况下，如果需要承载 64 个波束索引，则共需要 64 个正交的时频资源。在这种情况下，BRS 的开销就与候选波束的数量成正比。而在本发明的实施例中，由于 BRS 信息中还包括基序列的不同构造和/或对基序列的 CS 值等参数，因此在本发明的实施例中，除了正交的时频资源外还可以使用不同的基序列或针对相同基序列采用不同循环移位来发送 BRS 序列。在这种情况下，不同的 BRS 序列可以占用相同的时频资源，从而达到减少 BRS 开销的目的。例如，在这种情况下，如果共有 8 个基序列可以选择，且供选择的 CS 值也有 8 个，则可以只用 1 个时频资源就可以同时承载这 64 个候选波束对应的 BRS 序列，BRS 开销将大大减少。同时，在 UE 侧还可以实现 BRS 序列的并行接收，有效减少波束选择的时间，减少时延。

基于上述配置，本发明的实施例给出了一种基站发送波束参考信号

的方法，具体实现流程如图 1 所示，主要包括如下步骤：

步骤 101，预先存储 BRS 信息和波束索引的对应关系。

步骤 102，针对每个候选波束，根据该候选波束的波束信息以及与该候选波束的波束索引对应的 BRS 信息生成与该候选波束对应的 BRS 信号。

步骤 103，分别将与各个候选波束对应的 BRS 信号发送给 UE。

下面将进一步结合附图详细说明上述步骤 102 的实现方法。图 2 显示了根据本发明实施例的生成与每个候选波束对应的 BRS 信号的方法。针对每个候选波束，基站都将执行如图 2 所示的操作。如图 2 所示，该方法主要包括：

步骤 1021，确定该候选波束的波束信息。

如前所述，波束信息具体为波束索引与波束赋形参数的对应关系。

步骤 1022，根据预先存储的 BRS 信息和波束索引的对应关系，确定与该候选波束对应的 BRS 信息。

如前所述 BRS 信息包括：BRS 自身承载的基序列的构造以及在发送该 BRS 时所占用的时频资源的位置。BRS 信息还可以包括对基序列进行 CS 操作的 CS 值。

若上述 BRS 信息中包括对基序列进行 CS 操作的 CS 值，则基站还需要通过下行的信令通知 UE BRS 信息中包括 CS 操作，即通知 UE 在波束选择过程中需要进一步检测基序列的 CS 操作。同时，基站还需要通过下行信令通知 UE CS 操作的参数，例如最大的 CS 数量或实际的 CS 数量，以便 UE 进行 CS 检测。

步骤 1023，根据确定的 BRS 信息中的基序列构造生成基序列。

具体而言，在本步骤中，若对应各个候选波束的 BRS 中的基序列都相同，则基站针对各个候选波束生成的基序列都是相同的；若对应各个

候选波束的 BRS 中的基序列都不相同,则基站针对各个候选波束生成的基序列都是不同的;若对应各个候选波束的 BRS 中的基序列有相同的也有不同的,则基站针对各个候选波束生成的基序列则是部分相同而部分不同。

5 步骤 1024, 根据基序列确定候选波束的参考信号的序列。

具体包括, 若确定的 BRS 信息中包含 CS 值, 则根据该 CS 值对基序列进行相位旋转得到与该候选波束对应的参考信号的序列。若确定的 BRS 信息中不包含 CS 值, 则将不用执行该步骤, 在步骤 1023 直接将基序列作为与该候选波束对应的参考信号的序列。

10 具体而言, 在本步骤中, 如果确定的 BRS 信息包含 CS 值, 则根据该 CS 值对生成的基序列进行相位旋转。具体的操作方式可以参考如下公式 (1):

$$y_k = x_k \cdot e^{-j\frac{2\pi}{N}n_s k} \quad (1)$$

15 其中, x_k 代表某个候选波束的基序列的第 k 个样值; y_k 代表该候选波束对应的参考信号的序列的第 k 个样值; n_s 代表 CS 操作的 CS 值, 即循环移位的样值数; N 代表 OFDM 调制的 FFT 大小。

步骤 1025, 根据确定的波束信息中的波束赋形参数对参考信号的序列进行波束赋形, 得到该候选波束对应的 BRS 序列。

20 具体而言, 在本步骤中, 基站可以通过模拟波束赋形、数字波束赋形以及混合波束赋形等波束赋形方式对参考信号的序列进行波束赋形。

步骤 1026, 根据确定的 BRS 信息中传输 BRS 信号的时频资源的位置将生成的 BRS 序列进行资源映射, 得到对应该候选波束的 BRS 信号。

由此可以看出, 通过上述波束参考信号发送方法, 基站即可将承载波束索引的波束参考信号通过各个波束发送到 UE, 供 UE 进行波束选

择。

在本发明的实施例中，在进行 BRS 序列的资源映射时，基站可以采用块状映射方式（连续 BRS）或梳状映射方式（Comb-type BRS）。在采用梳状映射方式时，基站还需要通过下行信令通知 UE 梳状间隔（Comb
5 Interval）以及频率偏置（Frequency Offset），供 UE 进行 BRS 信号的检测。

接下来再结合图 3，详细说明 UE 侧进行波束选择的方法。

图 3 显示了本发明实施例所述的 UE 进行波束选择的方法。如图 3 所示，该方法主要包括：

10 步骤 301，UE 在系统配置的基站发送 BRS 信号的时频资源位置，从接收的信号中提取各个候选波束对应的 BRS 信号。

由于系统在初始配置时将预先确定基站发送 BRS 信号的时频资源的位置，且基站和 UE 会配置上述信息。也即，基站预先知道在哪些时频资源上发送各个候选波束的 BRS 信号，UE 也预先知道基站会在哪些
15 时频资源上发送各个候选波束的 BRS 信号。因此，在本步骤中，UE 可以从接收的信号中提取各个候选波束对应的 BRS 信号。

步骤 302，UE 对提取的各个候选波束对应的 BRS 信号进行处理，得到各个候选波束所对应 BRS 信号的质量参数。

在本步骤中，上述 BRS 信号的质量参数可以是 BRS 信号的信道状态信息（Channel State Information, CSI）或 BRS 信号的参考接收功率（Reference Signal Receiving Power, RSRP）。
20

具体而言，若 BRS 信号的质量参数是 BRS 信号的 CSI，则在本步骤中，UE 将根据提取的 BRS 信号进行信道估计，从而得到 BRS 信号的 CSI；若 BRS 信号的质量参数是 BRS 信号的 RSRP，则在本步骤中，UE
25 将进行接收功率测量，从而得到 BRS 的 RSRP。

在 UE 从接收信号中提取出 BRS 信号后，获得 BRS 序列，由于 UE 预先知道基站可用的基序列的集合，因此，可以先通过检测确定该 BRS 序列中承载的实际的基序列。接下来，UE 可以将提取出的 BRS 序列先乘以已确定的基序列的共轭，然后使用快速傅里叶反变换（IFFT）将处理后的 BRS 序列变换到时域，此时具有不同 CS 的 BRS 序列的时域信道冲激响应是彼此分开的，因而，UE 可以一次并行获得多个 BRS 序列的 CSI 或 RSRP。由上述 BRS 序列的检测过程可以看出，在本发明的实施例中，基站侧通过对基序列引入 CS 操作，可以在 UE 侧实现并行的波束选择，从而达到减小 BRS 开销以及降低波束选择时延的目的。

10 步骤 303，UE 根据各个候选波束所对应 BRS 信号的质量参数从所提取的 BRS 信号中选择 N 个 BRS 信号。

在本步骤中，上述 N 为自然数，是预先配置的 UE 可以选择的候选波束的数量。在实际应用中，N 的具体数值可以根据经验设定。

具体而言，若 BRS 信号的质量参数是 BRS 信号的 CSI，则在本步骤中，UE 将从中选择幅度最大的 N 个 BRS 信号；若 BRS 信号的质量参数是 BRS 信号的 RSRP，则在本步骤中，UE 将从中选择功率最大的 N 个 BRS 信号。

步骤 304，UE 确定所选择的 N 个 BRS 信号对应的 BRS 信息。

20 UE 在选择 N 个 BRS 信号后通过对上述步骤中对信号进行处理的过程至少可以得到如下信息：BRS 信号承载的基序列、对该基序列进行 CS 操作的 CS 值以及发送该 BRS 信号的时频资源等。如前所述，上述信息为 BRS 信号对应的 BRS 信息。

具体而言，如前所述，UE 会预先知道基站会在哪些时频资源上发送各个候选波束的 BRS 信号，因此，对应各个候选波束的 BRS 信息中的时频资源信息，对 UE 来讲是可以确定的。此外，如前所述，UE 预先知

道基站可用的基序列的集合以及 CS 值的集合，因此，UE 可以通过检测接收的 BRS 信号可以确定该 BRS 信号实际对应的基序列以及 CS 值，从而分别确定每个 BRS 信号对应的 BRS 信息。

步骤 305，UE 根据 N 个 BRS 信号对应的 BRS 信息以及预先配置的 BRS 信息与波束索引之间的关系，确定上述所选择的 N 个 BRS 信号对应的 N 个波束索引。

如前所述，UE 预先存储有 BRS 信息与波束索引的对应关系，因此 UE 在选择了 N 个 BRS 信号并确定这 N 个 BRS 信号对应的 BRS 信息后，可以进一步通过自身存储的 BRS 信息与波束索引的对应关系确定与这 N 个 BRS 信息对应的波束索引。

步骤 306，UE 将确定的 N 个波束索引反馈给基站。

在本步骤中，UE 可以直接将确定的 N 个波束索引通过上行信令反馈给基站。UE 也可以先对 N 个波束索引进行编码，得到一个二进制序列，再通过波束位图（bitmap）的方式将这个二进制序列反馈给基站。通过 bitmap 的方式反馈波束索引方式的好处在于，信令的开销小。特别是在 N 较大的情况下，采用 bitmap 的方式的信令开销会减少很多。

在 UE 将所选择的波束索引反馈给基站后，基站就可以根据 UE 所反馈的波束索引确定 UE 所选择波束的波束赋形参数。然后，在向该 UE 发送数据时，就可以根据 UE 所选择波束的波束赋形参数对待发送给该 UE 的数据进行波束赋形，形成 UE 所选择的信号质量较好的波束，从而进行有效的数据传输。

对应上述发送波束参考信号的方法，本发明的实施例还提供了一种基站，其内部结构如图 4 所示，主要包括：

配置单元 401，预先存储各个候选波束的波束信息以及 BRS 信息和波束索引的对应关系；

BRS 信号生成单元 402，针对每个候选波束，用于根据与该候选波束的波束信息以及与该候选波束的波束索引对应的 BRS 信息生成与该候选波束对应的 BRS 信号；以及

发送单元 403，分别将与各个候选波束对应的 BRS 信号发送给 UE。

5 其中，BRS 信号生成单元 402 的内部结构如图 5 所示，主要包括：

信息确定模块 4021，用于确定该候选波束的波束信息以及根据预先存储的 BRS 信息和波束索引的对应关系，确定与该候选波束对应的 BRS 信息；

10 基序列生成模块 4022，用于根据确定的 BRS 信息中的基序列构造生成基序列；

参考信号的序列确定模块 4023，用于根据所述基序列确定与所述候选波束对应的参考信号的序列；

波束赋形模块 4024，用于根据确定的波束信息中的波束赋形参数对参考信号的序列进行波束赋形，得到该候选波束对应的 BRS 序列；

15 资源映射模块 4025，用于根据确定的 BRS 信息中的传输 BRS 信号的时频资源的位置将生成的 BRS 序列进行资源映射，得到对应该候选波束的 BRS 信号。

若 BRS 信息中包括对基序列进行 CS 操作的 CS 值，则上述基站还将包括通知单元，用于通过下行的信令通知 BRS 信息中包括 CS 操作以及 CS 操作的参数，例如最大的 CS 数量或实际的 CS 数量等，以便 UE 20 进行 CS 检测。

在一实施例中，BRS 信息进一步包括：循环移位 CS 值；

相应地，参考信号的序列确定模块 4023，用于根据 BRS 信息中的 CS 值对基序列进行相位旋转，得到与该候选波束对应的参考信号的序 25 列。

对应上述波束选择的方法，本发明的实施例还提供了执行上述方法的 UE，其内部结构如图 6 所示，主要包括：

接收单元 601，用于在系统配置的基站发送 BRS 信号的时频资源位置，从接收的信号中提取各个候选波束对应的 BRS 信号。

- 5 信号质量检测单元 602，用于对提取的各个候选波束对应的 BRS 信号进行处理，得到各个候选波束所对应 BRS 信号的质量参数。

上述信号质量检测单元 602 的具体实现方法可以参考上述步骤 302 的具体操作，在此不再赘述。

- 10 波束选择单元 603，用于根据各个候选波束所对应 BRS 信号的质量参数从所提取的 BRS 信号中选择 N 个 BRS 信号，确定所选择的 N 个 BRS 信号对应的 BRS 信息，并根据预先配置的 BRS 信息与波束索引之间的关系，确定上述所选择的 N 个 BRS 信号对应的 N 个波束索引。

上述波束选择单元 603 的具体实现方法请参考上述步骤 303~305 的具体操作，在此不再赘述。

- 15 反馈单元 604，用于将确定的 N 个波束索引反馈给基站。

上述反馈单元的具体实现方法请参考上述步骤 306，在此不再赘述。

- 20 在 UE 将所选择的波束索引反馈给基站后，基站就可以根据 UE 所反馈的波束索引确定 UE 所选择波束的波束赋形参数。然后，在向该 UE 发送数据时，就可以根据 UE 所选择波束的波束赋形参数对待发送给该 UE 的数据进行波束赋形，形成 UE 所选择的信号质量较好的波束，从而进行有效的数据传输。

- 25 图 7 为本发明一实施例提供的基站的结构示意图。如图 7 所示，该基站包括一个或多个处理器 701、存储器 702 以及存储在存储器 702 上用来由一个或多个处理器 701 来执行的一个或多个指令单元 703。指令单元 703 可以包括配置单元 401、BRS 信号生成单元 402 和发送单元 403。

这些虚拟单元包括了用于实现各自功能的指令，这样当处理器 701 和存储器 702 进行通信，读取并执行指令时，基站可以实现相应的功能。

图 8 为本发明一实施例提供的 UE 的结构示意图。如图 8 所示，该 UE 包括一个或多个处理器 801、存储器 802 以及存储在存储器 802 上用来由一个或多个处理器 801 来执行的一个或多个指令单元 803。指令单元 803 可以包括接收单元 601、信号质量检测单元 602、波束选择单元 603 和反馈单元 604。这些虚拟单元包括了用于实现各自功能的指令，这样当处理器 801 和存储器 802 进行通信，读取并执行指令时，UE 可以实现相应的功能。

由上述方案可以看出，通过上述基站侧的波束参考信号的发送过程以及 UE 侧的波束的选择过程，基站可以实现有效的波束赋形，充分利用 AAS 以及大规模 MIMO 技术所带来的数量多且方向性好的波束，从而大幅提高目标 UE 处的 SINR 以及数据吞吐量。同时，本发明的实施例通过使用不同的基序列、不同 CS 值以及不同时频资源位置等组合来扩展可以承载的波束索引的数量，与单纯通过正交时频资源来传输 BRS 信号的方式相比，可以大大降低 BRS 的开销，同时减少波束选择的时延，实现快速的波束赋形。

以上所述仅为本发明的较佳实施例而已，并不用以限制本发明，凡在本发明的精神和原则之内，所做的任何修改、等同替换、改进等，均应包含在本发明保护的范围之内。

权利要求书

- 1、一种波束参考信号 BRS 的发送方法，其特征在于，包括：
预先存储 BRS 信息和波束索引的对应关系；
针对每个候选波束，根据所述候选波束的波束信息以及与所述候选
5 波束的波束索引对应的 BRS 信息生成与所述候选波束对应的 BRS 信号；
以及
分别将与各个候选波束对应的 BRS 信号发送给用户终端 UE。
- 2、根据权利要求 1 所述的方法，其特征在于，所述 BRS 信息包括：
基序列构造和传输 BRS 信号的时频资源的位置；以及
10 所述波束信息为波束索引与波束赋形参数的对应关系。
- 3、根据权利要求 2 所述的方法，其特征在于，所述生成与所述候选
波束对应的 BRS 信号包括：
确定所述候选波束的波束信息；
根据预先存储的 BRS 信息和波束索引的对应关系，确定与所述候选
15 波束对应的 BRS 信息；
根据确定的 BRS 信息中的基序列构造生成基序列；
根据所述基序列确定所述候选波束的参考信号的序列；
根据确定的波束信息中的波束赋形参数对所述候选波束的参考信号
的序列进行波束赋形，得到与所述候选波束对应的 BRS 序列；以及
20 根据确定的 BRS 信息中的传输 BRS 信号的时频资源的位置将得到
的 BRS 序列进行资源映射，得到与所述候选波束对应的 BRS 信号。
- 4、根据权利要求 3 所述的方法，其特征在于，所述 BRS 信息进一步包括：循环移位 CS 值；
所述根据所述基序列确定所述候选波束的参考信号的序列包括：

根据确定的 BRS 信息中的 CS 值对生成的基序列进行相位旋转，得到与所述候选波束对应的参考信号的序列。

5、根据权利要求 4 所述的方法，其特征在于，进一步包括：

5 通过下行的信令通知 UE BRS 信息中包括 CS 操作以及 CS 操作的参数。

6、根据权利要求 3 所述的方法，其特征在于，所述波束赋形包括模拟波束赋形、数字波束赋形以及混合波束赋形中的任一项；和/或，所述资源映射为块状映射方式或梳状映射方式。

7、一种波束选择方法，其特征在于，包括：

10 在系统配置的基站发送波束参考信号 BRS 的时频资源位置，从接收的信号中提取各个候选波束对应的 BRS 信号；

对提取的各个候选波束对应的 BRS 信号进行处理，得到各个候选波束所对应 BRS 信号的质量参数；

15 根据各个候选波束所对应 BRS 信号的质量参数从所提取的 BRS 信号中选择 N 个 BRS 信号，其中，N 为自然数；

确定所选择的 N 个 BRS 信号对应的 BRS 信息，并根据预先配置的 BRS 信息与波束索引之间的关系，确定上述所选择的 N 个 BRS 信号对应的 N 个波束索引；以及

将确定的 N 个波束索引反馈给基站。

20 8、根据权利要求 7 所述的方法，其特征在于，所述 BRS 信号的质量参数为 BRS 信号的信道状态信息 CSI；

所述对提取的各个候选波束对应的 BRS 信号进行处理包括：将提取的 BRS 信号进行信道估计，得到 BRS 信号的 CSI；以及

25 所述从所提取的 BRS 信号中选择 N 个 BRS 信号包括：从所提取的 BRS 信号中选择幅度最大的 N 个 BRS 信号。

9、根据权利要求 7 所述的方法，其特征在于，所述 BRS 信号的质量参数为 BRS 信号的参考信号接收功率 RSRP；

所述对提取的各个候选波束对应的 BRS 信号进行处理包括：将提取的 BRS 信号进行功率测量，得到 BRS 信号的 RSRP；以及

5 所述从所提取的 BRS 信号中选择 N 个 BRS 信号包括：从所提取的 BRS 信号中选择功率最大的 N 个 BRS 信号。

10、根据权利要求 7 所述的方法，其特征在于，所述将确定的 N 个波束索引反馈给基站包括：对 N 个波束索引进行编码，得到一个二进制序列，再通过波束位图 bitmap 的方式将所述二进制序列反馈给基站。

10 11、一种基站，其特征在于，包括：

配置单元，预先存储各个候选波束的波束信息以及波束参考信号 BRS 信息和波束索引的对应关系；

BRS 信号生成单元，针对每个候选波束，用于根据与所述候选波束的波束信息以及与所述候选波束的波束索引对应的 BRS 信息生成与所
15 述候选波束对应的 BRS 信号；以及

发送单元，分别将与各个候选波束对应的 BRS 信号发送给用户终端 UE。

12、根据权利要求 11 所述的基站，其特征在于，所述 BRS 信号生成单元包括：

20 信息确定模块，用于确定所述候选波束的波束信息以及根据预先存储的 BRS 信息和波束索引的对应关系，确定与所述候选波束对应的 BRS 信息；

基序列生成模块，用于根据确定的 BRS 信息中的基序列构造生成基序列；

25 参考信号的序列确定模块，用于根据所述基序列确定与所述候选波

束对应的参考信号的序列；

波束赋形模块，用于根据确定的波束信息中的波束赋形参数对与所述候选波束对应的参考信号的序列进行波束赋形，得到与所述候选波束对应的 BRS 序列；以及

- 5 资源映射模块，用于根据确定的 BRS 信息中的传输 BRS 信号的时频资源的位置将生成的 BRS 序列进行资源映射，得到对应所述候选波束的 BRS 信号。

13、根据权利要求 12 所述的基站，其特征在于，所述 BRS 信息进一步包括：循环移位 CS 值；

- 10 所述参考信号的序列确定模块用于，根据 BRS 信息中的 CS 值对所述基序列进行相位旋转，得到与所述候选波束对应的参考信号的序列。

14、根据权利要求 13 所述的基站，其特征在于，进一步包括：

通知单元，用于通过下行的信令通知 UE BRS 信息中包括 CS 操作以及 CS 操作的参数。

- 15 15、一种用户终端 UE，其特征在于，包括：

接收单元，用于在系统配置的基站发送波束参考信号 BRS 信号的时频资源位置，从接收的信号中提取各个候选波束对应的 BRS 信号；

信号质量检测单元，用于对提取的各个候选波束对应的 BRS 信号进行处理，得到各个候选波束所对应 BRS 信号的质量参数；

- 20 波束选择单元，用于根据各个候选波束所对应 BRS 信号的质量参数从所提取的 BRS 信号中选择 N 个 BRS 信号，确定所选择的 N 个 BRS 信号对应的 BRS 信息，并根据预先配置的 BRS 信息与波束索引之间的关系，确定上述所选择的 N 个 BRS 信号对应的 N 个波束索引；以及

反馈单元，用于将确定的 N 个波束索引反馈给基站。

1/4

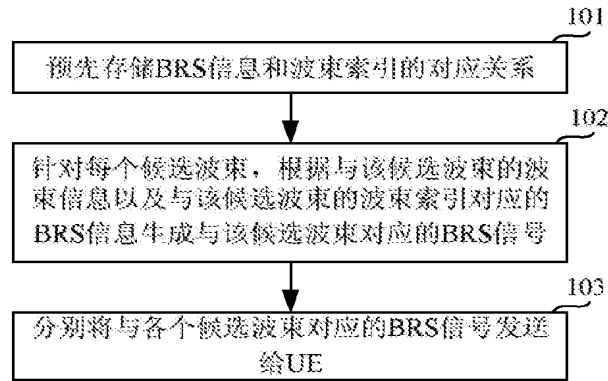


图 1

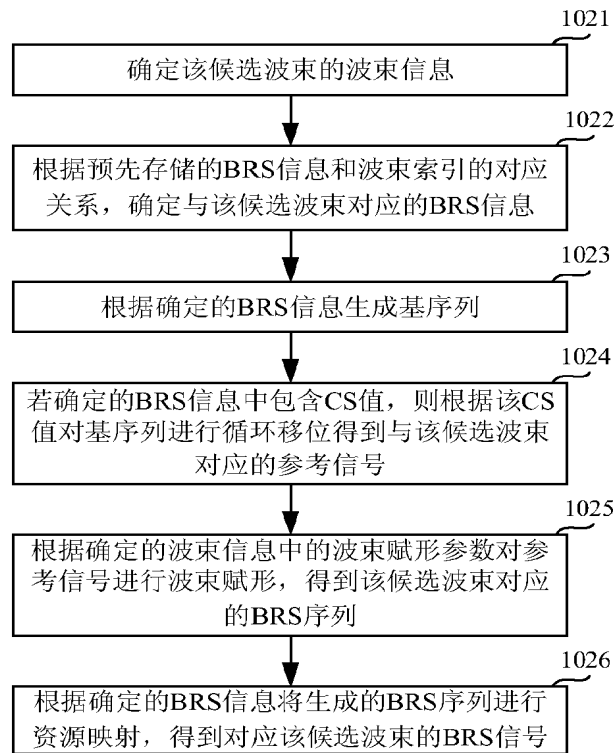


图 2

2/4

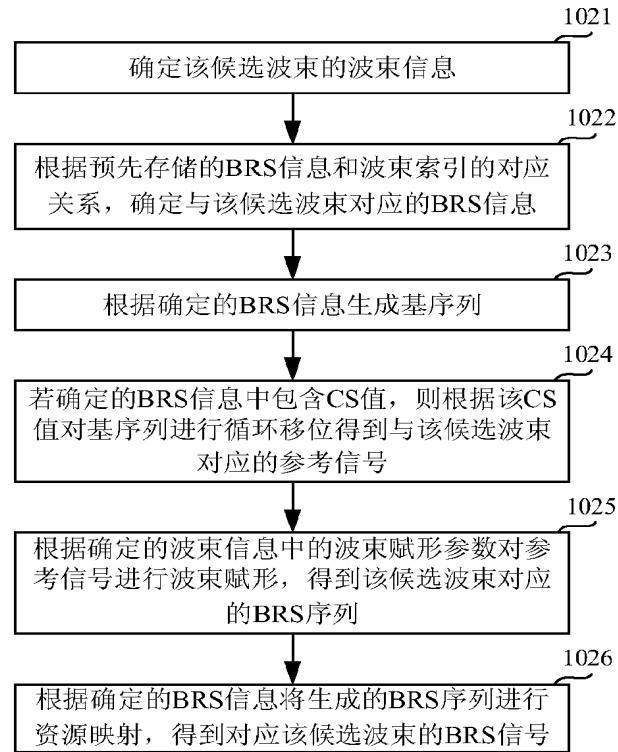


图 3

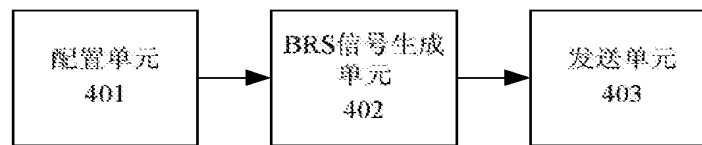


图 4

3/4

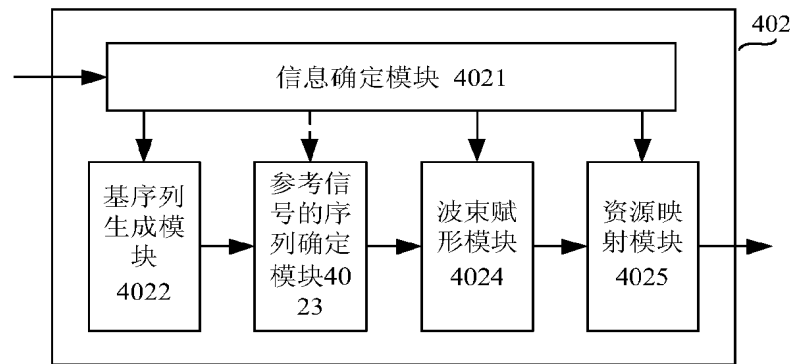


图 5

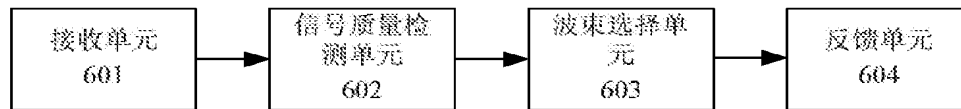


图 6

4/4

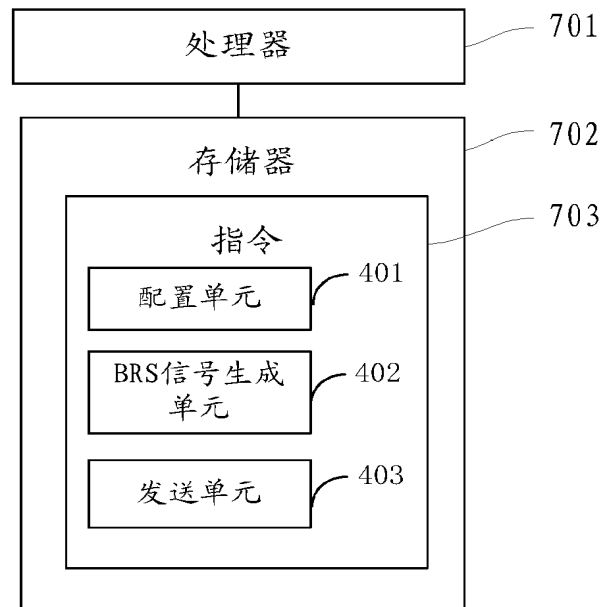


图 7

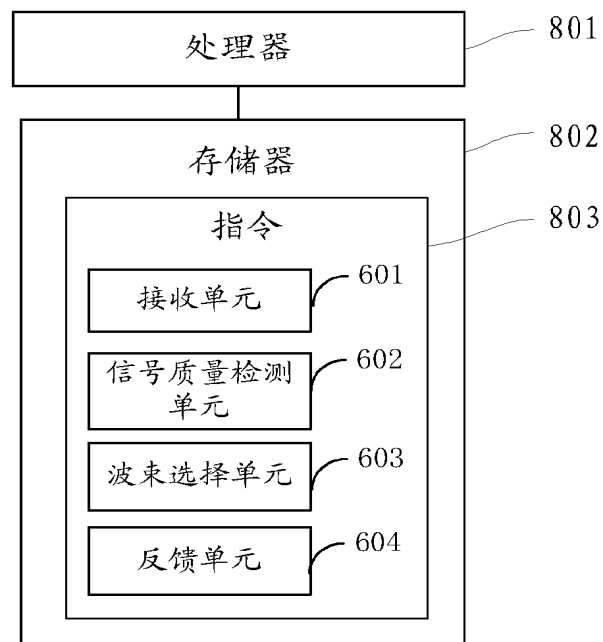


图 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/089766**A. CLASSIFICATION OF SUBJECT MATTER**

H04B 7/06 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L; H04W; H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT; CNABS; CNKI; VEN: reference signal, select, reference, signal, BRS, sequence, beamformed, MIMO, cyclic shift, resource, map

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103812546 A (HUAWEI TECHNOLOGIES CO., LTD.), 21 May 2014 (21.05.2014), description, paragraphs [0100], [0115]-[0118], [0158], [0163] and [0164]	1-15
A	CN 104184561 A (ZTE CORP.), 03 December 2014 (03.12.2014), the whole document	1-15
A	WO 2015060645 A1 (SAMSUNG ELECTRONICS CO., LTD.), 30 April 2015 (30.04.2015), the whole document	1-15

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
07 September 2016 (07.09.2016)Date of mailing of the international search report
27 September 2016 (27.09.2016)Name and mailing address of the ISA/CN:
State Intellectual Property Office of the P. R. China
No. 6, Xitucheng Road, Jimenqiao
Haidian District, Beijing 100088, China
Facsimile No.: (86-10) 62019451

Authorized officer

JIANG, LingTelephone No.: (86-10) **62089875**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/089766

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 103812546 A	21 May 2014	WO 2014071852 A1	15 May 2014
CN 104184561 A	03 December 2014	None	
WO 2015060645 A1	30 April 2015	KR 20150046530 A	30 April 2015
		US 20160226640 A1	04 August 2016

国际检索报告

国际申请号 PCT/CN2016/089766

A. 主题的分类 H04B 7/06 (2006.01) i 按照国际专利分类 (IPC) 或者同时按照国家分类和 IPC 两种分类														
B. 检索领域 检索的最低限度文献 (标明分类系统和分类号) H04L; H04W; H04B 包含在检索领域中的除最低限度文献以外的检索文献 在国际检索时查阅的电子数据库 (数据库的名称, 和使用的检索词 (如使用)) CNXTX; CNABS; CNKI; VEN; 参考信号, 波束赋形, 序列, 循环移位, 资源, 映射, 选择, reference, signal, BRS, sequence, beamformed, MIMO, cyclic shift, resource, map														
C. 相关文件 <table border="1"> <thead> <tr> <th>类 型*</th> <th>引用文件, 必要时, 指明相关段落</th> <th>相关的权利要求</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>CN 103812546 A (华为技术有限公司) 2014年 5月 21日 (2014 - 05 - 21) 说明书第[0100]、[0115]–[0118]、[0158]、[0163]、[0164]段</td> <td>1–15</td> </tr> <tr> <td>A</td> <td>CN 104184561 A (中兴通讯股份有限公司) 2014年 12月 3日 (2014 - 12 - 03) 全文</td> <td>1–15</td> </tr> <tr> <td>A</td> <td>WO 2015060645 A1 (SAMSUNG ELECTRONICS CO LTD) 2015年 4月 30日 (2015 - 04 - 30) 全文</td> <td>1–15</td> </tr> </tbody> </table>			类 型*	引用文件, 必要时, 指明相关段落	相关的权利要求	X	CN 103812546 A (华为技术有限公司) 2014年 5月 21日 (2014 - 05 - 21) 说明书第[0100]、[0115]–[0118]、[0158]、[0163]、[0164]段	1–15	A	CN 104184561 A (中兴通讯股份有限公司) 2014年 12月 3日 (2014 - 12 - 03) 全文	1–15	A	WO 2015060645 A1 (SAMSUNG ELECTRONICS CO LTD) 2015年 4月 30日 (2015 - 04 - 30) 全文	1–15
类 型*	引用文件, 必要时, 指明相关段落	相关的权利要求												
X	CN 103812546 A (华为技术有限公司) 2014年 5月 21日 (2014 - 05 - 21) 说明书第[0100]、[0115]–[0118]、[0158]、[0163]、[0164]段	1–15												
A	CN 104184561 A (中兴通讯股份有限公司) 2014年 12月 3日 (2014 - 12 - 03) 全文	1–15												
A	WO 2015060645 A1 (SAMSUNG ELECTRONICS CO LTD) 2015年 4月 30日 (2015 - 04 - 30) 全文	1–15												
☐ 其余文件在C栏的续页中列出。 ☒ 见同族专利附件。														
* 引用文件的具体类型: “A” 认为不特别相关的表示了现有技术一般状态的文件 “E” 在国际申请日的当天或之后公布的在先申请或专利 “L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件 (如具体说明的) “O” 涉及口头公开、使用、展览或其他方式公开的文件 “P” 公布日先于国际申请日但迟于所要求的优先权日的文件 “T” 在申请日或优先权日之后公布, 与申请不相抵触, 但为了理解发明之理论或原理的在后文件 “X” 特别相关的文件, 单独考虑该文件, 认定要求保护的发明不是新颖的或不具有创造性 “Y” 特别相关的文件, 当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时, 要求保护的发明不具有创造性 “&” 同族专利的文件														
国际检索实际完成的日期 2016年 9月 7日		国际检索报告邮寄日期 2016年 9月 27日												
ISA/CN的名称和邮寄地址 中华人民共和国国家知识产权局 (ISA/CN) 中国北京市海淀区蓟门桥西土城路6号 100088 传真号 (86-10) 62019451		授权官员 蒋玲 电话号码 (86-10) 62089875												

表 PCT/ISA/210 (第2页) (2009年7月)

国际检索报告
关于同族专利的信息

国际申请号

PCT/CN2016/089766

检索报告引用的专利文件			公布日 (年/月/日)	同族专利			公布日 (年/月/日)
CN	103812546	A	2014年 5月 21日	WO	2014071852	A1	2014年 5月 15日
CN	104184561	A	2014年 12月 3日	无			
WO	2015060645	A1	2015年 4月 30日	KR	20150046530	A	2015年 4月 30日
				US	20160226640	A1	2016年 8月 4日

表 PCT/ISA/210 (同族专利附件) (2009年7月)

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM		
First Named Inventor/Applicant Name:		Ko-Chiang Lin		
Filer:		Sang N. Dang/Sandy Kim		
Attorney Docket Number:		1426-188.101		
Filed as Large Entity				
Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				5740

Electronic Acknowledgement Receipt

EFS ID:	31419924
Application Number:	15863267
International Application Number:	
Confirmation Number:	5504
Title of Invention:	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Ko-Chiang Lin
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-188.101
Receipt Date:	05-JAN-2018
Filing Date:	
Time Stamp:	15:50:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$5740
RAM confirmation Number	010818INTEFSW15523500
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	WebADS.pdf	126193	no	8
			4f17e3022671ac9605481f1dd377bf7f9a3a1380		
Warnings:					
Information:					
2		1426-188-101--Package.pdf	1900735	yes	46
			a8081b97c95cc0e8936c7782d7451a39e6f0875a		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal of New Application		1	1	
	Fee Worksheet (SB06)		2	2	
	TrackOne Request		3	3	
	Specification		4	23	
	Claims		24	26	
	Abstract		27	27	
	Drawings-only black and white line drawings		28	39	
	Oath or Declaration filed		40	41	
	Information Disclosure Statement (IDS) Form (SB08)		42	43	
	Power of Attorney		44	45	
	Miscellaneous Incoming Letter		46	46	
Warnings:					
Information:					

Petitioners' Exhibit 1002, p. 202
AT&T et al v. Asustek Technology & Celerity

3	Foreign Reference	WO2017067138A1.pdf	2659140	no	36
			a53675260f93e4aba8ddef6fedda74e32f1e324a		
Warnings:					
Information:					
4	Foreign Reference	WO2017020688A1.pdf	1282518	no	30
			ca4dad211accac03a33e23f50f55fba429667ff		
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	40013	no	2
			e10a41c191cb5927384900b67855ce32d224eead		
Warnings:					
Information:					
Total Files Size (in bytes):			6008599		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1426-188.101
		Application Number	
Title of Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1				
Legal Name				
Prefix	Given Name	Middle Name	Family Name	Suffix
	Ko-Chiang		Lin	
Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service				
City	Taipei City	Country of Residence ⁱ	TW	
Mailing Address of Inventor:				
Address 1	No. 15, Lite Rd., Peitou District			
Address 2				
City	Taipei City 112	State/Province	OT	
Postal Code		Country ⁱ	TW	
Inventor 2				
Legal Name				
Prefix	Given Name	Middle Name	Family Name	Suffix
	Richard	Lee-Chee	Kuo	
Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service				
City	Taipei City	Country of Residence ⁱ	TW	
Mailing Address of Inventor:				
Address 1	No. 15, Lite Rd. Peitou District			
Address 2				
City	Taipei City 112	State/Province	OT	
Postal Code		Country ⁱ	TW	
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.				

[Add](#)

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	1426-188.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM	

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	106622	
Email Address		Add Email Remove Email

Application Information:

Title of the Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM		
Attorney Docket Number	1426-188.101	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	12	Suggested Figure for Publication (if any)	

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.
--

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		1426-188.101	
		Application Number			
Title of Invention		METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM			
Please Select One:		☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)	
Customer Number		106622			
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					
Additional Representative Information blocks may be generated within this form by selecting the Add button.					

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 this 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 blank.

Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Claims benefit of provisional	62/443291	2017-01-06
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			

Foreign Priority Information:

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

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-188.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM	

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.
--------------------------	---

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	1426-188.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM	

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.

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	1426-188.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.								
Applicant 1								
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.								
			Clear					
☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor						
☐ Person to whom the inventor is obligated to assign.	☐ Person who shows sufficient proprietary interest							
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:								
Name of the Deceased or Legally Incapacitated Inventor:								
If the Applicant is an Organization check here. ☒								
Organization Name	ASUSTek Computer Inc.							
Mailing Address Information For Applicant:								
Address 1	No. 15, Lite Rd., Peitou District							
Address 2								
City	Taipei City 112	State/Province	OT					
Country ⁱ	TW	Postal Code						
Phone Number		Fax Number						
Email Address								
Additional Applicant Data may be generated within this form by selecting the Add button.								

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	1426-188.101
		Application Number	
Title of Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM		

Assignee Information including Non-Applicant Assignee Information:

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

Assignee 1							
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.							
If the Assignee or Non-Applicant Assignee is an Organization check here.				☐			
Prefix	Given Name	Middle Name	Family Name	Suffix			
Mailing Address Information For Assignee including Non-Applicant Assignee:							
Address 1							
Address 2							
City		State/Province					
Country i			Postal Code				
Phone Number		Fax Number					
Email Address							
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.							

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	1426-188.101
		Application Number	
Title of Invention	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM		

Signature:

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

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

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

Signature	/Sang N. Dang/			Date (YYYY-MM-DD)	
First Name	Sang N.	Last Name	Dang	Registration Number	51186
Additional Signature may be generated within this form by selecting the Add button.					

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.

UTILITY PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 CFR 1.53(b))		Attorney Docket No. 1426-188.101
		First Named Inventor Ko-Chiang Lin
		Title Method and Apparatus for Beam Management...
		Priority Mail Express® Label No.

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents. 1. ☒ Fee Transmittal Form (PTO/SB/17 or equivalent) 2. ☐ Applicant asserts small entity status. See 37 CFR 1.27 3. ☐ Applicant certifies micro entity status. See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent. 4. ☒ Specification [Total Pages <u>24</u>] Both the claims and abstract must start on a new page. (See MPEP § 608.01(a) for information on the preferred arrangement) 5. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets <u>12</u>] 6. Inventor's Oath or Declaration [Total Pages <u>2</u>] (including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e)) a. ☒ Newly executed (original or copy) b. ☐ A copy from a prior application (37 CFR 1.63(d)) 7. ☒ Application Data Sheet * See note below. See 37 CFR 1.76 (PTO/AIA/14 or equivalent) 8. CD-ROM or CD-R in duplicate, large table, or Computer Program (Appendix) ☐ Landscape Table on CD 9. Nucleotide and/or Amino Acid Sequence Submission (if applicable, items a. – c. are required) a. ☐ Computer Readable Form (CRF) b. ☐ Specification Sequence Listing on: i. ☐ CD-ROM or CD-R (2 copies); or ii. ☐ Paper c. ☐ Statements verifying identity of above copies	ADDRESS TO: Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450 ACCOMPANYING APPLICATION PAPERS 10. ☐ Assignment Papers (cover sheet & document(s)) Name of Assignee _____ 11. ☐ 37 CFR 3.73(c) Statement ☒ Power of Attorney (when there is an assignee) 12. ☐ English Translation Document (if applicable) 13. ☒ Information Disclosure Statement (PTO/SB/08 or PTO-1449) ☒ Copies of citations attached 14. ☐ Preliminary Amendment 15. ☐ Return Receipt Postcard (MPEP § 503) (Should be specifically itemized) 16. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed) 17. ☐ Nonpublication Request Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. 18. ☒ Other: Track 1 Request 2 foreign references _____ _____ _____
---	---

***Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS				
☒ The address associated with Customer Number: <u>106622</u> OR ☐ Correspondence address below				
Name				
Address				
City	State	Zip Code		
Country	Telephone	Email		

Signature	/Sang N. Dang/	Date	January 5, 2018
Name (Print/Type)	Sang N. Dang	Registration No. (Attorney/Agent)	51,186

This collection of information is required by 37 CFR 1.53(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.

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.

FEE TRANSMITTAL		Complete if known	
		Application Number	Not Yet Assigned
		Filing Date	January 5, 2018
☐ Applicant asserts small entity status. See 37 CFR 1.27.		First Named Inventor	Ko-Chiang Lin
☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.		Examiner Name	Not Yet Assigned
		Art Unit	Not Yet Assigned
TOTAL AMOUNT OF PAYMENT	(\$ 1600	Practitioner Docket No.	1426-188.101

METHOD OF PAYMENT (check all that apply)
☐ Check ☒ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☐ Deposit Account Deposit Account Number: _____ Deposit Account Name: _____

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**
☐ Charge any additional fee(s) or underpayment of fee(s) ☐ Credit any overpayment of fee(s) under 37 CFR 1.16 and 1.17
WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.**FEE CALCULATION****1. BASIC FILING, SEARCH, AND EXAMINATION FEES** (U = undiscounted fee; S = small entity fee; M = micro entity fee)

Application Type	FILING FEES			SEARCH FEES			EXAMINATION FEES			Fees Paid (\$)
	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	
Utility	280	140*	70	600	300	150	720	360	180	1600
Design	180	90	45	120	60	30	460	230	115	
Plant	180	90	45	380	190	95	580	290	145	
Reissue	280	140	70	600	300	150	2,160	1,080	540	
Provisional	260	130	65	0	0	0	0	0	0	

* The \$140 small entity status filing fee for a utility application is further reduced to \$70 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	Undiscounted Fee (\$)	Small Entity Fee (\$)	Micro Entity Fee (\$)
Each claim over 20 (including Reissues)	80	40	20
Each independent claim over 3 (including Reissues)	420	210	105
Multiple dependent claims	780	390	195
Total Claims			
20 _____ -20 or HP = _____ x _____ = _____			
HP = highest number of total claims paid for, if greater than 20.			
Indep. Claims			
3 _____ -3 or HP = _____ x _____ = _____			
HP = highest number of independent claims paid for, if greater than 3.			

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is \$400 (\$200 for small entity) (\$100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fees Paid (\$)
38 _____ - 100 = _____ / 50 = _____ (round up to a whole number) x _____ = _____				

4. OTHER FEE(S)

Non-English specification, \$130 fee (no small or micro entity discount)

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, \$400 fee (\$200 small or micro entity)

Other (e.g., late filing surcharge): _____

SUBMITTED BY			
Signature	/Sang N. Dang/	Registration No. (Attorney/Agent)	51,186
Name (Print/Type)	Sang N. Dang	Telephone (714)	839-3800
		Date	January 5, 2018

This collection of information is required by 37 CFR 1.136. 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, 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.

**CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION
UNDER 37 CFR 1.102(e) (Page 1 of 1)**

First Named Inventor:	Ko-Chiang Lin	Nonprovisional Application Number (if known):	
Title of Invention:	METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently \$0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.
2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.
3. The applicable box is checked below:

I. ☒ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

- i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.
---OR---
(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.
- ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, or the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

- i. A request for continued examination has been filed with, or prior to, this form.
- ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
- iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
- iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
- v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Sang N. Dang/	Date January 5, 2018
Name (Print/Typed) Sang N. Dang	Practitioner Registration Number 51,186

Note: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.*

☐ *Total of _____ forms are submitted.

METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present Application claims the benefit of U.S. Provisional Patent Application Serial No. 62/443,291 filed on January 6, 2017, the entire disclosure of which is incorporated herein in its entirety by reference.

FIELD

[0002] This disclosure generally relates to wireless communication networks, and more particularly, to a method and apparatus for beam management in a wireless communication system.

BACKGROUND

[0003] With the rapid rise in demand for communication of large amounts of data to and from mobile communication devices, traditional mobile voice communication networks are evolving into networks that communicate with Internet Protocol (IP) data packets. Such IP data packet communication can provide users of mobile communication devices with voice over IP, multimedia, multicast and on-demand communication services.

[0004] An exemplary network structure is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). The E-UTRAN system can provide high data throughput in order to realize the above-noted voice over IP and multimedia services. A new radio technology for the next generation (e.g., 5G) is currently being discussed by the 3GPP standards organization. Accordingly, changes to the current body of 3GPP standard are currently being submitted and considered to evolve and finalize the 3GPP standard.

SUMMARY

[0005] A method and apparatus are disclosed from the perspective of a base station. In one embodiment, the method includes the base station transmitting to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement. The method also includes the base station transmitting the reference signal for beam measurement to the UE.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 shows a diagram of a wireless communication system according to one exemplary embodiment.

[0007] FIG. 2 is a block diagram of a transmitter system (also known as access network) and a receiver system (also known as user equipment or UE) according to one exemplary embodiment.

[0008] FIG. 3 is a functional block diagram of a communication system according to one exemplary embodiment.

[0009] FIG. 4 is a functional block diagram of the program code of FIG. 3 according to one exemplary embodiment.

[0010] FIG. 5 illustrates three exemplary types of beamforming according to one exemplary embodiment.

[0011] FIG. 6 is a flow chart according to one exemplary embodiment.

[0012] FIG. 7 is a flow chart according to one exemplary embodiment.

[0013] FIG. 8 is a flow chart according to one exemplary embodiment.

[0014] FIG. 9 is a flow chart according to one exemplary embodiment.

[0015] FIG. 10 is a flow chart according to one exemplary embodiment.

[0016] FIG. 11 is a flow chart according to one exemplary embodiment.

DETAILED DESCRIPTION

[0017] The exemplary wireless communication systems and devices described below employ a wireless communication system, supporting a broadcast service. Wireless communication systems are widely deployed to provide various types of communication such as voice, data, and so on. These systems may be based on code division multiple access (CDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), 3GPP LTE (Long Term Evolution) wireless access, 3GPP LTE-A or LTE-Advanced (Long Term Evolution Advanced), 3GPP2 UMB (Ultra Mobile Broadband), WiMax, or some other modulation techniques.

[0018] In particular, the exemplary wireless communication systems devices described below may be designed to support one or more standards such as the standard offered by a consortium named “3rd Generation Partnership Project” referred to herein as 3GPP, including: R2-162366, “Beam Forming Impacts”, Nokia and Alcatel-Lucent; R2-163716, “Discussion on terminology of beamforming based high frequency NR”, Samsung; R2-162709, “Beam support in NR”, Intel; R2-162762, “Active Mode Mobility in NR: SINR drops in higher frequencies”, Ericsson; TS 36.213 v13.2.0, “E-UTRA; Physical layer procedures (Release 14)”; TS 36.101 v14.1.0, “E-UTRA User Equipment (UE) radio transmission and reception (Release 14)”; and TS 36.321 v14.0.0, “Medium Access Control (MAC) protocol specification (Release 14)”. The standards and documents listed above are hereby expressly incorporated by reference in their entirety.

[0019] FIG. 1 shows a multiple access wireless communication system according to one embodiment of the invention. An access network 100 (AN) includes multiple antenna groups, one including 104 and 106, another including 108 and 110, and an additional including 112 and 114. In FIG. 1, only two antennas are shown for each antenna group, however, more or fewer antennas may be utilized for each antenna group. Access terminal 116 (AT) is in communication with antennas 112 and 114, where antennas 112 and 114 transmit information to access terminal 116 over forward link 120 and receive information from access terminal 116 over reverse link 118. Access terminal (AT) 122 is in communication with antennas 106 and 108, where antennas 106 and 108 transmit information to access terminal (AT) 122 over forward link 126 and receive

information from access terminal (AT) 122 over reverse link 124. In a FDD system, communication links 118, 120, 124 and 126 may use different frequency for communication. For example, forward link 120 may use a different frequency than that used by reverse link 118.

[0020] Each group of antennas and/or the area in which they are designed to communicate is often referred to as a sector of the access network. In the embodiment, antenna groups each are designed to communicate to access terminals in a sector of the areas covered by access network 100.

[0021] In communication over forward links 120 and 126, the transmitting antennas of access network 100 may utilize beamforming in order to improve the signal-to-noise ratio of forward links for the different access terminals 116 and 122. Also, an access network using beamforming to transmit to access terminals scattered randomly through its coverage causes less interference to access terminals in neighboring cells than an access network transmitting through a single antenna to all its access terminals.

[0022] An access network (AN) may be a fixed station or base station used for communicating with the terminals and may also be referred to as an access point, a Node B, a base station, an enhanced base station, an evolved Node B (eNB), or some other terminology. An access terminal (AT) may also be called user equipment (UE), a wireless communication device, terminal, access terminal or some other terminology.

[0023] FIG. 2 is a simplified block diagram of an embodiment of a transmitter system 210 (also known as the access network) and a receiver system 250 (also known as access terminal (AT) or user equipment (UE)) in a MIMO system 200. At the transmitter system 210, traffic data for a number of data streams is provided from a data source 212 to a transmit (TX) data processor 214.

[0024] In one embodiment, each data stream is transmitted over a respective transmit antenna. TX data processor 214 formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0025] The coded data for each data stream may be multiplexed with pilot data using OFDM techniques. The pilot data is typically a known data pattern that is processed in a known

manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on a particular modulation scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions performed by processor 230.

[0026] The modulation symbols for all data streams are then provided to a TX MIMO processor 220, which may further process the modulation symbols (e.g., for OFDM). TX MIMO processor 220 then provides N_T modulation symbol streams to N_T transmitters (TMTR) 222a through 222t. In certain embodiments, TX MIMO processor 220 applies beamforming weights to the symbols of the data streams and to the antenna from which the symbol is being transmitted.

[0027] Each transmitter 222 receives and processes a respective symbol stream to provide one or more analog signals, and further conditions (e.g., amplifies, filters, and upconverts) the analog signals to provide a modulated signal suitable for transmission over the MIMO channel. N_T modulated signals from transmitters 222a through 222t are then transmitted from N_T antennas 224a through 224t, respectively.

[0028] At receiver system 250, the transmitted modulated signals are received by N_R antennas 252a through 252r and the received signal from each antenna 252 is provided to a respective receiver (RCVR) 254a through 254r. Each receiver 254 conditions (e.g., filters, amplifies, and downconverts) a respective received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding “received” symbol stream.

[0029] An RX data processor 260 then receives and processes the N_R received symbol streams from N_R receivers 254 based on a particular receiver processing technique to provide N_T “detected” symbol streams. The RX data processor 260 then demodulates, deinterleaves, and decodes each detected symbol stream to recover the traffic data for the data stream. The processing by RX data processor 260 is complementary to that performed by TX MIMO processor 220 and TX data processor 214 at transmitter system 210.

[0030] A processor 270 periodically determines which pre-coding matrix to use (discussed below). Processor 270 formulates a reverse link message comprising a matrix index portion and a rank value portion.

[0031] The reverse link message may comprise various types of information regarding the communication link and/or the received data stream. The reverse link message is then processed by a TX data processor 238, which also receives traffic data for a number of data streams from a data source 236, modulated by a modulator 280, conditioned by transmitters 254a through 254r, and transmitted back to transmitter system 210.

[0032] At transmitter system 210, the modulated signals from receiver system 250 are received by antennas 224, conditioned by receivers 222, demodulated by a demodulator 240, and processed by a RX data processor 242 to extract the reserve link message transmitted by the receiver system 250. Processor 230 then determines which pre-coding matrix to use for determining the beamforming weights then processes the extracted message.

[0033] Turning to FIG. 3, this figure shows an alternative simplified functional block diagram of a communication device according to one embodiment of the invention. As shown in FIG. 3, the communication device 300 in a wireless communication system can be utilized for realizing the UEs (or ATs) 116 and 122 in FIG. 1 or the base station (or AN) 100 in FIG. 1, and the wireless communications system is preferably the LTE system. The communication device 300 may include an input device 302, an output device 304, a control circuit 306, a central processing unit (CPU) 308, a memory 310, a program code 312, and a transceiver 314. The control circuit 306 executes the program code 312 in the memory 310 through the CPU 308, thereby controlling an operation of the communications device 300. The communications device 300 can receive signals input by a user through the input device 302, such as a keyboard or keypad, and can output images and sounds through the output device 304, such as a monitor or speakers. The transceiver 314 is used to receive and transmit wireless signals, delivering received signals to the control circuit 306, and outputting signals generated by the control circuit 306 wirelessly. The communication device 300 in a wireless communication system can also be utilized for realizing the AN 100 in FIG. 1.

[0034] FIG. 4 is a simplified block diagram of the program code 312 shown in FIG. 3 in accordance with one embodiment of the invention. In this embodiment, the program code 312 includes an application layer 400, a Layer 3 portion 402, and a Layer 2 portion 404, and is coupled to a Layer 1 portion 406. The Layer 3 portion 402 generally performs radio resource control. The Layer 2 portion 404 generally performs link control. The Layer 1 portion 406 generally performs physical connections.

[0035] As described in 3GPP R2-162366, in lower frequency bands (e.g., current LTE bands < 6GHz), the required cell coverage may be provided by forming a wide sector beam for transmitting downlink common channels. However, utilizing wide sector beam on higher frequencies (>> 6GHz) the cell coverage is reduced with same antenna gain. Thus, in order to provide required cell coverage on higher frequency bands, higher antenna gain is needed to compensate the increased path loss. To increase the antenna gain over a wide sector beam, larger antenna arrays (number of antenna elements ranging from tens to hundreds) are used to form high gain beams.

[0036] As a consequence, the high gain beams are narrow compared to a wide sector beam. Therefore, multiple beams for transmitting downlink common channels are needed to cover the required cell area. The number of concurrent high gain beams that access point is able to form may be limited by the cost and complexity of the utilized transceiver architecture. In practice, on higher frequencies, the number of concurrent high gain beams is much less than the total number of beams required to cover the cell area. In other words, the access point is able to cover only part of the cell area by using a subset of beams at any given time.

[0037] As described in 3GPP R2-163716, beamforming is generally a signal processing technique used in antenna arrays for directional signal transmission/reception. With beamforming, a beam can be formed by combining elements in a phased array of antennas in such a way that signals at particular angles experience constructive interference while others experience destructive interference. Different beams can be utilized simultaneously using multiple arrays of antennas.

[0038] Beamforming can be categorized into three types of implementation: digital beamforming, hybrid beamforming, and analog beamforming. For digital beamforming, the

beam is generated on the digital domain, i.e., the weighting of each antenna element can be controlled by baseband (e.g., connected to a TXRU). Therefore it is very easy to tune the beam direction of each subband differently across the system bandwidth. Also, to change beam direction from time to time does not require any switching time between OFDM (Orthogonal Frequency Division Multiplexing) symbols. All beams whose directions cover the whole coverage can be generated simultaneously. However, this structure requires (almost) one-to-one mapping between TXRU (transceiver/RF chain) and antenna element and is quite complicated as the number of antenna element increases and system bandwidth increases (also heat problem exists).

[0039] For Analog beamforming, the beam is generated on the analog domain, i.e., the weighting of each antenna element can be controlled by an amplitude/phase shifter in the RF (Radio Frequency) circuit. Since the weighing is purely controlled by the circuit, the same beam direction would apply on the whole system bandwidth. Also, if beam direction is to be changed, switching time is required. The number of beam generated simultaneous by an analog beamforming depends on the number of TXRU. Note that for a given size of array, the increase of TXRU may decrease the antenna element of each beam, such that wider beam would be generated. In short, analog beamforming could avoid the complexity and heat problem of digital beamforming, while is more restricted in operation. Hybrid beamforming can be considered as a compromise between analog and digital beamforming, where the beam can come from both analog and digital domain. Examples of the three types of beamforming are shown in FIG. 5.

[0040] In 3GPP R2-162709, an eNB may have multiple TRPs (either centralized or distributed). Each TRP can form multiple beams. The number of beams and the number of simultaneous beams in the time/frequency domain depend on the number of antenna array elements and the RF at the TRP.

[0041] Potential mobility type for NR can be listed as follows:

- Intra-TRP mobility
- Inter-TRP mobility
- Inter-NR eNB mobility

[0042] In 3GPP R2-162762, reliability of a system purely relying on beamforming and operating in higher frequencies might be challenging, since the coverage might be more sensitive to both time and space variations. As a consequence of that the SINR of that narrow link can drop much quicker than in the case of LTE.

[0043] Using antenna arrays at access nodes with the number of elements in the hundreds, fairly regular grid-of-beams coverage patterns with tens or hundreds of candidate beams per node may be created. The coverage area of an individual beam from such array may be small, down to the order of some tens of meters in width. As a consequence, channel quality degradation outside the current serving beam area is quicker than in the case of wide area coverage, as provided by LTE.

[0044] With the support of beam operation and TRP (Transmission/Reception Point), a cell may have multiple choices to schedule a UE. For example, there may be multiple beams from a TRP transmitting the same data to the UE, which can provide more reliability for the transmission. Alternatively, multiple beams from multiple TRPs can transmit the same data to the UE. To increase the throughput, it is also possible for a single TRP to transmit different data on different beams for the UE. Also, multiple TRPs can transmit different data on different beams to the UE.

[0045] Depending on UE capability, a UE may also generate a narrow beam when transmitting or receiving data/signal and may suffer from above restriction of base station beam, i.e., the number of UE beams can be generated simultaneously is limited. The following UE beam could correspond to beam(s) generated by a UE when transmitting or receiving signals, to distinguish from base station beam or network beam, which refers to beam(s) generated by a base station or network node when transmitting or receiving signals. If it is not specifically mentioned, the following beam can refer to a base station beam, a UE beam, or both.

[0046] One way to track the current beam(s) (either or both of base station beam and UE beam) available for communication could be to perform measurement from the UE side. A base station may transmit reference signal on all base station beams or some of the base station beams in certain time occasion(s). After measuring the reference signal, the UE may detect whether there is any beam change or update, e.g., an existing beam disappears or a new beam comes out.

Also, UE may send a report with beam measurement result to the base station to inform base station the new status of beam(s). The reference signal for beam measurement may be sent periodically, aperiodically, or semi-persistently. For periodic beam reference signal, the base station may configure a proper periodicity for measurement occasion(s) when UE would perform measurement.

[0047] Within a measurement occasion, the base station may generate all base station beams to allow UE to update the status of all base station beams. (Note that a measurement occasion may be composed of several symbols, and different base station beam could be transmitted on different symbols). On the other hand, an aperiodic beam reference signal is transmitted when there is an associated triggering signal. When the UE detects the associated triggering signal (e.g., a control signal, a control channel, an uplink grant, or a downlink assignment), the UE would realize there would be beam reference signal in an associated timing occasion, e.g., the rest of the symbol(s) in the same slot or the symbol(s) in the following slot.

[0048] For aperiodic beam reference signals, as there is already information obtained from the periodic beam reference signal, the base station may choose some base station beams, e.g., those may reach the UE, instead of sending beam reference signal on all beams. Also, the base station beam(s) used to transmit the aperiodic beam reference signal may be different from the base station beam(s) used to transmit the periodic beam reference signal. For example, the base station beam(s), which are used to transmit the aperiodic beam reference signal, may be narrower than those used to transmit the periodic beam reference signal.

[0049] Another example could be the direction of base station beam(s) used to transmit the aperiodic beam reference signal may be different from the direction of base station beam(s) used to transmit the periodic beam reference signal. For example, the direction of base station beam(s) used to transmit the aperiodic beam reference signal could be slightly adjusted compared to the periodic one so that the beam quality could be improved, refined, or fine-tuned (e.g., if UE location is not on the same direction of a beam used to carry periodic beam reference signal). Semi-persistent reference signal could be something in between (e.g., first being configured, start periodic transmission if there is an associated signal, and could modify or pause the transmission if another associated signal is detected).

[0050] It is possible for UE to request the beam reference signal (e.g., an aperiodic beam reference signal) if UE detects there is a beam quality change, UE mobility, UE rotation or any other case when beam refinement or adjustment is required. The UE may send such request with a control element, a control signal, a control channel, or a preamble. Of course, as discussed above, an aperiodic beam reference signal can be sent by the base station without request from the UE, if the base station detects that a beam refinement or adjustment is required.

[0051] A UE may be served by more than one TRP, where one or multiple base station beam(s) from each TRP could be used to transmit data/signal to the UE. One or multiple base station beam(s) from all the serving TRP(s) could form a base station beam set of the UE.

[0052] It is possible that a UE may detect beam refinement/adjustment is required for some beam(s) or some TRP(s) among the beams within the base station beam set of the UE while beam refinement/adjustment is not require for other beam(s) or other TRP(s) among the beams within the base station beam set of the UE. In this situation (i.e., only beam direction of some beam(s) or beam direction of some TRP(s) are changed and beam direction of other beam(s) or beam direction of other TRP(s) are unchanged), simply requesting beam reference signal for beam adjustment/refinement is inefficient as the base station has no idea beam direction of which beam(s) or of which TRP(s) is changed/unchanged. Therefore, the base station would need to send the beam reference signal for refining/adjusting all the beams within the beam set of the UE, even if some of them does not require any adjustment. As one base station beam might needs several transmission occasions to carry the beam reference signal (with a narrower beam or several different beam directions), performing refinement or adjustment for all beams in the beam set of the UE would require more resources to carry a beam reference signal (e.g., many symbols or slots). Also, as the number of occasions associated with one triggering signal is expected to be limited, performing refinement or adjustment for all beams in the beam set of the UE may also result in more triggering of beam reference signal, which increases the control overhead as well.

[0053] From the perspective of the base station, it is also possible that the base station detects only some beam(s) or some TRP(s) among the beams within the base station beam set of the UE would require refinement or adjustment. When the base station transmits the beam

reference signal on the beam(s) or the TRP(s), the UE may not be able to decide what is the correct UE beam to perform the beam measurement for beam adjustment or refinement.

[0054] A first general concept of this invention is that when a UE requests beam refinement or adjustment, the UE would indicate which beam(s) or beam(s) from which TRP(s) would require beam refinement/adjustment associated with the request. An example of requesting beam refinement or adjustment would be to request beam reference signal.

[0055] A general second concept of this invention is that when a base station triggers beam refinement or adjustment for a UE, the base station would indicate that beam refinement or adjustment is performed on which beam(s) or beam(s) from which TRP(s) associated with the trigger. An example of triggering beam refinement or adjustment for a UE would be to send an aperiodic trigger for beam reference signal to the UE.

[0056] In one embodiment, a UE could send a request to a base station to request a beam reference signal, wherein the request could include information indicating which beam(s) or which TRP(s) would require beam reference signal(s). In one embodiment, the information could indicate beam id(s) or TRP id(s). The information could be carried explicitly on a channel used to send the request. Alternatively, the information could be carried implicitly according to which resource is used to send the request. More specifically, an association between resource(s) and beam id or TRP id could be previously configured.

[0057] In one embodiment, the request could be transmitted on a control channel, on a data channel, or via a preamble. The beam reference signal could be an aperiodic beam reference signal. The UE could decide which beam(s) or which TRP(s) requires beam reference signal according to measurement on periodic beam reference signal, according to decoding failure of a channel, UE mobility, UE rotation, and/or UE location.

[0058] In one embodiment, a base station could transmit the aperiodic beam reference signal in accordance with the request from the UE. More specifically, the UE could perform measurement on the aperiodic beam reference signal with the UE beam(s) associated with the requested beam(s) or beam(s) from requested TRP(s).

[0059] In another embodiment, a base station could send a trigger to a UE to trigger aperiodic beam reference signal(s) for some beam(s) or for some TRP(s), wherein the trigger could include information of aperiodic beam reference signal(s) corresponding to which beam(s) or which TRP(s). The information could indicate beam id(s) or TRP id(s). Furthermore, the information could be carried explicitly on a channel used to trigger aperiodic reference signal(s).

[0060] In one embodiment, the trigger could be transmitted on a control channel. More specifically, the trigger could be transmitted together with a downlink assignment or together with an uplink grant. Alternatively, the trigger could be transmitted on a data channel. The base station could decide which beam(s) or which TRP(s) requires a beam reference signal according to measurement on reference signal(s) transmitted by the UE, according to decoding failure of a channel, according to UE mobility, and/or according to UE location.

[0061] In one embodiment, the UE could perform measurement on the aperiodic beam reference signal(s) in accordance with the trigger from the base station. More specifically, the UE could perform measurement on aperiodic beam reference signal with UE beam(s) associated with the triggered beam(s) or beam(s) from triggered TRP(s).

[0062] In one embodiment, the trigger could indicate how many symbols are used to carry the aperiodic beam reference signal. Furthermore, the trigger could indicate the mapping between symbols and beam(s) or beam from which TRP(s).

[0063] FIG. 6 is a flow chart 600 according to one exemplary embodiment from the perspective of a UE. In step 605, the a UE sends a signal to request transmission of a beam reference signal(s) from a base station, wherein the signal includes information indicating which beam(s) or TRP(s) the beam reference signal is requested.

[0064] Referring back to FIGS. 3 and 4, in one exemplary embodiment of a UE, the device 300 includes a program code 312 stored in the memory 310. The CPU 308 could execute program code 312 to enable the network node to send a signal to request transmission of a beam reference signal(s) from a base station, wherein the signal includes information indicating which beam(s) or TRP(s) the beam reference signal is requested. Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others described herein.

[0065] FIG. 7 is a flow chart 700 according to one exemplary embodiment from the perspective of a base station. In step 705, the base station receives from a UE a signal which requests transmission of a beam reference signal(s), wherein the signal includes information indicating which beam(s) or TRP(s) the beam reference signal is requested.

[0066] Referring back to FIGS. 3 and 4, in one exemplary embodiment of a base station, the device 300 includes a program code 312 stored in the memory 310. The CPU 308 could execute program code 312 to receive from a UE a signal which requests transmission of a beam reference signal(s), wherein the signal includes information indicating which beam(s) or TRP(s) the beam reference signal is requested.. Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others described herein.

[0067] In the context of the embodiments illustrated in FIGS. 6 and 7 and discussed above, in one embodiment, the information could indicate beam id(s) or TRP id(s). The beam refinement or adjustment for the UE could be performed for the beam(s) or TRP(s) indicated by the information. The beam reference signal(s) could be aperiodic beam reference signal(s).

[0068] In one embodiment, the signal to request a beam reference signal(s) could be a preamble. The preamble could be a dedicated preamble. In addition, the preamble could be different from a preamble used to initiate a random access procedure. Furthermore, the preamble could use a resource different from the resource of a preamble used to initiate a random access procedure. In one embodiment, the preamble can only be sent if the UE has a valid timing advance.

[0069] In one embodiment, the signal to request a beam reference signal(s) could be a control channel or a scheduling request. Furthermore, the scheduling request could be a different from a scheduling request to request uplink grant. In general, a resource configured to send the scheduling request is different from a resource configured to send scheduling request to request uplink grant. In one embodiment, the signal to request a beam reference signal(s) could be a data channel. The information could be carried on the signal.

[0070] In one embodiment, the information could be indicated based on the resource used to transmit the signal. Multiple resources are configured, and each resource could be associated with a beam/TRP/set of beams/set of TRP(s). In one embodiment, the determination

of a which beam(s) or TRP(s) is indicated in the information is based on a measurement of a reference signal(s). In one embodiment, the reference signal(s) could be periodic reference signal(s). Furthermore, the determination of which beam(s) or TRP(s) is indicated in the information could be based on decoding of a downlink channel, UE mobility, UE location, and/or UE rotation.

[0071] In one embodiment, the base station could send the beam reference signal for beam(s) or TRP(s) indicated in the information. The UE could measure the beam reference signal with UE beams associated with the indicated beam(s) or with the indicated TRP.

[0072] In one embodiment, beam refinement or adjustment is required for some beam(s) or some TRP(s) among the beams within the base station beam set of the UE while beam refinement or adjustment may not require for other beam(s) or other TRP(s) among the beams within the base station beam set of the UE.

[0073] FIG. 8 is a flow chart 800 according to one exemplary embodiment from the perspective of a base station. In step 805, the base station transmits a trigger and an associated beam reference signal(s) to a UE, wherein the trigger includes information indicating which beam(s) or TRP(s) the beam reference signal(s) is transmitted.

[0074] Referring back to FIGS. 3 and 4, in one exemplary embodiment of a base station, the device 300 includes a program code 312 stored in the memory 310. The CPU 308 could execute program code 312 to transmit a trigger and an associated beam reference signal(s) to a UE, wherein the trigger includes information indicating which beam(s) or TRP(s) the beam reference signal(s) is transmitted. Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others described herein.

[0075] FIG. 9 is a flow chart 900 according to one exemplary embodiment from the perspective of a UE. In step 905, the UE receives a trigger requesting the UE to measure a beam reference signal(s), wherein the trigger includes information indicating which beam(s) or TRP(s) the beam reference signal(s) is transmitted.

[0076] Referring back to FIGS. 3 and 4, in one exemplary embodiment of a UE, the device 300 includes a program code 312 stored in the memory 310. The CPU 308 could execute

program code 312 to receive a trigger requesting the UE to measure a beam reference signal(s), wherein the trigger includes information indicating which beam(s) or TRP(s) the beam reference signal(s) is transmitted.. Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others described herein.

[0077] In the context of the embodiments illustrated in FIGS. 8 and 9 and discussed above, in one embodiment, the UE could perform measurement on the beam reference signal(s) with UE beam(s) associated with the indicated beam(s) or the indicated TRP(s). The information could indicate beam id(s) or TRP id(s). The beam refinement or adjustment for the UE could be performed for the beam(s) or TRP(s) indicated by the information. The beam reference signal(s) could be aperiodic beam reference signal(s).

[0078] In one embodiment, the trigger could be a control channel, a downlink assignment, an uplink grant, or a data channel. The information could be carried on the trigger. Furthermore, the information could be indicated based on which beam(s) or TRP(s) is used to carry the trigger.

[0079] In one embodiment, the determination of which beam(s) or TRP(s) is indicated in the information could be based on a measurement of a reference signal(s). The reference signal(s) could be sounding reference signal(s). In one embodiment, the determination of which beam(s) or TRP(s) is indicated in the information could be based on decoding of an uplink channel, on UE mobility, on UE location, or on UE rotation. Beam refinement or adjustment could be required for some beam(s) or some TRP(s) among the beams within the base station beam set of the UE while beam refinement or adjustment may not require for other beam(s) or other TRP(s) among the beams within the base station beam set of the UE.

[0080] In one embodiment, the trigger could indicate how many symbols are used to carry the aperiodic beam reference signal. Furthermore, the trigger could indicate the mapping between symbols and beam(s) or beam from which TRP(s).

[0081] FIG. 10 is a flow chart 1000 according to one exemplary embodiment from the perspective of a base station. In step 1005, the base station transmits to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement. In step 1010, the base station transmits the reference signal for beam measurement to the UE.

[0082] Referring back to FIGS. 3 and 4, in one exemplary embodiment of a base station, the device 300 includes a program code 312 stored in the memory 310. The CPU 308 could execute program code 312 (i) to transmit to a UE a control channel associated with a reference signal for beam measurement, wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement, and (ii) to transmit the reference signal for beam measurement to the UE. Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others described herein.

[0083] FIG. 11 is a flow chart 1100 according to one exemplary embodiment from the perspective of a UE. In step 1105, the UE receives from a base station a control signal associated with a reference signal for beam measurement, wherein the control signal includes beam-related information for transmitting the reference signal for beam measurement. In step 1110, the UE measures the reference signal for beam measurement from the base station.

[0084] Referring back to FIGS. 3 and 4, in one exemplary embodiment of a UE, the device 300 includes a program code 312 stored in the memory 310. The CPU 308 could execute program code 312 (i) to receive from a base station a control signal associated with a reference signal for beam measurement, wherein the control signal includes beam-related information for transmitting the reference signal for beam measurement, and (ii) to measure the reference signal for beam measurement from the base station. Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others described herein.

[0085] In the context of the embodiments illustrated in FIGS. 10 and 11 and described above, in one embodiment, the beam-related information could indicate at least a beam on which the reference signal for beam measurement is transmitted. Alternatively or additionally, the beam-related information could indicate a first beam and the reference signal for beam measurement is transmitted on at least a refined beam of the first beam.

[0086] In one embodiment, the reference signal for beam measurement could be transmitted aperiodically. The control signal could be transmitted via a control channel. In one embodiment, the control signal could be transmitted via a data channel. In one embodiment, the control signal could indicate how many symbols are used to carry the reference signal for beam

measurement. In one embodiment, the control signal indicates a presence of the reference signal for beam measurement. In addition, the control signal indicates resources used to carry the reference signal for beam measurement.

[0087] In one embodiment, the UE could perform measurement on the reference signal for beam measurement with UE beam(s) associated with the beam indicated by the beam-related information. In addition, beam refinement for the UE could be performed for the beam indicated by the beam-related information.

[0088] Various aspects of the disclosure have been described above. It should be apparent that the teachings herein may be embodied in a wide variety of forms and that any specific structure, function, or both being disclosed herein is merely representative. Based on the teachings herein one skilled in the art should appreciate that an aspect disclosed herein may be implemented independently of any other aspects and that two or more of these aspects may be combined in various ways. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, such an apparatus may be implemented or such a method may be practiced using other structure, functionality, or structure and functionality in addition to or other than one or more of the aspects set forth herein. As an example of some of the above concepts, in some aspects concurrent channels may be established based on pulse repetition frequencies. In some aspects concurrent channels may be established based on pulse position or offsets. In some aspects concurrent channels may be established based on time hopping sequences. In some aspects concurrent channels may be established based on pulse repetition frequencies, pulse positions or offsets, and time hopping sequences.

[0089] Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0090] Those of skill would further appreciate that the various illustrative logical blocks, modules, processors, means, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware (e.g., a digital

implementation, an analog implementation, or a combination of the two, which may be designed using source coding or some other technique), various forms of program or design code incorporating instructions (which may be referred to herein, for convenience, as “software” or a “software module”), or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[0091] In addition, the various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented within or performed by an integrated circuit (“IC”), an access terminal, or an access point. The IC may comprise a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, electrical components, optical components, mechanical components, or any combination thereof designed to perform the functions described herein, and may execute codes or instructions that reside within the IC, outside of the IC, or both. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0092] It is understood that any specific order or hierarchy of steps in any disclosed process is an example of a sample approach. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[0093] The steps of a method or algorithm described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module (e.g., including executable instructions and related data) and other data may reside in a data memory such as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of computer-readable storage medium known in the art. A sample storage medium may be coupled to a machine such as, for example, a computer/processor (which may be referred to herein, for convenience, as a “processor”) such the processor can read information (e.g., code) from and write information to the storage medium. A sample storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in user equipment. In the alternative, the processor and the storage medium may reside as discrete components in user equipment. Moreover, in some aspects any suitable computer-program product may comprise a computer-readable medium comprising codes relating to one or more of the aspects of the disclosure. In some aspects a computer program product may comprise packaging materials.

[0094] While the invention has been described in connection with various aspects, it will be understood that the invention is capable of further modifications. This application is intended to cover any variations, uses or adaptation of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within the known and customary practice within the art to which the invention pertains.

CLAIMS

1. A method of a base station, comprising:
the base station transmits to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement; and
the base station transmits the reference signal for beam measurement to the UE.
2. The method of claim 1, wherein the beam-related information indicates at least a beam on which the reference signal for beam measurement is transmitted.
3. The method of claim 1, wherein the beam-related information indicates a first beam and the reference signal for beam measurement is transmitted on at least a refined beam of the first beam.
4. The method of claim 1, wherein the reference signal for beam measurement is transmitted aperiodically.
5. The method of claim 1, wherein the control signal is transmitted via a control channel.
6. The method of claim 1, wherein the control signal indicates how many symbols are used to carry the reference signal for beam measurement.
7. A method of a User Equipment (UE), comprising:
the UE receives from a base station a control signal associated with a reference signal for beam measurement, wherein the control signal includes beam-related information for transmitting the reference signal for beam measurement; and
the UE measures the reference signal for beam measurement from the base station.
8. The method of claim 7, wherein the beam-related information indicates at least a

beam on which the reference signal for beam measurement is transmitted.

9. The method of claim 7, wherein the beam-related information indicates a first beam and the reference signal for beam measurement is transmitted on at least a refined beam of the first beam.

10. The method of claim 7, wherein the UE performs measurement on the reference signal for beam measurement with UE beam(s) associated with the at least a beam indicated by the beam-related information.

11. The method of claim 7, wherein beam refinement for the UE is performed for the at least a beam indicated by the beam-related information.

12. The method of claim 7, wherein the reference signal for beam measurement is transmitted aperiodically.

13. The method of claim 7, wherein the control signal is transmitted via a control channel.

14. The method of claim 7, wherein the control signal indicates how many symbols are used to carry the reference signal for beam measurement.

15. A base station, comprising:
a control circuit;
a processor installed in the control circuit; and
a memory installed in the control circuit and operatively coupled to the processor;
wherein the processor is configured to execute a program code stored in the memory to:
transmit to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement; and

transmit the reference signal for beam measurement to the UE.

16. The base station of claim 15, wherein the beam-related information indicates at least a beam on which the reference signal for beam measurement is transmitted.

17. The base station of claim 15, wherein the beam-related information indicates a first beam and the reference signal for beam measurement is transmitted on at least a refined beam of the first beam.

18. The base station of claim 15, wherein the reference signal for beam measurement is transmitted aperiodically.

19. The base station of claim 15, wherein the control signal is transmitted via a control channel.

20. The base station of claim 15, wherein the control signal indicates how many symbols are used to carry the reference signal for beam measurement.

ABSTRACT

A method and apparatus are disclosed from the perspective of a base station. In one embodiment, the method includes the base station transmitting to a UE a control signal associated with a reference signal for beam measurement, wherein the control signal includes a beam-related information for transmitting the reference signal for beam measurement. The method also includes the base station transmitting the reference signal for beam measurement to the UE.

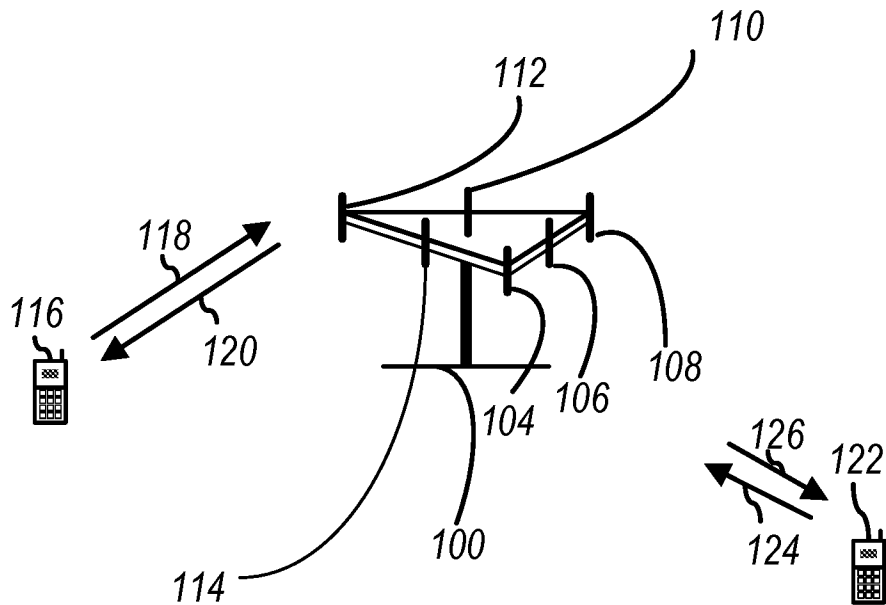


FIG. 1

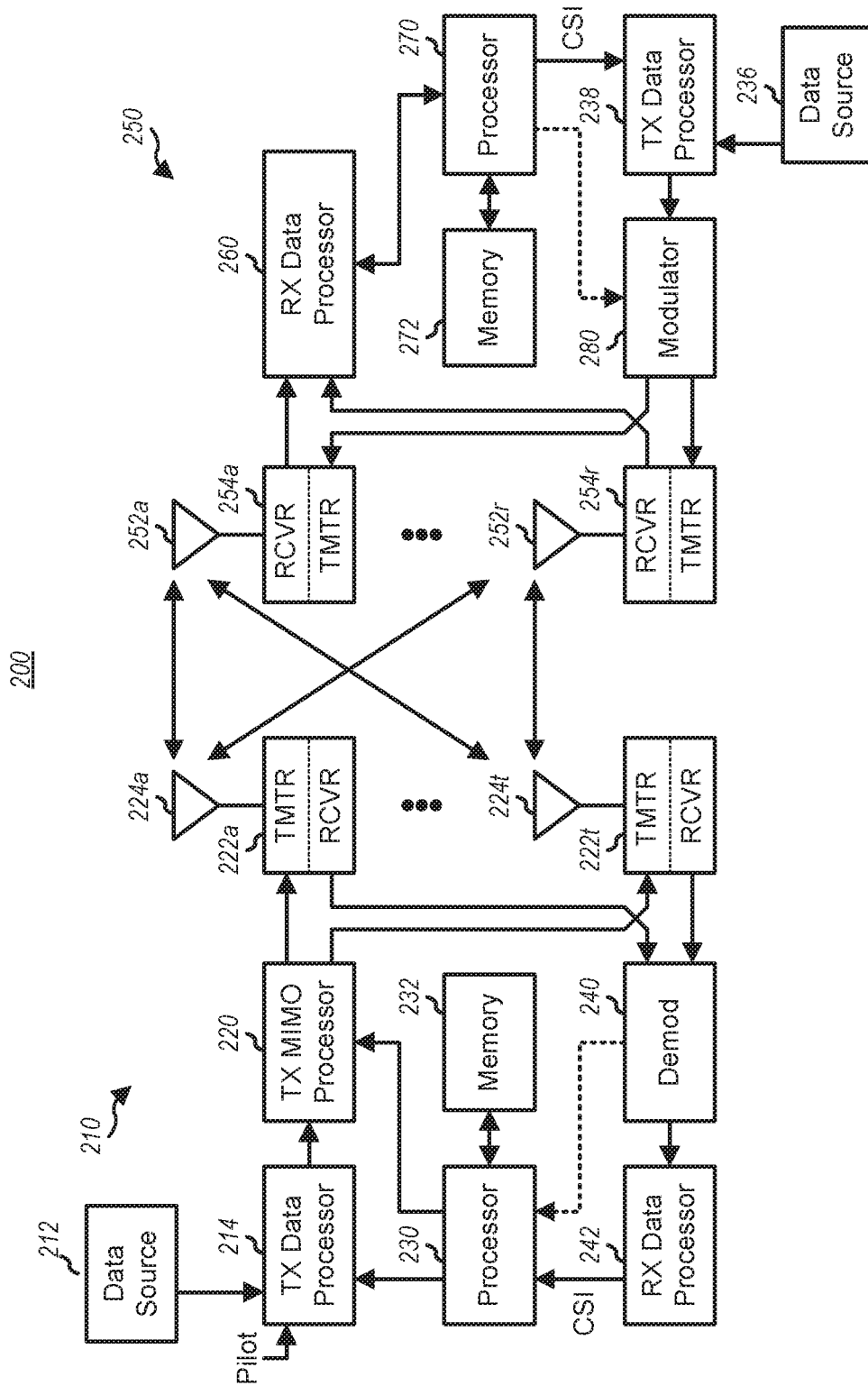
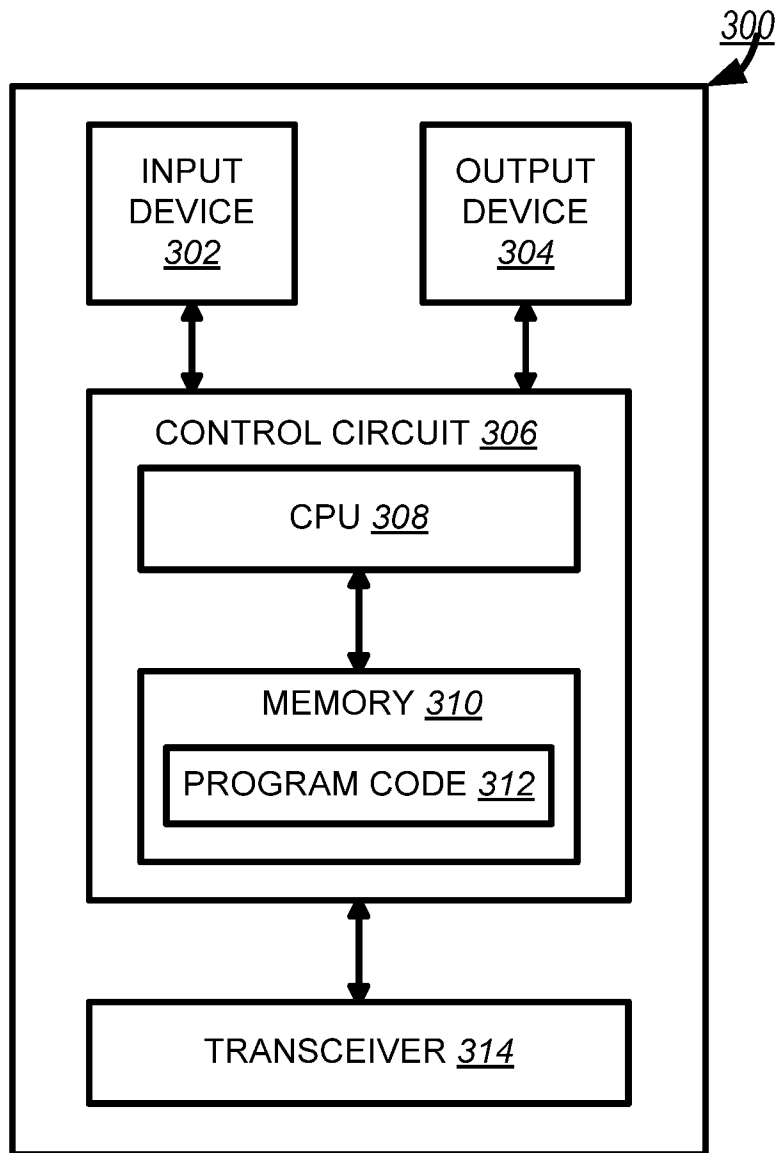
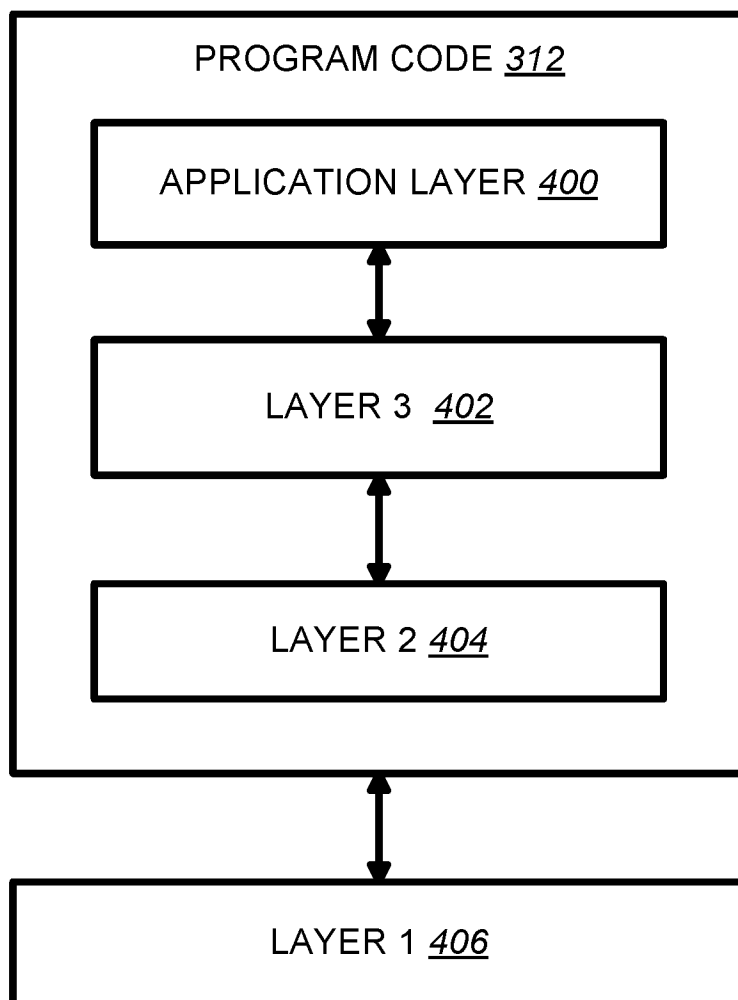
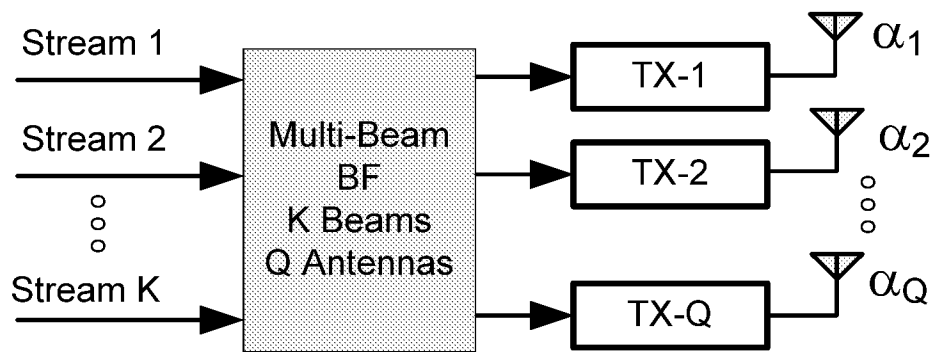


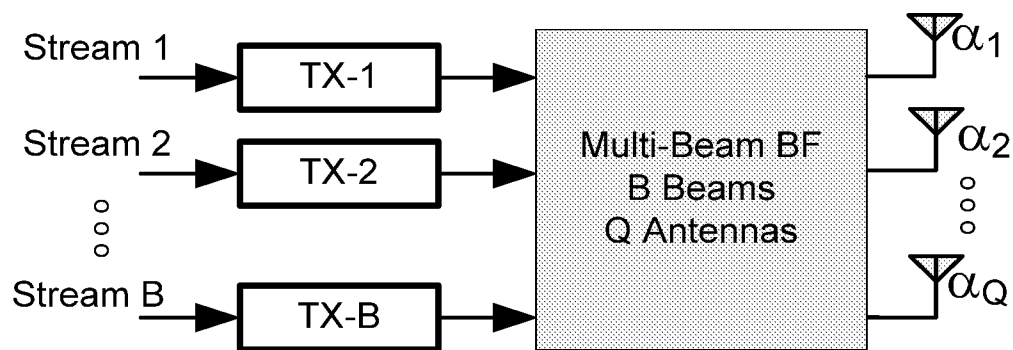
FIG. 2

**FIG. 3**

**FIG. 4**

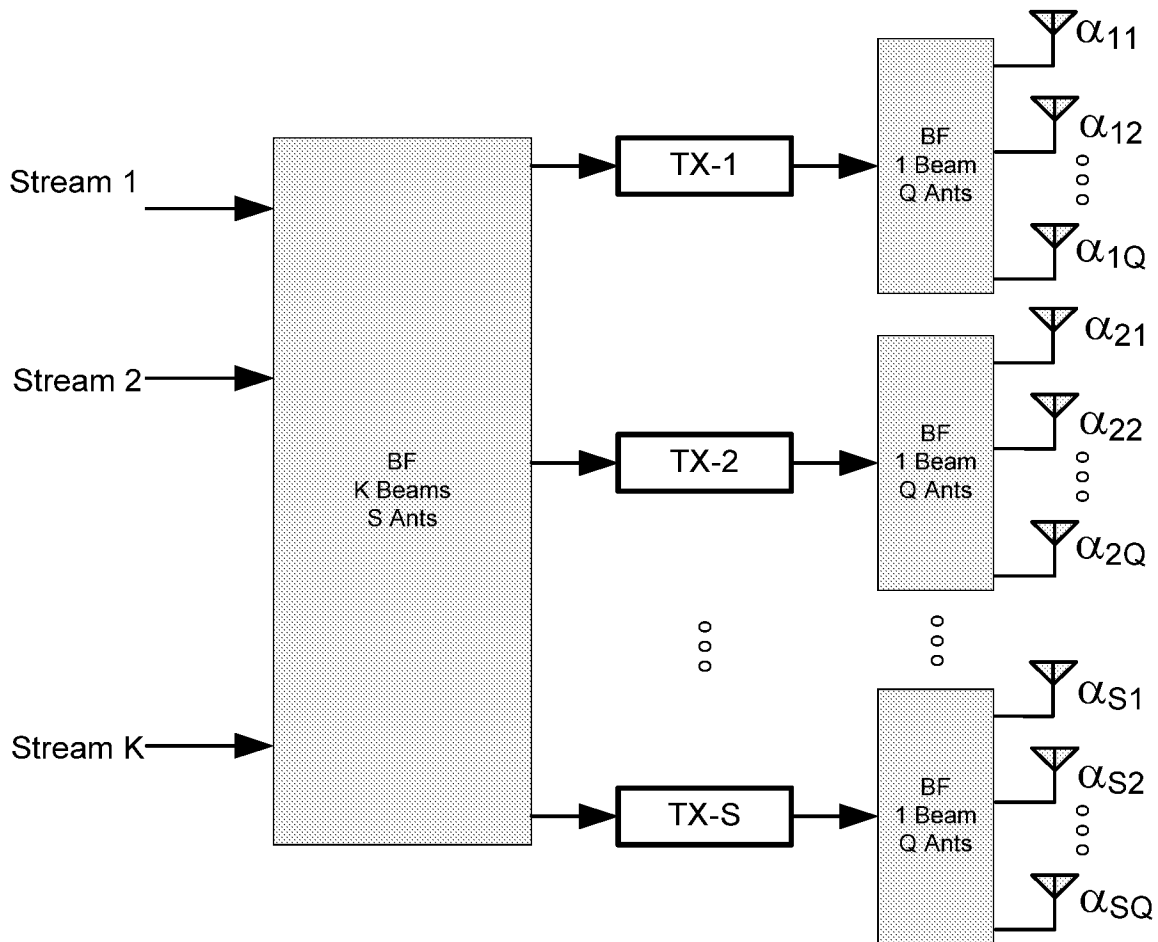
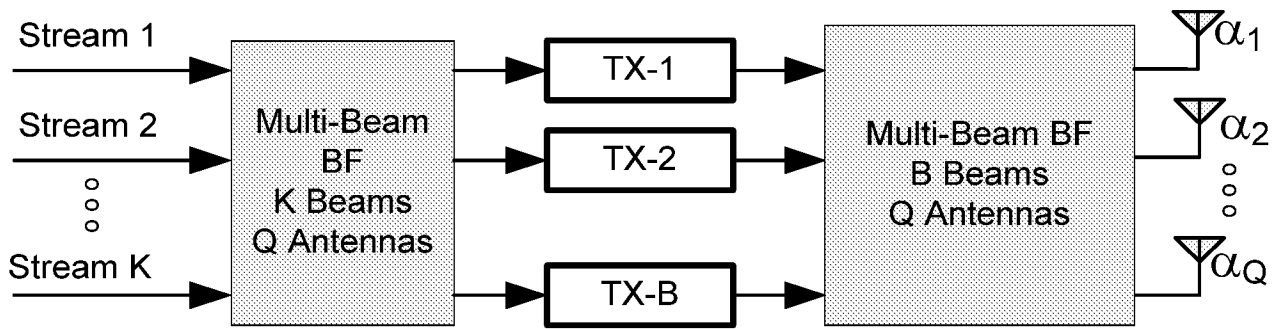


(a) Digital beamforming



(b) Analogue beamforming

FIG. 5



(c) Hybrid beamforming: Left = fully connected, Right = sub-array

FIG. 5 CONTINUED

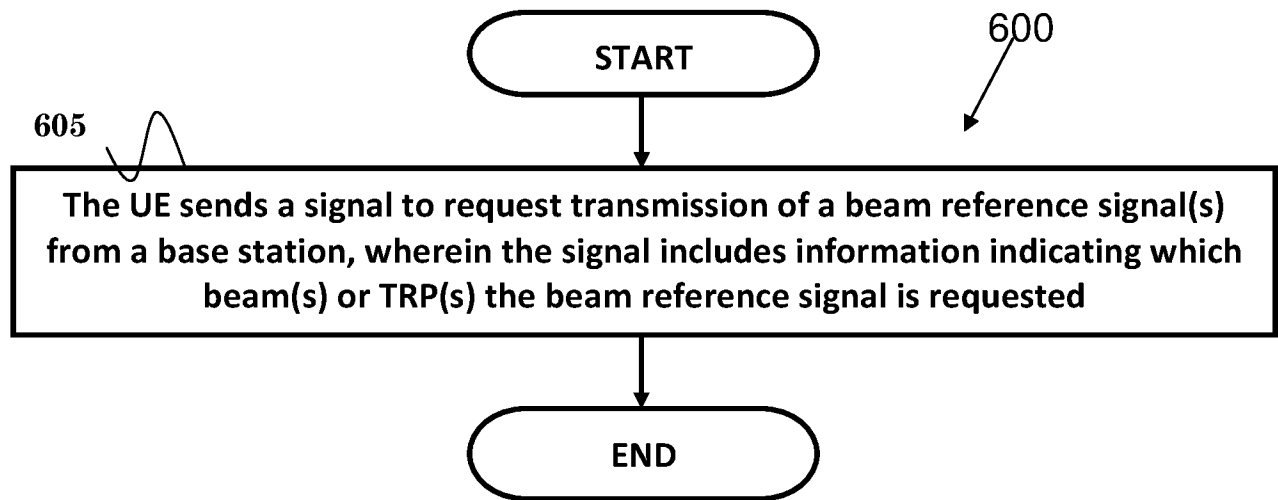


FIG. 6

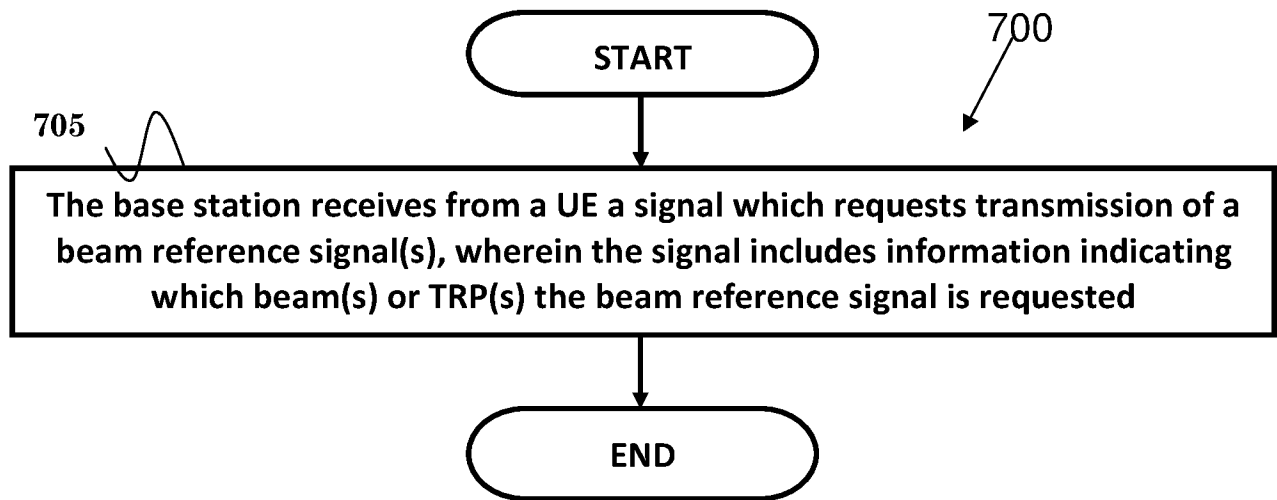


FIG. 7

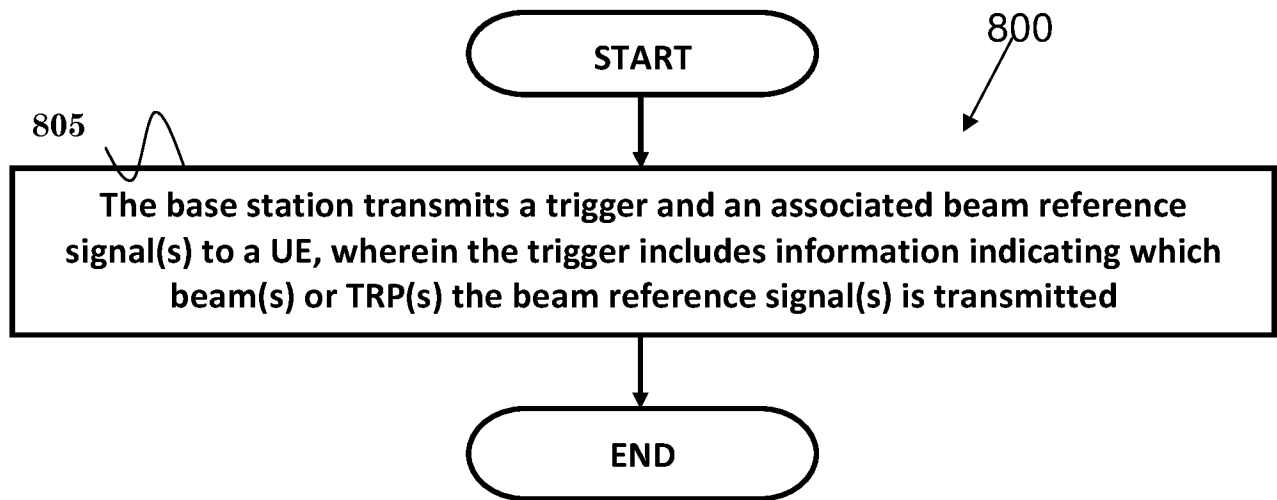


FIG. 8

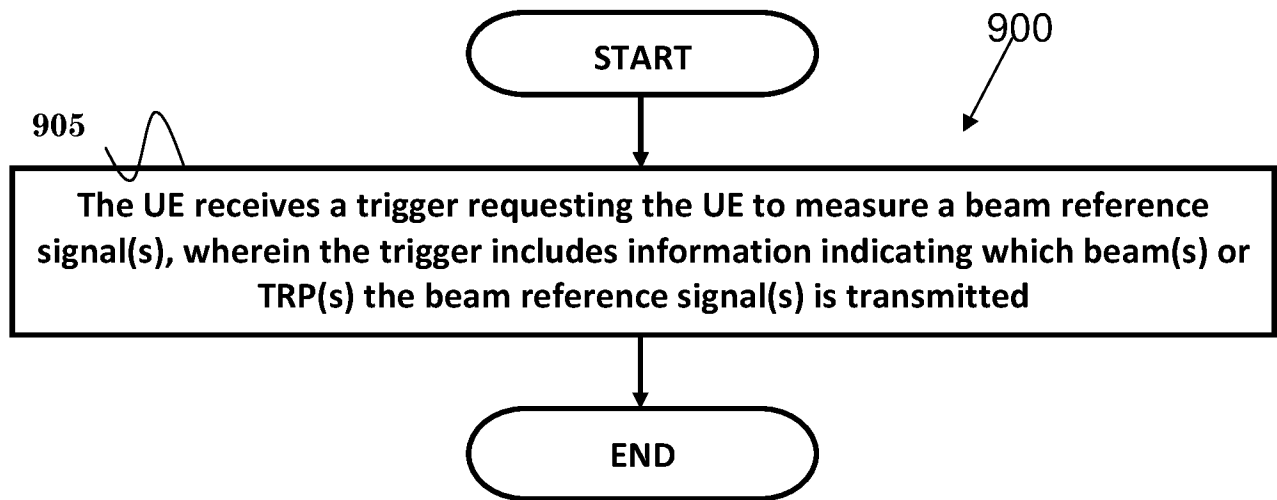


FIG. 9

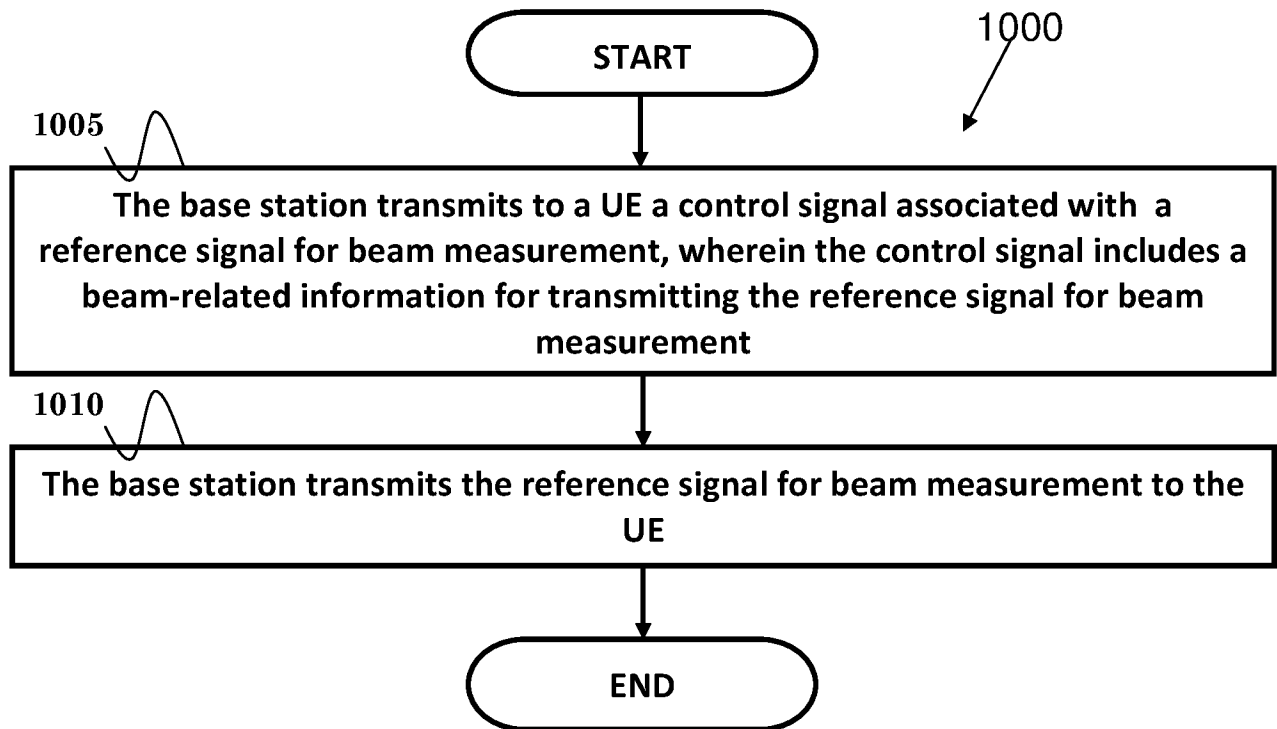


FIG. 10

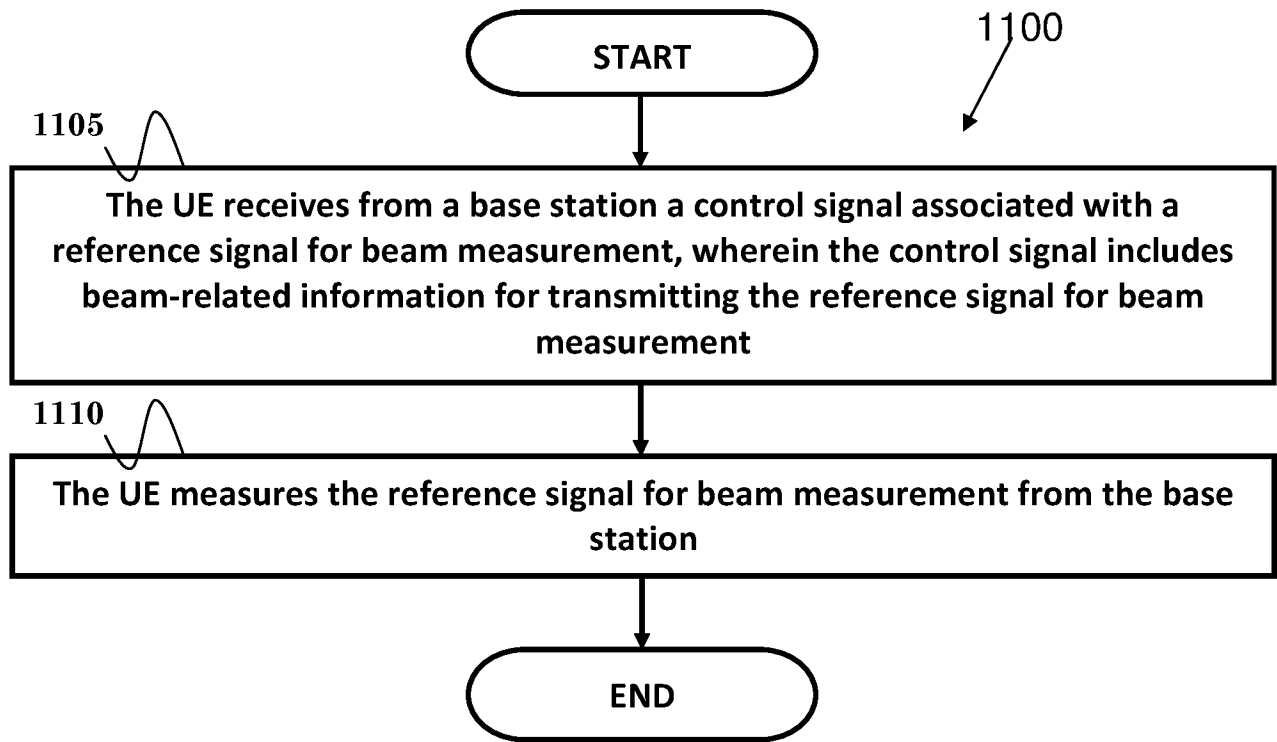


FIG. 11

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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

Title of
Invention

**METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS
COMMUNICATION SYSTEM**

As the below named inventor, I hereby declare that:

This declaration
is directed to:



The attached application, or



United States application or PCT international application number _____

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.

WARNING:

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

LEGAL NAME OF INVENTOR

Inventor: Lin, Ko-Chiang

Date (Optional): 2017/11/23

Signature: Lin, Ko-Chiang

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

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

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

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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

Title of
Invention

**METHOD AND APPARATUS FOR BEAM MANAGEMENT IN A WIRELESS
COMMUNICATION SYSTEM**

As the below named inventor, I hereby declare that:

This declaration
is directed to:



The attached application, or



United States application or PCT international application number _____
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.

WARNING:

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

LEGAL NAME OF INVENTOR

Inventor: Richard Lee-Chee Kuo

Date (Optional): Nov. 23, 2017

Signature: Richard Lee-Chee Kuo

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

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

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

SCORE Placeholder Sheet for IFW Content

Application Number: 15863267

Document Date: 01/05/2018

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via eDAN using the Supplemental Content tab, or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.