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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	07/13/2021	11063625	08610010PA	2489

30743 7590 06/23/2021

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11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

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 1243 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):

Theodore S. Rappaport, Riner, VA;

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PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13966853
Filing Date	2013-08-14
First Named Inventor	Rappaport
Art Unit	2845 3648
Examiner Name	Choi, Jacob Y. /Helena Seraydaryan/
Attorney Docket Number	08610010PA

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7403164	B2	2008-07-22	Sanz et al.	
	2	7187945	B2	2007-03-06	Ranta et al.	
	3	7042417	B2	2006-05-09	Santhoff et al.	
Change(s) applied to document, /P.H./ 3/25/2021	4	6957081	B2	10/2005 ~~2008-10-18~~	Leyh et al.	
	5	6990357	B2	2006-01-24	Ella et al.	
	6	6865376	B2	2005-03-08	Forrester	
	7	6560443	B1	2003-05-06	Vaisanen et al.	
	8	6381471	B1	2002-04-30	Dvorkin	

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /H.S./

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

30743 7590 03/15/2021

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Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

TITLE OF INVENTION: Steerable Antenna Device

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	06/15/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
SERAYDARYAN, HELENA H	3648	342-368000

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.

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2
3

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

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

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

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

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

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

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

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

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

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

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

Authorized Signature /Michael E. Whitham/ Date 6/14/2021

Typed or printed name Michael E. Whitham Registration No. 32635

Electronic Patent Application Fee Transmittal

Application Number:	13966853
Filing Date:	14-Aug-2013
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham/Walter Richardson
Attorney Docket Number:	08610010PA

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	600	600

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**600**

Electronic Acknowledgement Receipt

EFS ID:	42976301
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham/Walter Richardson
Filer Authorized By:	Michael E. Whitham
Attorney Docket Number:	08610010PA
Receipt Date:	14-JUN-2021
Filing Date:	14-AUG-2013
Time Stamp:	13:09:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$600
RAM confirmation Number	E20216DD10114748
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	08610010PA_IF.pdf	81626 1e8ba276e01dac84998c4b2c6cc64d6ff3f9be62	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30353 50fc7f153acac111482137dc54c49a514e4e9413	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	111979		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 04/01/2021

W&C IP
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

EXAMINER	
SERAYDARYAN, HELENA H	

ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
04/01/2021	PAPER

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.

Corrected ***Notice of Allowability***	**Application No.** 13/966,853	**Applicant(s)** Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	**Art Unit** 3648	**AIA (FITF) Status** No

-- 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 03/30/2021.
   ☐ 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 1,3-12,14-16,18-20 and 22-37 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

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

   Certified copies:

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

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

   * Certified copies not received: _____ .

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

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

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

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

Attachment(s)

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/ERIN F HEARD/ Supervisory Patent Examiner, Art Unit 3648

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13966853
Filing Date	
First Named Inventor	Theodore S. Rappaport
Art Unit	3648
Examiner Name	/Helena Seraydaryan/
Attorney Docket Number	08610010PA

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4499606		1985-02-12	Rambo	
	2	6693600		2004-02-17	Elliot	
	3	7088299		2006-08-06	Siegler et al.	
	4	3381222		1968-04-30	Gray	
	5	3689928		1972-09-05	Felsenheld	
	6	6140966		2000-10-31	Pankinaho	
	7	6762723		2004-07-13	Nallo et al.	
	8	7132989		2006-11-07	Poilasne	

Receipt date: 08/14/2013	Application Number	13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	
	First Named Inventor	Theodore S. Rappaport
	Art Unit	
	Examiner Name	/Helena Seraydaryan/
	Attorney Docket Number	08610010PA

	9	8421695		2013-04-16	Friman et al.	
	10	8456366		2013-06-04	Vance	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030151556		2003-08-14	Cohen	
	2	20080158081		2008-07-03	Rofougaran	
/H.H.S/	3	20130040655 ~~20013004065~~		2013-02-14	Keidar	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /H.S./

Receipt date: 08/14/2013	Application Number	13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	
	First Named Inventor	Theodore S. Rappaport
	Art Unit	
	Examiner Name	/Helena Seraydaryan/
	Attorney Docket Number	08610010PA

	1		☐

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

EXAMINER SIGNATURE

Examiner Signature	/Helena Seraydaryan/	Date Considered	04/01/2016

*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.

Receipt date: 08/14/2013	Application Number	13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	
	First Named Inventor	Theodore S. Rappaport
	Art Unit	
	Examiner Name	/Helena Seraydaryan/
	Attorney Docket Number	08610010PA

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael E. Whitham/	Date (YYYY-MM-DD)	2013-08-14
Name/Print	Michael E. Whitham	Registration Number	32635

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /H.S./
Samsung Ex. 1002, Page 13 of 679

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

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EFS Web 2.1.17

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NOTICE OF ALLOWANCE AND FEE(S) DUE

30743 7590 03/15/2021

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EXAMINER
SERAYDARYAN, HELENA H

ART UNIT	PAPER NUMBER
3648	

DATE MAILED: 03/15/2021

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

TITLE OF INVENTION: Steerable Antenna Device

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	06/15/2021

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

Samsung Ex. 1002, Page 15 of 679

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

30743 7590 03/15/2021

W&C IP
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

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

Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

TITLE OF INVENTION: Steerable Antenna Device

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	06/15/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
SERAYDARYAN, HELENA H	3648	342-368000

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

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

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

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

1 _____
2 _____
3 _____

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

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

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

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

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

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

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

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

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Samsung Ex. 1002, Page 16 of 679

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.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 03/15/2021

W&C IP
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

EXAMINER	
SERAYDARYAN, HELENA H	
ART UNIT	PAPER NUMBER
3648	

DATE MAILED: 03/15/2021

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.

Samsung Ex. 1002, Page 17 of 679

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

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

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

Privacy Act Statement

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

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

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

Notice of Allowability	Application No. 13/966,853	Applicant(s) Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	Art Unit 3648	AIA (FITF) Status No

-- 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 12/29/2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

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

3. ☑ The allowed claim(s) is/are 1,3-12,14-16,18-20 and 22-37 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

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

   Certified copies:

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

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

   * Certified copies not received: _____ .

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

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

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

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

Attachment(s)

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/ERIN F HEARD/ Supervisory Patent Examiner, Art Unit 3648

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

CPC - Searched*		
Symbol	**Date**	**Examiner**
H01Q1/245	4/11/2016	H.S.
H01Q1/245 (updated)	11/2/2016	H.S.
H01Q1/245 (updated)	07/19/2017	HS
H01Q1/245 (updated)	11/07/2017	HS
H01Q1/245 (updated)	05/29/2018	HS
H01Q1/245 (updated)	10/22/2018	HS
H01Q1/245 (updated)	03/10/2021	HS

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
342	368	4/1/2016	H.S.
342	368 (updated)	11/2/2016	H.S.
342	368 (updated)	7/19/2017	HS
342	368 (updated)	11/07/2017	HS
342	368 (updated)	05/29/2018	HS
342	368 (updated)	10/22/2018	HS
342	368 (updated)	03/10/2021	HS

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor Name Search in PALM	4/1/2016	H.S.
Inventor Name Search in EAST	4/1/2016	H.S.
Text Search in EAST	4/11/2016	H.S.
Consulted with Primary G. Issing	4/1/2016	H.S.
Consulted with G. Issing	11/2/2016	H.S.
Consulted with G. Issing	7/19/2017	HS
Consulted with G. Issing	10/18/2018	HS
Consulted with E. Heard	03/09/2021	HS

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
342	368	03/10/2021	HS
H01Q	1/245	03/10/2021	HS
H04B	1/3838	03/10/2021	HS

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	**Art Unit**
	HELENA H SERAYDARYAN	3648

CPC						
Symbol					**Type**	**Version**
H04B	/	1	/	3838	F	2013-01-01
H01Q	/	1	/	243	I	2013-01-01
H01Q	/	1	/	245	I	2013-01-01
H04B	/	1	/	0053	I	2013-01-01
H01Q	/	3	/	24	I	2013-01-01
H01Q	/	21	/	28	I	2013-01-01
H01Q	/	5	/	335	I	2013-01-01
H01Q	/	5	/	35	I	2013-01-01
H01Q	/	5	/	357	I	2015-01-15

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	10 March 2021	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	33	
/ERIN F HEARD/ Supervisory Patent Examiner, Art Unit 3648	10 March 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04B	/	1	/	38
H01Q	/	1	/	24
	/		/	

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS
342	368

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	10 March 2021	Total Claims Allowed:	
(Assistant Examiner)	(Date)	33	
/ERIN F HEARD/ Supervisory Patent Examiner, Art Unit 3648	10 March 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	**Art Unit**
	HELENA H SERAYDARYAN	3648

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

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	25	10	17	19	19	28	22	37						
	2	26	11	27	20	20	29								
2	3	3	12		21	30	30								
11	4		13	28	22	31	31								
12	5	4	14	29	23	32	32								
13	6	5	15	6	24	9	33								
14	7	15	16	7	25	21	34								
23	8		17	8	26	33	35								
24	9	16	18	18	27	10	36								

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	10 March 2021	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	33	
/ERIN F HEARD/ Supervisory Patent Examiner, Art Unit 3648	10 March 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	867	342/368.ccls.	USPAT	AND	ON	2021/03/10 12:12
L4	560	H04B1/3838.cpc.	USPAT	AND	ON	2021/03/10 12:12
L5	578	H01Q1/245.cpc.	USPAT	AND	ON	2021/03/10 12:12
L8	188	(l3 or l4 or l5) and (zones or spans)	USPAT	AND	ON	2021/03/10 12:14
L9	48	l8 and (radiation near2 pattern)	USPAT	AND	ON	2021/03/10 12:15

3/10/2021 12:36:28 PM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	683	H01Q1/245.cpc. and @pd>"20181030"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2021/03/10 12:10
L2	63	342/368.ccls. and @pd>"20181030"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2021/03/10 12:10
S1	104	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2016/04/01 13:02
S2	218	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:02
S3	1	S2 and ((steerable adj antenna) with sensors)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S4	1,748	342/368.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S5	3,044	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S6	2,704	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO;	AND	ON	2016/04/11 16:44

			JPO; DERWENT			
S7	4,870	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S8	6,373	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S10	23,279	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S11	196	steer$4 with sensor with phone	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:47
S14	36,859	S5 or S6 or S7 or S8 or S10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S16	775	steer$4 with sensor with (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S17	11	S16 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S18	6	S14 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO;	AND	ON	2016/04/11 16:50

			JPO; DERWENT			
S19	3	"52780741".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/11 16:51
S20	1,533	S14 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S21	452	S20 and (cellphone or phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S22	77	S20 and (cellphone or phone)S21 and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S23	1	S22 and (steer$4 or redirect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:55
S24	73	S22 and (steer$4 or redirect$4 or direct$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:56
S25	1	2014-T60821.NRAN.	DERWENT	AND	ON	2016/04/11 16:57
S26	19,336	((steer$4 or redirect$4 or direct or direction or directionality) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S27	41	S14 and S26	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27

S28	25,566	((steer$4 or redirect$4 or direct or direction or directionality or pattern) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:33
S29	79	S14 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:34
S30	27	H01Q1/245.cpc. and steer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:35
S31	277	H01Q1/245.cpc. and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:49
S32	1,058	steer$4 with antenna with mobile	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/12 09:08
S33	5	"9529117".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/12 09:34
S34	2	(US-20080242349-$).did. or (US-6456856-$).did.	US-PGPUB; USPAT	AND	ON	2016/04/12 10:53
S35	40	342/368.ccls. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:57
S36	91	H01Q1/245.cpc. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:59
S37	13,356	(multiple or dual) near2 (frequency adj2 band)	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45

S38	5,187	S37 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S39	4,852	S38 and communicat$4	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:46
S40	3,177	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S41	2,962	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S42	5,154	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S43	6,655	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S44	25,291	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S45	39,574	S40 or S41 or S42 or S43 or S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S46	705	S39 and S45	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:48
S47	1	("2013/0328723").URPN.	USPAT	AND	ON	2016/11/14 14:56

S48	224	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S49	89	S48 and GHz and (dual or multiple)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S50	29	("2010/0060531").URPN.	USPAT	AND	ON	2016/11/15 10:28
S51	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 10:42
S52	38	("2003/0210203").URPN.	USPAT	AND	ON	2016/11/15 10:59
S53	21	S52 and GHz	USPAT	AND	ON	2016/11/15 10:59
S54	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S55	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S56	16	("2009/0011806").URPN.	USPAT	AND	ON	2016/11/15 11:11
S59	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 11:12
S60	55	("5229975" | "5274844" | "5541609" | "5729238" | "5805067" | "5924020" | "5956626" | "5995862").PN. OR ("6456856").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:19
S61	4	("2008/0242349").URPN.	USPAT	AND	ON	2016/11/15 11:27
S62	24	("2008/0018543").URPN.	USPAT	AND	ON	2016/11/15 11:28
S63	0	("2013/0342416").URPN.	USPAT	AND	ON	2016/11/15 11:32
S64	4	("2009/0124306").URPN.	USPAT	AND	ON	2016/11/15 11:33
S65	9	("20070008235" | "20080204240" | "20130135171" | "5983119" | "7492254" | "8106836").PN. OR ("8649833").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:35
S66	3	("2010/0081491").URPN.	USPAT	AND	ON	2016/11/15 11:38

S67	0	("2008/0150798").URPN.	USPAT	AND	ON	2016/11/15 11:39
S68	6	("2007/0057843").URPN.	USPAT	AND	ON	2016/11/15 11:40
S69	46	("4352109" | "4518968" | "4700194" | "4868576" | "5257033" | "5612705").PN. OR ("6421016").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:41
S71	7	(mmw or (milimeter adj wave)) same (multi?band or (multiple adj band) or (dual adj band) or dual-band) same antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:09
S72	23	(mmw or (milimeter adj wave)) same2 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same2 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:10
S73	19	S72 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:11
S74	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:13
S76	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:14
S77	46	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:15
S78	4	("2014/0321282").URPN.	USPAT	AND	ON	2017/06/21 10:52
S79	2	US-6556836-$.did.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 08:04
S80	2	"25301096".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/18 08:07
S81	4	("2002/0164957").URPN.	USPAT	AND	ON	2017/07/18 09:12

S82	4,401	(millimeter adj wave) same (cellular or mobile or cellphone or communication)	USPAT	AND	ON	2017/07/18 09:34
S84	944	S82 and dual	USPAT	AND	ON	2017/07/18 09:34
S85	184	((millimeter adj wave) same wireless) and (multiband or (dual adj band))	USPAT	AND	ON	2017/07/18 13:54
S86	563	(cellphone or (cellular or mobile) adj phone) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:40
S87	563	(cellphone or ((cellular or mobile) adj phone)) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:49
S88	2	"40137022".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/19 11:04
S89	0	H01Q1/245.cpc. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15
S90	0	342/368.ccls. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15
S91	60	H01Q1/245.cpc. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24
S92	32	342/368.ccls. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24
S94	3,994	sensor near10 (three adj dimensions)	US-PGPUB; USPAT; USOCR	AND	ON	2018/04/26 10:06

S95	1,206	S94 and phone	US-PGPUB; USPAT; USOCR	AND	ON	2018/04/26 10:07
S97	2	us-20090295648-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:34
S99	2	"WO 2012066562"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:41
S100	2	us-20040204027-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:43
S101	7,620,701	WO "2012066562"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:09
S102	4,611	S101 and prasad.inv.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:09
S103	9	((Muthukumar) near2 (Prasad)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/16 10:10
S104	9	S101 and S103	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/16 10:11
S105	7	S102 and SAR and proximity	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:16
S106	9	((Muthukumar) near2 (Prasad)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:46
S107	1	"wo 2012/176217"	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:47
S108	9	"wo 2012176217"	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:47

S109	15	"wo 2012176217"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/23 15:48
S110	96	H01Q1/245.cpc. and @pd>"20171115"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/29 13:08
S111	39	342/368.ccls. and @pd>"20171115"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/29 13:09
S112	2	"41379128".FMID.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 07:11
S113	72	("20050090288" | "20050124305" | "20060161871" | "20060205368" | "20060232468" | "5463406" | "5905467" | "6285893" | "6456856" | "6862433" | "6959209" | "6978121").PN. OR ("8159399").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/07 07:11
S114	2	"41379128".FMID.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 07:12
S115	8,104	343/702.ccls.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:21
S117	952	343/876.ccls.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S118	2,324	H01Q1/2266.cpc.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S119	5,174	H01Q3/24.cpc.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S120	15,520	S115 or S117 or S118 or S119	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S121	839	S120 and sensors	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S122	812	S121 and antenna	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S123	306	S122 and orientation	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S124	65	H01Q1/245.cpc. and @pd>"20180614"	US-PGPUB; USPAT;	AND	ON	2018/10/22 09:13

			USOCR; FPRS; EPO; JPO; DERWENT			
S125	24	342/368.ccls. and @pd>"20180614"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/10/22 09:13

3/10/2021 12:36:19 PM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

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

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte THEODORE S. RAPPAPORT

Appeal 2020-000432
Application 13/966,853
Technology Center 3600

Before DANIEL S. SONG, ANNETTE R. REIMERS, and GEORGE R. HOSKINS, *Administrative Patent Judges*.

HOSKINS, *Administrative Patent Judge*.

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134(a), Appellant[1] appeals from the Examiner's decision rejecting all pending claims 1, 3–12, 14–16, 18–20, and 22–37 in this application.

We REVERSE.

[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. The Appeal Brief identifies the solely-named inventor, Theodore S. Rappaport, as the real party in interest. Appeal Br. 3.

CLAIMED SUBJECT MATTER

Claims 1, 4, and 8 are the independent claims on appeal. Claim 1 illustratively recites, with our emphases added:

> 1. A method for avoiding radiation of a user or structure by a wireless device having *at least one steerable antenna*, comprising the steps of:
>
> detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, an orientation of said wireless device relative to either or both said user and said structure;
>
> determining *zones or spans of directions in the three dimensional space corresponding with one or more directions of either or both said user and said structure* relative to said at least one steerable antenna; and
>
> *adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions* in the three dimensional space, wherein *said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions*, and wherein said adjusting step adjusts one or more beam radiation patterns for direction of energy to one or more of said particular directions while *avoiding said zones or spans of directions* in the three dimensional space, and
>
> wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz.

Appeal Br. 37 (Claims App.) (emphases added).

REJECTIONS ON APPEAL

Claims 1, 3–12, 14–16, 18–20, 22–24, 26, 27, 29, 30, and 32–37 are rejected under 35 U.S.C. § 102(a) as anticipated by Dorsey (US 2009/0295648 A1, pub. Dec. 3, 2009). The rejection additionally refers to and

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discusses claim 13. *See* Final Act. 3, 10. However, Appellant canceled claim 13 via an Amendment filed on March 22, 2017. Therefore, claim 13 is not before us in this appeal.

Claims 25, 28, and 31 are rejected under 35 U.S.C. § 103 as unpatentable over Dorsey and VistaMAX (*Duplexing Techniques — VistaMAX, WiMAX, IEEE 802.16-2004*, Vecima Networks (2004)).

OPINION

A. Anticipation by Dorsey

1. Claims 1, 3, 12, 14, 15, 24, 26, 33, and 36

The Examiner finds Dorsey's Figure 3 illustrates wireless device 10 having at least one steerable antenna 100, 101, or 102, because Dorsey indicates each of these antennas may comprise "an electronically steerable antenna array." Final Act. 3 (citing Dorsey ¶¶ 7–8, 46, 60); Dorsey ¶ 46. The Examiner also finds processor 36 of device 10 determines a zone corresponding to a user of device 10, based on data gathered by sensors 200, 201, and 202. Final Act. 3 (citing Dorsey ¶¶ 45–46, 50, 62, 65, 69). The Examiner next finds Dorsey's device 10 adjusts the beam radiation pattern of one antenna 100, 101, or 102, to radiate in a direction that is not in the determined zone, thereby providing a null or a dead zone in the determined zone and avoiding the determined zone, as recited in claim 1. *Id.* at 3–4 (citing Dorsey ¶¶ 45–46, 50, 62, 65, 69). In particular, according to the Examiner, switching circuitry 54 of device 10 "switch[es] the antenna elements," which "corresponds to adjusting the beam radiation pattern" of a steerable antenna. *Id.* at 4. The Examiner further explains:

> Switching the beam from one antenna element to some other antenna element creates nulls and dead zones in some directions,

> while radiating the energy in some other zones or spa[n]s of directions. Moreover, according to Dorsey the antenna may be implemented as an array of antennas. Antennas may be formed of multiple antenna elements that make up an electronically steerable antenna array.

Id. at 2 (citing Dorsey ¶ 46).

Appellant argues the Examiner errs in finding Dorsey anticipates claim 1 in the foregoing regards. *See* Appeal Br. 26–33. We partly agree, for the following reasons.

The Examiner correctly finds Dorsey's device 10 determines a zone corresponding to a user of device 10, based on data gathered by sensors 200, 201, and 202. Dorsey discloses these sensors may be "environment sensors" that "monitor[] the environment around device 10." Dorsey ¶ 45. In one example, device 10 may be a cellular telephone, as illustrated in Figure 6. *Id.* ¶ 57. Figure 6 is reproduced below:

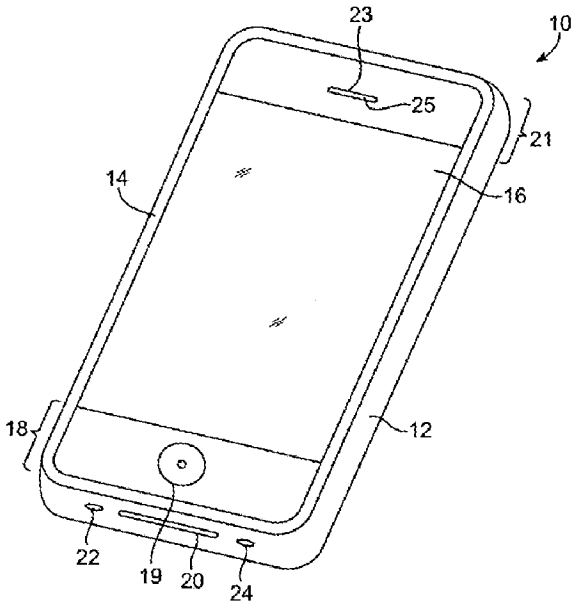

FIG. 6

Figure 6 of Dorsey is a perspective view of device 10, which includes antenna structures in two different regions 18 and 21, and sensor 25 in

region 21 near speaker port 23. *Id.* ¶¶ 16, 58–60. Sensor 25 "detects when an object such as a user's ear is close to port 23," which corresponds to determining a zone corresponding to the user as recited in claim 1, because it reflects "the proximity of the user's head" to region 21. *Id.* ¶¶ 61–62.

However, Dorsey does not disclose that device 10 reacts to this determination in the specific way required by claim 1. Dorsey indicates "device 10 may use sensor 25 to determine which of the two antennas is more likely to be suitable for wireless communications activities," such that "when device 10 determines that the user's ear is near port 23, device 10 may switch to using the antenna in region 18 for wireless communications since the antenna in region 21 is likely to have reduced performance due to the proximity of the user's head." *Id.* ¶ 62. More generally, pursuant to Dorsey's "[a]ntenna diversity system," a mobile device includes two or more "redundant" antennas and then selects which antenna to use for the best wireless communication performance, based on sensor data reflecting environmental conditions around the device. *Id.* ¶¶ 7–8, 45, 50, 69.

Claim 1, by contrast, recites "one" antenna that is "steerable," and requires adjusting the beam radiation pattern of the one steerable antenna to radiate in a direction that is not in the zone determined to correspond with the user of the device, thereby providing a null or a dead zone in the determined zone and avoiding the determined zone. The foregoing disclosures of Dorsey, which reflect selecting one of two or more separately located, steerable antennas to use for wireless communication, do not correspond to this claim requirement. None of the disclosures cited by the Examiner reflects adjusting the beam radiation pattern of one steerable antenna to avoid the zone where the user of the device is located.

The Answer attempts to address this deficiency by finding that "[c]ell phones transmit radio waves *in all directions*." Ans. 4 (emphasis added). The Answer further finds that "directional" antennas, such as the steerable antenna of claim 1, have a single peak direction in the antenna's radiation pattern where the bulk of the radiated power travels to form a main radiation lobe, but they also have side radiation lobes in all other directions. *Id.* at 6–7.

The foregoing findings are not supported by any citation to evidence in the record. *See id.* at 4–7. Nonetheless, even granting the Examiner's point that steerable antennas will direct some (albeit reduced) radiation in the direction of what claim 1 describes as a null or dead zone where radiation is avoided, still Dorsey does not anticipate the claim. The Examiner does not cite any disclosure in Dorsey that reflects *adjusting the beam radiation pattern* of *one* steerable antenna to be directed away from the user of the device. Dorsey instead selects one antenna from among multiple redundant antennas in a mobile device, because the selected antenna's location appears to provide the most unobstructed wireless communication path versus the locations of the other unselected redundant antennas.

According to the Examiner, this disclosure in Dorsey is "an equivalent of" claim 1, because Dorsey's selection of one antenna from among multiple redundant antennas "*change[s] the direction of the radiation*" to avoid blockages for successful communication. Ans. 8, 10 (emphasis added) (citing Dorsey ¶¶ 45–46, 50, 60, 62, 65, 69). It is not clear to us what the Examiner's reference to equivalency means in the context of the present anticipation rejection. Anticipation requires Dorsey to expressly or

inherently disclose each and every limitation of the claimed invention, not something close to the claimed invention.

In any event, the Examiner's finding that Dorsey's selection of one antenna from among multiple redundant antennas changes the direction of the radiation is not supported by a preponderance of the evidence. Granted, Dorsey discloses that the antennas may each be "steerable." Dorsey ¶¶ 46, 60. However, Dorsey does not disclose adjusting the individual radiation pattern of any one antenna. *Id.* Nor does Dorsey disclose how multiple steerable antennas might be directed in different directions, such that selection of one steerable antenna changes the direction of radiation. *Id.* Thus, the Examiner's finding that Dorsey's selection of one antenna from among multiple redundant antennas changes the direction of the radiation of at least one steerable antenna is based on speculation, not on the disclosure of Dorsey.

Instead, Dorsey discloses selecting the antenna that appears from sensor data to be the furthest away from the user of the device, and therefore provides the greatest likelihood of an unobstructed wireless communication path. *Id.* ¶ 7–8 ("a diversity system may use information from the proximity sensors to determine which antennas have external objects nearby that may obstruct wireless signals and may then select an antenna that does not have an external object nearby"); *id.* ¶¶ 45–46, 50, 62, 65, 69. That is not what is claimed here.

For the foregoing reasons, we do not sustain the rejection of claim 1, or of claims 3, 12, 14, 15, 24, 26, 33, and 36 depending therefrom, as anticipated by Dorsey.

2. Claims 4–11, 16, 18–20, 22, 23, 27, 29, 30, 32, 34, 35, and 37

The Examiner's rejection of independent claims 4 and 8 as anticipated by Dorsey relies on the same findings discussed above in connection with claim 1. *See* Final Act. 5–7 (claim 4), 7–9 (claim 8). Thus, for the reasons provided above in connection with claim 1, we do not sustain the rejection of claims 4 and 8, or of claims 5–7, 9–11, 16, 18–20, 22, 23, 27, 29, 30, 32, 34, 35, and 37 depending therefrom, as anticipated by Dorsey.

B. Obviousness over Dorsey and VistaMAX

The Examiner's rejection of claims 25, 28, and 31 as having been obvious over Dorsey and VistaMAX relies upon the same findings concerning Dorsey's disclosure discussed above in connection with claim 1. *See* Final Act. 15–17. Thus, for the reasons provided above in connection with claim 1, we do not sustain the obviousness rejection of claims 25, 28, and 31.

SUMMARY OF DECISION

In summary, we reverse the rejections presented on appeal:

Claims Rejected	**35 U.S.C. §**	**Reference(s)**	**Affirmed**	**Reversed**
1, 3–12, 14–16, 18–20, 22–24, 26, 27, 29, 30, 32–37	102	Dorsey		1, 3–12, 14–16, 18–20, 22–24, 26, 27, 29, 30, 32–37
25, 28, 31	103	Dorsey, VistaMAX		25, 28, 31
Overall Outcome				**1, 3–12, 14–16, 18–20, 22–37**

REVERSED

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 10/29/2019

W&C IP
11491 SUNSET HILLS ROAD
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EXAMINER	
SERAYDARYAN, HELENA H	

ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
10/29/2019	PAPER

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

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte THEODORE RAPPAPORT

Appeal 2020-000432
Application 13/966,853
Technology Center 3600

APPEAL DOCKETING NOTICE

The Patent Trial and Appeal Board received the appeal in the above-identified application from the Technology Center on October 28, 2019, and has assigned it the appeal number indicated above.

The recipient of this notice is reminded of its ongoing duty, within 20 days of any change during the proceeding, to update its mandatory notices to identify the real party-in-interest and each judicial or administrative proceeding that could affect, or be affected by, the Board proceeding. 37 C.F.R. § 41.8. For example, another docketed appeal in a related application may have the potential to affect, or be affected by, the Board proceeding.

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P.O. BOX 1450
ALEXANDRIA, VIRGINIA 22313-1450

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

In re patent application of

Rappaport	Confirmation No. 2489
Serial No. 13/966,853	Group Art Unit: 3648
Filed: August 14, 2013	Examiner: Seraydaryan

For: STEERABLE ANTENNA DEVICE

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

REPLY BRIEF

This brief is in reply to the Examiner's Answer mailed August 19, 2019.

As indicated in the Applicant's Brief filed June 21, 2019, most of the claims are rejected as being anticipated by Dorsey. A few of the claims are rejected as being obvious over a combination of Dorsey in view of VistaMax. As noted in the Applicant's Brief, the Examiner has either overlooked or minimized requirements of the claims. That is, the claims require

1) 10GHz-500GHz
2) A steerable antenna
3) Determination of zones or spans of directions in three dimensional space
4) Adjusting beam radiation patterns to not be in the determined zones or spans with beams being directed in particular directions and nulls or dead zones in other directions

These are not described or shown in Dorsey. Furthermore, the Examiner has relied upon Dorsey and the state of knowledge at the time of Dorsey, in dealing with transmissions which might occur in earlier cell phone designs, as opposed to 5G cellphones that would operate at 10-500GHz. Simply put, the earlier antenna designs

of Dorsey, and the state of the art at that time, were constructed and designed under different conditions than devices which will operate at 10-500 GHz. Solutions for those earlier devices simply do not work for these higher frequencies. Furthermore, at the time this patent application was filed, the prior art did not anticipate or make obvious the solutions taught and claimed in the present application. The Examiner's Answer restates positions highlighted in Applicant's Brief as being the prior art (common beliefs held before the Applicant's invention), and therefore underscores the main deficiencies of Dorsey and the novelty of the present invention.

Each of the claims in the present application require the steerable antenna to operate in the 10-500 GHz range. Prior notions of radio propagation and omnidirectional antennas, before the Applicant's pioneering work at millimeter wave frequencies, are simply incorrect as frequencies move into the realm of 10 GHz and above, since the channels become much more directional in nature, with energy arriving at only specific angles of arrival or departure (not in an omnidirectional manner as asserted by Examiner's Answer). The inventor has conducted some of the world's leading work on millimeter wave propagation channels and antenna impact, showing that unlike at lower frequencies (for the earlier four generations of mobile telephones, for example), the spectrum above 10 GHz becomes much more directional in nature, requiring much more care and precision in forming the beams than for conventional mobile radio around 1-2 GHz.

Thus, the Examiner's discussion which bridges pages 4 and 5 of the Answer describes how cell phone antennas are omnidirectional, and how the radio waves may cause injury to the user, and how the radio waves being absorbed into the body of the user and thus may not be useful for communicating between transmitter and receiver, all point to the need for the present invention. The discussion does not demonstrate or suggest obviousness of the claimed invention. As explained in paragraphs [0043] and [0044] of the present application, the coming use of millimeter wave bands, which is in fact now beginning to find use in emerging 5G networks, requires exploitation of the directional antenna and radio channel properties to overcome propagation losses at frequencies of 10 GHz and above. The claimed invention uses

steering capabilities using a novel approach to provide a widely varying antenna beam pattern that specifically avoids users, avoids and/or reflects off buildings and other surfaces, etc. Thus, the invention satisfies safety precautions and enables a more predictable and adaptively enhanced signal strength over time which continually reforms the specific beam patterns to avoid particular radiation zones over movement or changes in surroundings.

Dorsey does not create a mapping or computer model/image of the environment near the device, but instead merely uses the sensors to detect if something is close or not to a particular antenna, without specific knowledge or abilities to continually contour the radiated beam patterns of antennas. This course sensing by Dorsey merely informs if a particular antenna should be or should not be selected. It does not allow arbitrary or even known antenna patterns to be formed and varied. Dorsey never teaches the ability to provide arbitrary beams that are specifically contoured based on the orientation or surroundings of the antennas. That is, Dorsey merely is selecting for best signal, without knowledge of how the signal is specifically propagating in relation to the surroundings. The described and claimed invention is much more sophisticated than that, and is different from Dorsey in that it requires determination of the surrounding three dimensional space, the determination of zones or spans which should be avoided, transmission at frequencies above 10 GHz into particular directions, and the generation of nulls or voids by the antenna system in other directions, all while the user or the surroundings are changing over time. This requires computer or processor control, beam steering, and sensors for the three dimensional space assessment. Greater sophistication is required due to the greater loss and smaller wavelengths that occur for traditional omnidirectional antennas above 10 GHz. Directional patterns are more desirous and needed for improved performance and range in mobile and fixed wireless systems above 10 GHz. Unlike Dorsey, the present invention uses sensors to create site specific knowledge of surroundings and orientation (the claims require detection in three dimensions—this not being shown in Dorsey), such that the proper antenna beam pattern may be computed "on the fly" as user orientation or surroundings change, to

assure exclusion zones of antenna radiation patterns are continually met over movement. Nothing of this sort is taught by Dorsey. It is simply incorrect to assume that all of these computations could or wouldbe done when Dorsey never uses the sensors to build a relative map or computer model of surroundings in 3D and fails to compute any antenna weightings or phases that seek to understand and control the particular antenna beam pattern relative to the surroundings of the antenna.

The independent claims, in contrast to Dorsey, require these calculations to be made. Dorsey is picking from a finite number of antennas that happen to give some patterns (which are not known or computed or ever even specified in Dorsey), where each of these unknown antenna patterns cannot be varied in a known/concerted way with respect to orientation or surroundings. Rather, in Dorsey, the antenna radiation patterns are locked into whatever they provide, and thus those selected antenna patterns will change with respect to a fixed 3-D coordinate system as the user moves the handset. That is, Dorsey's selections of antennas are locked in, so that when a particular antenna is selected by Dorsey, and the person moves the phone, the selected antenna patterns moves along with the phone itself, and has no way to adjust its pattern to contour a new beam pattern that accounts for these movements such that a particular exclusion zone is maintained in a fixed 3-D coordinate system. Dorsey simply cannot readjust a specific beam patterns as a user or its surroundings change – it has no way of knowing or adapting or forming the proper contoured beam, in direct contrast to the described and claimed invention.

Furthermore, Dorsey is limited to selecting between the finite number of selectable (and unknown) antenna patterns. At any time Dorsey has no idea if the particular selected antenna scheme is radiated in any particular direction. All Dorsey knows from its teaching is that some antenna selections are better than others, and that some antenna selections are easier to make if a phone is lying on a table. Thus, Dorsey never teaches the approach contemplated in the present invention to assure proper forming of exclusion zones over time.

Beamsteering, as required and taught in the claimed invention, cannot possibly be done without knowledge of the antenna patterns and knowledge of the

site specific environment (e.g., a map or computer model of objects near the antennas). Dorsey never teaches any knowledge or computations that may be used to adjust the precise beam pattern, and never teaches the use of sensors to know the site specific environment around the antenna. Hence, one of ordinary skill in the art at the time the invention was made and having full knowledge of Dorsey, would not implement beamsteering in a prior art or Dorsey style device, and would not be aware of its requirement in 10 GHz devices and/or how to implement it in 10 GHz devices (this being taught only by the inventor). As noted previously, there is no teaching in Dorsey which pertains to carefully controlling the radiated antenna pattern during motion of the device or the user, and the variability of orientation over time.

The advancements described and claimed in the present invention are best thought of in terms of packaging, manufacturing, processes, signal processing, and design, as opposed to advancements in antenna technologies. Thus, the theoretical background concerning antennas in particular (see page 5 of the Answer) is also lacking. Antennas can be made of dielectric materials or semiconductor materials, and are not merely a metallic element of a specific size and shape. As explained in paragraph [0043] of the present application, the directional antennas for use at the 10GHz and above frequencies can be much smaller than prior cell phone antennas.

On page 5 of the Answer, the Examiner's definition of a radiation pattern fails to indicate that this understanding is only applicable for a static antenna. That is, the Examiner's Answer only applies to rigid and fixed patterns and orientations, for both the antenna, as well as for rigid and fixed patterns and orientations for the surroundings of the antenna, which can alter or distort the far field antenna pattern. One of the key advantages of the claimed invention system and method is that it adapts the antenna patterns to account for the changing orientation of, for example, a cellphone and the orientation of the surroundings near the antenna. These changes in orientation may either singly or both change at any time. With omnidirectional antennas, one might simply live with impaired transmissions and exposure to radio waves (as stated in the Examiner's Answer). However, the claimed invention employs a steerable antenna and provides for rapidly readjusting the radiation pattern

as a user changes the orientation of the antenna. For example, it is normal, using older cell phones, for a person to change from having the phone against their ear to having the phone facing them for a face time communication. When this occurs, not only does the relationship of the cellphone antenna to the person change, but the surroundings near the antenna change (e.g., he or she strolls past a park and then past a large building while walking and talking on their phone). Using highly directional beams at 10-500 GHz, this would pose many problems for connectivity, safety, etc. (which may not exist with a Dorsey or other prior art device). With the present invention, the radiation pattern may be rapidly readjusted due to changes in the orientation of the antenna or changes to the surroundings external to the antenna, or both. See particularly claims 36 and 37 which require receiving, using and adjusting being performed multiple times as parameters change over time. Such a concept and capability has not existed in the prior art (e.g., the previous four generations of cellphone technologies). The references cited in the case by the Examiner simply do not have a need to be able to produce antenna patterns that can be formed to avoid zones which comes about from the sensitive nature of millimeter wave frequencies. Thus, this feature is not in, and would not be obvious over, the prior art.

Furthermore, with regard to commentary at the bottom of page 5 of the Answer, a slot antenna and a dipole antenna do not necessarily provide an omnidirectional antenna pattern. Only when a dipole is oriented vertically to the ground can it provide an omnidirectional pattern, and then only in the azimuthal plane, not the elevation plane. This also applies to a slot antenna, indicating the Examiner's lack of appreciation for the critical 3-D nature of millimeter wave antennas, propagation, and the importance of the present invention. In addition, with regard to the commentary at the top of page 6 of the Answer, directional antennas very often do have symmetrical radiation pattern, generally with symmetry around the boresight or maximum direction of radiation. For example, the pattern of a directional antenna such as a yagi, phased array, horn or dish antenna is very much symmetrical when taken in a planar cut. More importantly, none of the antennas in the literature at the time of the present invention had the characteristics of the present

invention. In particular, no antennas existed that featured items in the independent claims that require: detecting in three dimensional space the orientation of the wireless device relative to the use or other structures, determining zones or spans of directions which correspond to the directions of either or both the user or structures, and adjusting the beam radiation patterns of the steerable antenna to radiate in directions which are not in the zones or spans of directions in the three dimensional space where the user or structures are located. This is done by steering the antenna to radiate in particular directions, while providing nulls or dead zones in other directions. And, this is all done at frequencies of 10 GHz to 500 GHz. The prior art simply does not have these calculations, adjustments or capabilities.

Furthermore, the statement on page 6 of the Answer that cell phones should have a low directivity is simply not correct for frequencies above 10 GHz. Wireless devices above 10 GHz use such small wavelengths such that the air (free space) loss in the first meter of propagation for an omnidirectional antenna is much greater than at lower frequencies, such as at 1 GHz. Thus, there is a fundamental need for antennas in future millimeter wave cellphones to have HIGH directivity, NOT low directivity to create a useful link or cellphone network.

With reference to page 7 of the Answer, there are many ways to implement beam steering, but it is vital to understand that merely switching the antenna elements, or turning some antenna elements on or off (e.g., Dorsey), only provide a fixed (e.g., static) change in pattern for a fixed orientation. The approach of selecting between antennas is called "diversity", and using different combinations of specific antennas is known as "analog beam forming" or "antenna switching". Thus, a critical point overlooked during the prosecution of the present application is that it is not possible to contour a beam to specifically radiate in arbitrary directions and to reduce the radiation in arbitrary directions by simply switching in or out finite numbers of antenna elements, since switching merely implements a rigid, fixed pattern for a particularly selected antenna or antennas with an assumption of a fixed orientation (e.g., locked positioning) of both the antenna and its surroundings. That is to say, it simply is not physically possible to use Dorsey to provide an arbitrary, near-infinite

number of possible antenna beam patterns (such that one could be chosen to provide a dead zone that is maintained in a fixed coordinate space as a user moves or with changes in surroundings, as importantly taught by the present invention) with a typical number of antennas as taught in Dorsey. Put another way, switched antenna systems are not able to provide antenna patterns that provide arbitrary exclusion zones within a radiation pattern, using a reasonable finite number of antennas. Simple diversity or antenna selection, or turning on and off some antennas in a phased array, can only provide a finite number of beams, and these beams cannot be adjusted to handle both the changes in orientation of the antenna and the orientation of the surroundings of the antenna, as is taught only in the present application. The examiner relies on Dorsey, which only switches antennas due to proximity, and thus has no way of anticipating or implementing arbitrary dead zones or areas of low radiation over movement by either the user or its surroundings. Dorsey is locked in to just a few finite patterns and these patterns cannot be contoured or adjusted to provide arbitrary and specific dead zones as either the antennas or surroundings of the antenna are moved or changed.

The Examiner has failed to show that the prior art teaches what is taught by the present application. Unlike the prior art, the Applicant's invention makes it possible to provide arbitrary antenna patterns that provide exclusion zones. Dorsey does not contemplate the precise forming of the beam as is clearly needed when going above 10 GHz.

Certainly, beamforming as taught in Dorsey cannot in any way adjust for changes in both the orientation in both the antenna itself and the surroundings of the antenna, since the antenna patterns are limited number and very course when merely switching antenna elements; e.g. there is no way to arbitrarily form a particular beam pattern with exclusionary radiation zones as taught by the present inventor. Nothing is presented in Dorsey that informs a reader to be able to finely control and compute specific antenna patterns that provide exclusion zones. There simply is no teaching, nor would it be obvious at the time of Dorsey to implement, for example:

([0049] of the application) By using simple geometry calculations, accounting

for the camera's field of view (used to sense the human user and/or the user's body parts or clothing, etc.) and the orientation of the antenna elements in a portable wireless device, a zone or span of directions can be computed by the device (using a "beamformer" or "beamsteering" or "beam selection" approach, which may be implemented in software within the device, e.g. a computation module, or on a specialized processor or generalized processor such as processor 27 in FIG. 2, along with antenna and RF front end hardware to actuate the desired radiation pattern from antennas in the device, where computer algorithms are used to select proper hardware settings for desired beam patterns) to know where not to transmit energy, and the beamforming algorithms (which may include beam or antenna element selection, adaptive beamforming, beam selection, multibeam combining, mimo, phasing, etc.) may be adjusted to ensure that a primary energy is radiated away from the zone or span of directions.

Such an approach would not have been deemed possible before the inventor's pioneering work that showed the viability of millimeter wave mobile communications with steerable antennas.

Furthermore, Dorsey never describes any ability to understand, learn, or adapt the radiation pattern of the antenna pattern, or its relation to its surroundings. Never once does Dorsey identify the importance of knowing the particular beam pattern (e.g. its precise antenna pattern relative to orientation) as related to the environment or user (as is required in the claimed invention). There is no teaching in Dorsey or other prior art that ensures there is a known beam pattern for an arbitrary orientation so that a beam can be formed properly and as desired to a specific contour (e.g. to assure exclusion zones such that the antenna does not radiate into the face of a user, for example).

Dorsey describes selecting different antennas of unknown antenna pattern for a better signal. By contrast, the present invention requires a much more sophisticated and vital knowledge of the surroundings and orientation to ensure a known, precise beam pattern to be created. While Dorsey may be able to adjust its pattern, there is nothing at all in Dorsey that assures its new pattern, when adjusted, will maintain the

needed exclusionary zone (which is required in the claims of the present application). Dorsey never considers the relative position of the antenna and its orientation to surroundings such that the necessary adjustments could be made. There is no precision in Dorsey that enables the proper beamforming to take place as required at frequencies above 10 GHz. Dorsey could not possibly create the precise patterns of its beams since there is no teaching of the key inputs nor any teaching of particular beam patterns that would allow such precise beam patterns or exclusionary patterns to be formed in Dorsey.

The passages relied on in Dorsey by the Examiner merely pertain to relative signal strength. In contrast with claimed embodiments of the Applicant's invention, a particular beam pattern with a precise radiation pattern cannot possibly be done by Dorsey. Just because Dorsey's elected antennas and radiation patterns may be different, that does not guarantee that they are still providing the necessary exclusion zones. Dorsey gives no teaching to being able to steer the beam in a manner that assures particular zones are excluded over time and over motion.

In summary, the independent claims require

1) 10GHz-500GHz

2) A steerable antenna

3) Determination of zones or spans of directions in three dimensional space

4) Adjusting beam radiation patterns to not be in the determined zones or spans with beams being directed in particular directions and nulls or dead zones in other direction

Dependent claims are themselves separately patentable from the independent claims. Exemplary, separately patentable claims require the determination, computation and adjustments to be performed multiple times (claims 36 and 37), that the steerable antenna operates on multiple bands (claims 33-35), the radiated pattern of beams is different from the received beams (claims 16, 24, 30 and 32), receiving of signals within the zones or spans (claims 26 and 29 (e.g., ricochet of a structure)), etc. A system and method with the four requirements above simply is not described in Dorsey and would not be obvious over Dorsey in combination with VistaMax or any

other reference of record. Similarly, the requirements of the dependent claims as noted above and not taught in or obvious over Dorsey.

In view of the above, reversal of the rejections is requested.

Respectfully submitted,

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Electronic Patent Application Fee Transmittal

Application Number:	13966853
Filing Date:	14-Aug-2013
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham
Attorney Docket Number:	08610010PA

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
APPEAL FORWARDING FEE	2413	1	1120	1120
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1120**

Electronic Acknowledgement Receipt

EFS ID:	37500368
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	18-OCT-2019
Filing Date:	14-AUG-2013
Time Stamp:	15:21:39
Application Type:	Utility under 35 USC 111(a)

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1		08610010pa_10_18_19.pdf	546714 5e9699ba5c74dded3371b98733388ddb24a7de37	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Certification and Transmittal of Appeal Forwarding Fee	1	1
	Reply Brief Filed	2	12

Warnings:					
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2	Fee Worksheet (SB06)	fee-info.pdf	30412 d6298ba3e18dabdbf6a6e4938999ef423d526df9	no	2
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New International Application Filed with the USPTO as a Receiving Office
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Doc code: WFEE.APPEAL
Doc Description: Certification and Transmittal of Appeal Forwarding Fee

PTO/AIA/34 (06-14)

CERTIFICATION AND TRANSMITTAL OF APPEAL FORWARDING FEE

Docket Number (Optional): 08610010PA

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In re Application of Rappaport	
Application Number 13/966,853	Filed August 14, 2013
For Steerable Antenna Device	
Art Unit 3648	Examiner Seraydaryan

37 CFR 41.45 specifies that, in order to avoid dismissal of the appeal, appellant must pay the fee set in 37 CFR 41.20(b)(4) within two months of the later of the date of either the examiner's answer, or a decision refusing to grant a petition under 37 CFR 1.181 to designate a new ground of rejection in an examiner's answer.

The undersigned certifies that the appropriate fee accompanies this transmittal.

The fee for forwarding this appeal is (37 CFR 41.20(b)(4)) $ 2240

☑ Appellant asserts small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by 50%, and the resulting fee is: $ 1120

☐ Appellant certifies micro entity status. See 37 CFR 1.29. Therefore, the fee shown above is reduced by 75%, and the resulting fee is: $ _____
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

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☑ Payment made via EFS-Web.

Extensions of time under 37 CFR 1.136(a) for patent applications are not applicable to the time period set forth in 37 CFR 41.45. See 37 CFR 1.136(b) for extensions of time to reply for patent applications and 37 CFR 1.550(c) for extensions of time to reply for *ex parte* reexamination proceedings.

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I am the

☐ appellant

☑ attorney or agent of record Registration number 32,635

☐ attorney or agent acting under 37 CFR 1.34 Registration number _____

Signature _____

Typed or printed name Michael E. Whitham

Telephone Number 703-787-9400

Date October 18, 2019

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 08/19/2019

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EXAMINER	
SERAYDARYAN, HELENA H	

ART UNIT	PAPER NUMBER
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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Application Number: 13/966,853
Filing Date: 14 Aug 2013
Appellant(s): Rappaport, Theodore, S.

Michael Whitham
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 06/21/2019.

Every ground of rejection set forth in the Office action dated 10/30/2018 from which the appeal is taken is being maintained by the examiner except for the grounds of rejection (if any) listed under the subheading "WITHDRAWN REJECTIONS." New grounds of rejection (if any) are provided under the subheading "NEW GROUNDS OF REJECTION."

EXAMINER'S ANSWER

This is in response to the appeal brief filed 06/21/2019 appealing from the Office action mailed 10/30/2018.

(1) Theoretical Background

I. Cell Phone Antenna Basics

A. Radiation Pattern

In the basic form, cell phone is essentially a two-way radio, consisting of a radio transmitter and a radio receiver. When you chat with your friend on your cell phone, your phone converts your voice into an electrical signal, which is then transmitted via radio waves to the nearest cell tower. The network of cell towers then relays the radio wave to your friend's cell phone, which converts it to an electrical signal and then back to sound again.

Cell phones use radio waves to communicate. Radio waves transport digitized voice or data in the form of oscillating electric and magnetic fields, called the electromagnetic field (EMF). The rate of oscillation is called frequency. Radio waves carry the information and travel in air at the speed of light.

Cell phones transmit radio waves in all directions. The waves can be absorbed and reflected by surrounding objects before they reach the nearest cell tower. For example,

when the phone is placed next to your head during a call, a significant portion (over half in many cases) of the emitted energy is absorbed into your head and body. In this event, much of the cell phone's EMF energy is wasted and no longer available for communication.

Cell phones contain at least one radio antenna in order to transmit or receive radio signals. An antenna converts an electric signal to the radio wave (transmitter) and vice versa (receiver). Some cell phones use one antenna as the transmitter and receiver while others, such as the iPhone 5, have multiple transmitting or receiving antennas.

An antenna is a metallic element (such as copper) engineered to be a specific size and shape for transmitting and receiving specific frequencies of radio waves. While older generation cell phones have external or extractable antennas, modern cell phones contain more compact antennas inside the device thanks to advanced antenna technologies.

A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. This power variation as a function of the arrival angle is observed in the antenna's far field.

A pattern is "isotropic" if the radiation pattern is the same in all directions. Antennas with isotropic radiation patterns don't exist in practice, but are sometimes discussed as a means of comparison with real antennas.

Some antennas may also be described as "omnidirectional", which for an actual antenna means that the radiation pattern is isotropic in a single plane. Examples of omnidirectional antennas include the dipole antenna and the slot antenna.

The third category of antennas are "directional", which do not have a symmetry in the radiation pattern. These antennas typically have a single peak direction in the radiation pattern; this is the direction where the bulk of the radiated power travels. These antennas are very common; examples of antennas with highly directional radiation patterns include the dish antenna and the slotted waveguide antenna.

Directivity is a fundamental antenna parameter. It is a measure of how 'directional' an antenna's radiation pattern is. An antenna that radiates equally in all directions would have effectively zero directionality, and the directivity of this type of antenna would be 1 (or 0 dB).

Antennas for cell phones should have a low directivity because the signal can come from any direction, and the antenna should pick it up.

Main lobe is the radiation lobe going in the same direction of the maximum radiation.

Side lobe is the radiation lobe of any directional lobe except the intended direction.

One of the other important parameters is bandwidth which determines the range of the frequencies where the antenna is operating.

B. Beam Forming and Beam steering

Antenna beam forming and antenna beam steering are technologies or techniques that are finding increasing use with systems like cellular telecommunications and in particular 5G as well as many other wireless systems.

Antenna beam forming allows an antenna system consisting of a number of individual antennas to have the direction of the beam to be changed by altering the phase and amplitude of the signals applied to the individual antenna elements in the array.

Beam steering is about changing the direction of the main lobe of a radiation pattern. In radio systems, beam steering may be accomplished by switching the antenna elements or by changing the relative phases of the RF signals driving the elements.

(2) Response to Arguments

1. Appellant's arguments regarding the rejection of independent claims 1, 4 and 8 are not persuasive.

a. **Appellant argues** that reference by Dorsey (US 20090295648) does not teach claim elements:

1. adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions;

2. computing zones or spans of directions corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna in the three dimensional space; and

3. adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space;

4. wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space; or

5. wherein said at least one steerable antenna is configured to adjustably steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space.

b. **The Appellant further argues that** *"As the PTAB will recognize, a person may hold a wireless device a multiplicity of different ways while walking, and the user's relative position in three dimensional space will change. The user's relative position in three dimensional space may also change to features of the wireless device may also change when the user is stationary simply by holding the device differently at two different time periods. In contrast to Dorsey (and all of the other art cited during prosecution of this case), the claimed invention provides the ability to adjust the beam direction accordingly under these changing conditions. In operation, the method and device of the claimed invention directs signals in particular directions while nulls or dead zones are provided in the spans or zones where energy is not desired or useful.*

With the claimed invention, if the wireless device were moved, or the user changes hands for holding the device, different zones or spans of directions would be determined, and adjustments would be made such that the steerable antenna radiates in the directions which are not in those spans or zones."

c. **Examiner respectfully disagrees**, as Dorsey teaches changing the radiating antennas to change the direction of the radiation [0045-0046, 0050, 0062, 0065, 0069] and avoid blockages, such as, for example user's hand or face to close the radiated beam path [0062] to have successful communication. Changing the radiation direction changes the radiation pattern. The antennas can be steerable antenna arrays [0046, 0060]. However, by definition, changing the radiation direction by switching the radiating antennas is also an equivalent of beam steering. The antenna switching adjusts beam radiation patterns to radiate in one or more directions which are not in zones or spans of directions and provides nulls or dead zones in other directions.

d. **The Appellant asserts** "Moreover, as explained in the application, with the present invention the beams can also be steered away from the walls of buildings which a user might be walking next to in order to have a better signal. In addition, embodiments of the invention could be used by a fixed or mobile wireless device to steer energy such that the radiation avoids a particular structure and instead beams towards another structure or direction. In short, only the applicant teaches determining orientation of objects (e.g., a person or a structure relative to the wireless equipment) and adapting antenna patterns to the particular orientation and distance in 3D space as claimed."

e. **Examiner respectfully disagrees,** as Dorsey teaches using sensors (for example light sensors) to detect blockages around the device and to perform a successful communication. The sensors detect the surrounding objects in 3d space. [0031-0032, 0040, 0047, 0061].

f. **The Appellant asserts** "On page 2 of the office action mailed October 30, 2018, the Examiner equates "switching of antenna elements corresponds to steering the antenna and adjusting the beam radiation pattern. Switching the beam from one antenna element to some other antenna element creates nulls and dead zones in some directions, while radiating the energy in some other zones or [spans] of directions" to a steerable antenna. This is simply incorrect.

The Examiner is basically saying "if I have a plurality of antennas, spaced about all over an object such as an Ipad®, it's the same thing as a 'steerable antenna'". Of course, this faulty reasoning overlooks all of the real estate on the Ipad® which is required to have all those antenna elements. In contrast to the Examiner's reasoning and cited references, a steerable antenna, as is required in all of the claims of the present application, does not have a requirement for a giant amount real estate on or in the device. Rather, with the claimed invention, one can, from a single location and a single or multiple phased array antenna, steer

the beam radiation patterns away from an object such as a person or building so that the beam radiation patterns are safer or more effective."

g. **Examiner respectfully disagrees,** as the antennas can be steerable antenna arrays [0046, 0060]. However, by definition, changing the radiation direction by switching the radiating antennas is also an equivalent of beam steering.

h. **The Appellant further asserts** "*Moreover, the Examiner's reasoning completely overlooks the process steps or features of some of the elements which are required in the claims and which are not taught or obvious. To use a steerable antenna as required in the claims, one must:*

1) detect in 3D space using any of a variety of sensors where the wireless device is relative to either or both a user or a structure;

2) determine zones or spans of directions in the 3D space that are directed at either or both the user or structure; and

3) adjust one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the 3D space.

With Dorsey, and with how the Examiner has described Dorsey on page 2 of the office action of October 30, 2018, none of these steps are performed. This is because with Dorsey, and with the description of Dorsey provided by the Examiner, you do not have to do any of those steps. Such is the result when you are not using a steerable antenna as is required in the claimed invention.

Dorsey does not teach or infer in any way the sensing and characterizing the three dimensional space around a wireless device and adjusting a beam radiation pattern so as to steer or direct its energy in particular directions while providing nulls or dead zones in other directions. Rather, Dorsey switches from one redundant antenna to another so as to purportedly

produce more successful wireless communications (see paragraph [0047]). Wholly absent from Dorsey is any teaching of altering the antenna radiation pattern for specific exclusionary zones"

i. **Examiner respectfully disagrees.** The sensors detect the object in three dimensional space [0031-0032, 0040, 0047] and the antenna radiation pattern is adjusted in three dimensional space. The zones into which the radiation is avoided, such as the space areas where there is a blockage such as the user's body part are the *specific exclusionary zones*.

j. **Appellant also asserts**: "*Even with reference to paragraph [0060] of Dorsey where beam steering arrays are mentioned, it must be recognized that in Dorsey, only a single antenna or a single beamforming array (briefly in [0046] and [0060]) are contemplated for selection, and, importantly, Dorsey never contemplates using a combination of antennas to create a site specific antenna pattern or phased array pattern that can be altered to induce varying nulls or dead zones based on changing conditions in the channel. Rather, according to the teachings of Dorsey, in practicing the Dorsey invention it is either a single redundant antenna (beam steering or not) or a single redundant array that is used to avoid "interference" with the selected antenna. Dorsey never describes using antennas or antenna arrays, alone or in combination, to create radiation patterns with a specific intent of avoiding some zones and accentuating others, as is taught in the present application and clearly highlighted in the claims.*

In Figure 8 of Dorsey, there is shown a single antenna element being selected in a diversity scheme (see 72, 78 which selects only a single antenna). This clearly fits Dorsey's stated goal to enhance antenna selection diversity (see Abstract, [0001], [0013], [0018] Figure 3, and Figure 8) instead of beamforming or adjustment of the beam, as is done in the present application."

k. **Examiner respectfully disagrees.** Dorsey teaches beamforming through switching among individual antennas or by steering the steerable antenna array beam and there

is no requirement in the claim to perform the beamforming and beam adjusting process by simultaneously radiating by only multiple steerable antennas.

2. Appellant's arguments regarding the rejection of claims 36 and 37 are not persuasive. **Appellant asserts** that Dorsey does not teach claim limitation "*wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.*" **Examiner respectfully disagrees,** as [0068-0069] it is clearly described, that when a change in physical environment around the device is detected by the sensors or when the device is reoriented, the antennas are switched to change the radiation pattern. The sensor detection of the changes is performed constantly over time. Thus, every time a change in surrounding environment or orientation occurs, the radiation patter will be adjusted.

3. Appellant's arguments regarding the rejection of dependent claims 16, 20 and 24 are not persuasive. **Appellant asserts** that reference by Dorsey does not teach claim limitation "*wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna*". **Examiner respectfully disagrees** as according to [0073-0075], based on received signal quality, the transmission pattern may be changed, in which case the reception and radiation patterns will be different. Also, inherently the reception and radiation patterns are different, as the directional antennas transmit in particular directions, but the signal is received from all directions.

Conclusion

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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Requirement to pay appeal forwarding fee. In order to avoid dismissal of the instant appeal in any application or ex parte reexamination proceeding, 37 CFR 41.45 requires payment of an appeal forwarding fee within the time permitted by 37 CFR 41.45(a), unless appellant had timely paid the fee for filing a brief required by 37 CFR 41.20(b) in effect on March 18, 2013.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

In re patent application of

Rappaport

Serial No. 13/966,853

Filed: August 14, 2013

For: STEERABLE ANTENNA DEVICE

Confirmation No. 2489

Group Art Unit: 3648

Examiner: Seraydaryan

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

APPELLANT'S BRIEF UNDER 37 C.F.R. §41.37

This brief is in furtherance of the Notice of Appeal, filed in this case on April 22, 2019.

This brief contains these items under the following headings, and in the order set forth below (37 C.F.R. §41.37(c)):

I. REAL PARTY IN INTEREST

II. RELATED APPEALS AND INTERFERENCES

III. SUMMARY OF CLAIMED SUBJECT MATTER

IV. ARGUMENTS

☐ ARGUMENT IVA. REJECTIONS UNDER 35 U.S.C. §101

☐ ARGUMENT IVB. REJECTIONS UNDER 35 U.S.C. §112, FIRST PARAGRAPH

☐ ARGUMENT IVC. REJECTIONS UNDER 35 U.S.C. §112, SECOND PARAGRAPH

☑ ARGUMENT IVD. REJECTIONS UNDER 35 U.S.C. §102

☑ ARGUMENT IVE. REJECTIONS UNDER 35 U.S.C. §103

☐ ARGUMENT IVF. REJECTION OTHER THAN 35 U.S.C. §§ 101, 102, 103 AND 112

V. CLAIMS APPENDIX

VI. EVIDENCE APPENDIX

I. REAL PARTY IN INTEREST

The real party in interest in the appeal is:

☐ the party named in the caption of this brief.

☑ the following party: Theodore S. Rappaport

II. RELATED APPEALS AND INTERFERENCES

With respect to other appeals, interferences or judicial proceedings that will directly affect, or be directly affected by, or have a bearing on the Board's decision in this appeal:

☑ there are no related appeals, interferences or judicial proceedings related to, which directly affect or may be directly affected by or have a bearing on the Board's decision in this pending Appeal.

☐ these are as follows:

III. SUMMARY OF CLAIMED SUBJECT MATTER

The invention as defined in the claims on appeal pertains to a method for avoiding radiation of a user by a wireless device or avoiding structures that may be an impediment to radio waves by a wireless device. The devices claimed and the systems used for practicing the method include at least one steerable antenna. In operation, the method and device direct signals in particular directions while nulls or dead zones are provided in the spans or zones where energy is not desired or useful. Figure 8, by example, shows beams of energy being directed away from a user. Nulls or dead zones are provided in the spans or zones where energy is not desired or useful (e.g., in the direction of the user). However, as explained in the application, the beams can also be steered away from the walls of buildings which a user might be walking next to in order to have a better signal. Alternatively, the invention could be practiced with a fixed or mobile wireless device which steers energy such that the radiation from the device avoids a particular structure and instead beam radiation patterns are directed towards another structure or direction.

One of the features of the invention is that it allows for smooth operation as environmental parameters change over time. For example, a person walking down a city street or an automobile driving down a street may have buildings to his or her side when on the city block, but no buildings to the side when crossing a street. As another example, a person walking down a street may change hands for holding a radio device and/or change how he or she is holding the device with his or her hands based on conditions in the street. These changes would necessarily change the orientation of the person to the device and/or the orientation of the device to surrounding buildings. The invention takes these changes into account by a process where it determines zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to the at least one steerable antenna, and then adjusts one or more beams of the at least one steerable antenna to radiate in one or more directions which are <u>not</u> in said zones or spans of directions in the three dimensional space. Thus, the at least one steerable antenna is configured to adjustably steer or direct its energy in particular directions

while providing nulls or dead zones in other directions. As conditions change during use of the device, the device adjusts the direction of energy to one or more of the particular directions suited for the particular environmental conditions while avoiding the zones or spans of directions in the three dimensional space that are unsuitable for the environmental conditions at the particular period of time.

The present invention operates at frequencies of 10 GHz to 500 GHz and where the wavelengths are limited to much smaller wavelengths than those used in previous generations of cellphone technology. This permits the fabrication of multiple element antenna arrays that can provide distinct pattern nulls (lower signal power) in some directions and provide relatively higher signal power in particular directions. The invention is readily implementable with a cellphone or other wireless device. The present invention contemplates the ability to provide pattern differentiation in a time-varying environment which could not have practically been implemented and would not have been thought necessary or even commercially viable in prior mobile devices.

Support for the claims on appeal is found in the specification as originally filed as follows, as well as elsewhere in the specification:

1. A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna, comprising the steps of:	Concept of wireless device with steerable antenna: page 7, line 21, to page 8, line 4. Wireless device 10 and antenna 28: Fig. 2 Wireless portable device with steerable antenna: page 20, lines 4-27. Antenna elements 75 and antenna patterns/beams 80: Fig. 8
detecting in a three dimensional space, using one or more cameras, microphones, audio sensors,	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion

ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, an orientation of said wireless device relative to either or both said user and said structure;	detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 25-31. Gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Detecting in 3D space, Orientation of wireless device relative to user, structure: page 20, lines 4-27.
determining zones or spans of directions in the three dimensional space corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna; and	Determining zones or spans of directions in 3D space: page 17, lines 1-4 Spatial and avoidance zones relative to a human user: page 19, lines 1-19. Directions of user or structure relative to steerable antenna: Page 20, lines 4-27; fig. 8, elements person 74 (identified as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at	Beam patterns may be adjusted: p 16, line 28 to page 17, line 1. Steerable antenna: page 15, lines 10-15. Radiate directions not in zones/ spans of directions: page 17, lines 1-4.

least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the one or more beam radiation patterns for direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space, and	Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts…while avoiding: page 17, lines 1-4.
wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz.	One/multiple bands and radiates: page 14, lines 7-14. 10-500 GHz: page 14, lines 15-18.

3. The method of claim 1, wherein said detecting step comprises one or more of:	Detecting: page 19, lines 22-25. Fig. 7: sensors 70 detect one/more parameters which cause detection.
capturing one or more images with at least one camera;	Cameras: page 16, lines 9-11, 14-16 and 20-25. Also page 17, lines 1-4.
detecting ambient light or blockage thereof with at least one light sensor;	Light detectors…determine intensity: page 17, line 27, to page 18, line 5, and as claimed in original claim 3.
detecting motion of said wireless device with at least one gyroscope;	Gyroscopes: page 16, lines 9-13. Detecting device w/ gyroscope: page 17, lines 18-26.

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer; and	Microphones; ultrasound transducers, sensors or range finders: page 18, lines 24-31. User/structure: Page 20, lines 4-27; fig. 8, elements person 74 (identified as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
detecting relative position of the user or structure with at least one capacitive sensor.	Capacitive detectors....relative location of a user: page 16, lines 9-19. Fig. 2, sensor 29, and also Figs. 7 and 8, sensor 70 of device 71 relative to user 74.

4. A wireless device for avoiding radiation of a user or structure, comprising:	Avoid radiation: page 18, lines 1-5, 20-23. User/structure: page 20, lines 7-15.
one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, configured to detect in a three dimensional space an orientation of said wireless device relative to either or both said user and said structure;	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 25-31. gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Detecting in 3D space, Orientation of

	wireless device relative to user, structure: page 20, lines 4-27.
one or more processors communicatively coupled to said one or more sensors;	Processor: page 17, lines 5-17. Fig. 2, processor 27. Coupled to sensor(s): page 19, line30 to page 20, line 3.
at least one steerable antenna communicatively coupled to said one or more processors	Steerable antenna: page 15, lines 10-15. Coupled to sensor(s): page 19, line30 to page 20, line 3.
wherein said at least one steerable antenna is configured to adjust a beam radiation pattern so as to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,	Steerable antenna: page 15, lines 10-15. Radiate directions not in zones/spans of directions: page 17, lines 1-4. Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts…while avoiding: page 17, lines 1-4.
wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz; and	One/multiple bands and radiates: page 14, lines 7-14. 10-500 GHz: page 14, lines 15-18.
a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:	Software: page 17, lines 5-17. Processor(s): page 17, lines 5-17.
receiving signals from said one or	Receiving signals: page 12, line 9, to

more sensors pertaining to said orientation in the three dimensional space;	page 7, line 11. Orientation in space: page 16, lines 22-25.
using said signals, computing zones or spans of directions corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna in the three dimensional space; and adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space,	Computing zones/spans: page 7, line 26 to page 8, line 4; Fig. 2. Steerable antenna: page 15, lines 10-15. Radiate directions not in zones/ spans of directions: page 17, lines 1-4. Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts…while avoiding: page 17, lines 1-4.
wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions, and	Radiates based on signals determined on execution of executable instructions (software): page 17, lines 5-17
wherein said at least one steerable antenna operates on one or multiple bands; and	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.
a receiver for receiving over-the-air signals.	Over the air signaling received by transceiver(s): page 10, lines 5-6.

5. The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas.	Multiple antenna elements: antenna elements 75 and 75B, shown in Figs. 7 and 8; described on page 19, line 22-23, as steerable.

6. The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound sensors or transducers.	Cameras, gyroscopes, light detectors, capacitive detectors, microphones: page 17, lines 18-23. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 24-31.

7. The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.	Light: page 17, lines 27-28. Follow movement (motion and video): page 20, lines 23-27. Orientation: page 16, lines 22-25. Capacitance: 17, lines 18-22. Audio (sound)/ultrasound: page 18, lines 24-31.

8. A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:	Steerable antenna system in a wireless device: page 7, line 21, to page 8, line 4. Avoid radiation: page 18, lines 1-5, 20-23. User/structure: Page 20, lines 4-27; fig. 8, elements person 74 (identified

	as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, an orientation of said wireless device relative to either or both said user and said structure;	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 25-31. Gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Detecting in 3D space, Orientation of wireless device relative to user, structure: page 20, lines 4-27.
a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;	Fixed or mobile wireless devices (computation module): page 7, lines 19-26. Built-in sensors (coupled to sensors): page 16, lines 6-13. Configured to determine zones/spans: page 17, lines-5-26/
at least one steerable antenna that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said	One/multiple bands and radiates: page 14, lines 7-14. 10-500 GHz: page 14, lines 15-18. Coupled to computation module:

computation module, said at least one steerable antenna being configured for adjustably radiating one or more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space,	processor: page 17, lines 5-17; also Fig. 2, processor 27. Coupled to sensor(s): page 19, line30 to page 20, line 3. Radiate directions not in zones/ spans of directions: page 17, lines 1-4. Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts...while avoiding: page 17, lines 1-4.
wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space,	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 25-31. Gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Sensors used for computational determination of spatial orientation in 3D space: page 18, lines 16-19 Detecting in 3D space, Orientation of wireless device relative to user, structure: page 20, lines 4-27.
wherein said at least one steerable antenna is configured to adjustably	Determining zones or spans of directions in 3D space: page 17, lines

steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space,	1-4 Spatial and avoidance zones relative to a human user: page 19, lines 1-19. Directions of user or structure relative to steerable antenna: Page 20, lines 4-27; fig. 8, elements person 74 (identified as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
wherein said at least one steerable antenna operates on one or multiple bands; and	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.
a receiver for receiving signals.	Over the air signaling received by transceiver(s): page 10, lines 5-6.

9. The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas.	Multiple antenna elements (plurality of steerable antennas): Fig. 8, antenna patterns/beams 80; described on page 20, lines 6-21.

10. The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound transducers.	Cameras, gyroscopes, light detectors, capacitive detectors, microphones: page 17, lines 18-23. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 24-31.

11. The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.	Light: page 17, lines 27-28. Follow movement (motion and video): page 20, lines 23-27. Orientation: page 16, lines 22-25. Capacitance: 17, lines 18-22. Audio (sound)/ultrasound: page 18, lines 24-31.

12. The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.	Different beam patterns on transmit than on receive: page 19, lines 3-10, particularly line 10.

14. The method of claim 1 further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

15. The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna	Beamforming, beamsteering, beam selection, antenna selection, adaptive beamforming, beam selection, multibeam combining, MiMO, phasing: page 17, lines 5-17. MiMO and beam switchable array; antennas in a lumped, distributed, passive, active or hybrid manner: page 21, lines 4-18.

structure.	

16. The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

18. The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

19. The wireless device of claim 4 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.	Beamforming, beamsteering, beam selection, antenna selection, adaptive beamforming, beam selection, multibeam combining, MiMO, phasing: page 17, lines 5-17. MiMO and beam switchable array; antennas in a lumped, distributed, passive, active or hybrid manner: page 21, lines 4-18.

20. The steerable antenna system of	Pattern of beam(s) radiated is

claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.	different from a receiving pattern: page 19, lines 1-19.

22. The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

23. The steerable antenna system of claim 8 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.	Beamforming, beamsteering, beam selection, antenna selection, adaptive beamforming, beam selection, multibeam combining, MiMO, phasing: page 17, lines 5-17. MiMO and beam switchable array; antennas in a lumped, distributed, passive, active or hybrid manner: page 21, lines 4-18.

24. The method of claim 1,	
wherein a directional radiating	Pattern of beam(s) radiated is

pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.	different from a receiving pattern: page 19, lines 1-19.

25. The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna.	Time division duplexing: page 19, lines 6-19

26. The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

27. The wireless device of claim 4,	
wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver used to receive said over-the-air	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19. Over the air signaling received by transceiver(s): page 10, lines 5-6.

signals.	

28. The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver.	Time division duplexing: page 19, lines 6-19

29. The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

30. The steerable antenna system of claim 8,	
wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver.	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

31. The steerable antenna system of claim 30 wherein the steerable	Time division duplexing: page 19, lines 6-19

antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said receiver.	

32. The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

33. The method of claim 1 wherein the at least one steerable antenna operates on multiple bands.	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.

34. The wireless device of claim 4 wherein the at least one steerable antenna operates on multiple bands.	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.

35. The steerable antenna system of claim 8 wherein the at least one steerable antenna operates on multiple bands.	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.

36. The method of claim 1, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.	Time division duplexing: page 19, lines 6-19

37. The wireless device of claim 4 wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time.	Time division duplexing: page 19, lines 6-19.

ARGUMENT IVA. REJECTION UNDER 35 U.S.C. §101

There are no rejections under 35 U.S.C. §101.

ARGUMENT IVB. REJECTIONS UNDER 35 U.S.C. §112, FIRST PARAGRAPH

There are no rejections under 35 U.S.C. §112, first paragraph.

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ARGUMENT IVC. REJECTIONS UNDER 35 U.S.C. §112, SECOND PARAGRAPH

There are no rejections under 35 U.S.C. §112, second paragraph.

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ARGUMENT IVD. REJECTIONS UNDER 35 U.S.C. §102

Claims 1, 3-16, 18-20, 22-24, 26, 27, 29, 30, and 32-37 were anticipated by U.S. Patent Publication 2009/0295648 to Dorsey. This rejection is in error.

At the outset, Dorsey does not teach or suggest:

1. adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions;

2. computing zones or spans of directions corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna in the three dimensional space; and

3. adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space;

4. wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space; or

5. wherein said at least one steerable antenna is configured to adjustably steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space.

(see independent claims 1, 4, and 8)

In addition, Dorsey does not teach or suggest:

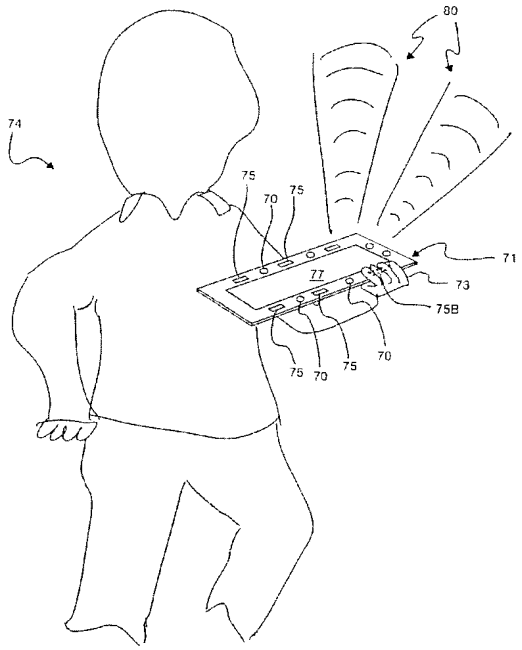
6. wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.

(see dependent claims 36 and 37)

Dorsey also lacks many other features in addition to the six enumerated above, and these six are highlighted merely to demonstrate basic differences between the claimed invention and Dorsey.

As the PTAB will recognize, a person may hold a wireless device a

multiplicity of different ways while walking, and the user's relative position in three dimensional space will change. The user's relative position in three dimensional space may also change to features of the wireless device may also change when the user is stationary simply by holding the device differently at two different time periods. In contrast to Dorsey (and all of the other art cited during prosecution of this case), the claimed invention provides the ability to adjust the beam direction accordingly under these changing conditions. In operation, the method and device of the claimed invention directs signals in particular directions while nulls or dead zones are provided in the spans or zones where energy is not desired or useful. Figure 8, by example, shows the beams of energy being directed away from a user (i.e., the beams are directed in directions which are not in the spans or zones which correspond with the direction of the user relative to the wireless device).



With the claimed invention, if the wireless device were moved, or the user changes hands for holding the device, different zones or spans of directions would be determined, and adjustments would be made such that the steerable antenna radiates

in directions which are not in those spans or zones. See beam patterns 80 in Figure 8 being directed from a steerable antenna or array 75. While Figure 8 also shows an antenna 75B being deactivated when it is covered up by a user's hand, it is vital to note that the claimed invention, and the teaching depicted by example in Figure 8 and within the specification, shows determining the 3D space and the steerable antenna radiating from a steerable antenna or array in directions that are not in zones or spans where the user is located and providing nulls or voids where the user is present. As required in claims 36 and 37, only the applicant teaches the steps of detecting, determining, and adjusting being performed multiple times as one or more parameters change over time. Because of this adaptability, which is taught only by the applicant, the invention also allows a fixed or stationary device to adapt to weather conditions or other parameters (e.g., birds flying overhead, trees moving or growing, or trucks moving nearby) which can change over time.

Moreover, as explained in the application, with the present invention the beams can also be steered away from the walls of buildings which a user might be walking next to in order to have a better signal. In addition, embodiments of the invention could be used by a fixed or mobile wireless device to steer energy such that the radiation avoids a particular structure and instead beams towards another structure or direction. In short, only the applicant teaches determining orientation of objects (e.g., a person or a structure relative to the wireless equipment) and adapting antenna patterns to the particular orientation and distance in 3D space as claimed.

On page 2 of the office action mailed October 30, 2018, the Examiner equates "switching of antenna elements corresponds to steering the antenna and adjusting the beam radiation pattern. Switching the beam from one antenna element to some other antenna element creates nulls and dead zones in some directions, while radiating the energy in some other zones or [spans] of directions" to a steerable antenna. This is simply incorrect.

The Examiner is basically saying "if I have a plurality of antennas, spaced about all over an object such as an Ipad®, it's the same thing as a 'steerable antenna'". Of course, this faulty reasoning overlooks all of the real estate on the

Ipad® which is required to have all those antenna elements. In contrast to the Examiner's reasoning and cited references, a steerable antenna, as is required in all of the claims of the present application, does not have a requirement for a giant amount real estate on or in the device. Rather, with the claimed invention, one can, from a single location and a single or multiple phased array antenna, steer the beam radiation patterns away from an object such as a person or building so that the beam radiation patterns are safer or more effective.

Moreover, the Examiner's reasoning completely overlooks the process steps or features of some of the elements which are required in the claims and which are not taught or obvious. To use a steerable antenna as required in the claims, one must

1) detect in 3D space using any of a variety of sensors where the wireless device is relative to either or both a user or a structure;

2) determine zones or spans of directions in the 3D space that are directed at either or both the user or structure; and

3) adjust one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the 3D space.

With Dorsey, and with how the Examiner has described Dorsey on page 2 of the office action of October 30, 2018, none of these steps are performed. This is because with Dorsey, and with the description of Dorsey provided by the Examiner, you do not have to do any of those steps. Such is the result when you are not using a steerable antenna as is required in the claimed invention.

Dorsey does <u>not</u> teach or infer in any way the sensing and characterizing the three dimensional space around a wireless device and adjusting a beam radiation pattern so as to steer or direct its energy in particular directions while providing nulls or dead zones in other directions. Rather, Dorsey switches from one redundant antenna to another so as to purportedly produce more successful wireless communications (see paragraph [0047]). <u>Wholly absent from Dorsey is any teaching of altering the antenna radiation pattern for specific exclusionary zones</u>.

Rather, as indicated on page 10 of the amendment filed September 14, 2018,

what Dorsey describes purportedly is an improvement antenna diversity systems (see title of Dorsey and as taught throughout). As explained in paragraph [0005] having redundant antennas in one device, was known before Dorsey, and having the mobile device switch from one redundant antenna to another was known (this is a diversity system). What Dorsey purportedly identifies and claims are ways to switch from one redundant antenna to another, without having to wait for the performance with first antenna to degrade before the switch occurs.

As explained on page 7-8 of the present application, in conjunction with Figure 2, a completely novel solution is given:

"Instead of requiring different antennas for the different RF bands, the present invention allows for the use of a single antenna 28 for multiple bands (or multiple antennas, at least one of which can be used for multiple bands, and at least one of which may be a steerable antenna, where a steerable antenna may steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and may be used on one or more bands). By providing the ability to use just a single antenna 28, the problem of mounting, locating, and feeding the antenna can be greatly reduced, so long as a desired antenna efficiency can be maintained for all bands of interest."

As shown in Figure 8 and discussed in the application, the invention, which produces steerable beams, may also be embodied in multiple antenna arrays.

As explained on pages 16 and 17 of the application it is taught that the beam steering performed involves adjusting the beam radiation pattern. As indicated on page 16

"Having information as to the presence and relative location of a user or a user's body, and/or other surroundings, an antenna system of the portable wireless device can steer away from the detected user and/or other surroundings a primary beam or beams formed by the portable wireless device to avoid radiating the user."

By contrast, in Dorsey, the focus on selecting or coupling energy to only one antenna is clearly taught throughout (see [0007] "for coupling a desire one of the antennas", and the continuous mention of an antenna diversity system which is

designed for selecting only one particular antenna, as taught in Figure 8 (72, 78), the Abstract, and elsewhere). Dorsey specifically discusses diversity as a mechanism for selecting only one antenna, or activating only one antenna, from a plurality of redundant antennas (See [0007] and [0008], where only "an antenna" and not an array or combination of antennas is ever contemplated for the specific purpose of excluding certain spatial zones and radiating in other spatial zones, as is required in the claims of the instant application. See also [0009] of Dorsey which discusses activating a single antenna for a desired signal strength when another antenna drops out.

While 101, 102, 103 and paragraphs [0046] and [0060] of Dorsey suggest that the single antenna may be antenna arrays, there is never any teaching given in Dorsey where the device is interacting with the 3D environment to properly steer the signal in particular directions while avoiding other directions. Dorsey simply teaches that a particular selection diversity criteria (a threshold for selection) must be reached for proper reception or selection (this is consistently discussed in Dorsey, for example, in paragraphs [0005], [0007], [0008], [0069], and [0070], and elsewhere). Review of these paragraphs reveals no concept of avoiding radiation to a person or structure, and merely seeks to address having wireless communications activities be "most successful," or selecting a single antenna to "less likely interfere with the antenna" (also see paragraph [0047]).

Wholly absent from Dorsey is any teaching of altering the antenna radiation pattern for specific exclusionary zones. This feature is only taught by the applicant. The claims also require, based on the detected 3D space, steering one or more beam radiation patterns in one or more directions away from the exclusionary zones.

Even with reference to paragraph [0060] of Dorsey where beam steering arrays are mentioned, it must be recognized that in Dorsey, only a single antenna or a single beamforming array (briefly in [0046] and [0060]) are contemplated for selection, and, importantly, Dorsey never contemplates using a combination of antennas to create a site specific antenna pattern or phased array pattern that can be altered to induce varying nulls or dead zones based on changing conditions in the channel. Rather, according to the teachings of Dorsey, in practicing the Dorsey

invention it is either a single redundant antenna (beam steering or not) or a single redundant array that is used to avoid "interference" with the selected antenna. Dorsey never describes using antennas or antenna arrays, alone or in combination, to create radiation patterns with a specific intent of avoiding some zones and accentuating others, as is taught in the present application and clearly highlighted in the claims.

In Figure 8 of Dorsey, there is shown a single antenna element being selected in a diversity scheme (see 72, 78 which selects only a single antenna). This clearly fits Dorsey's stated goal to enhance antenna selection diversity (see Abstract, [0001], [0013], [0018] Figure 3, and Figure 8) instead of beamforming or adjustment of the beam, as is done in the present application.

While Dorsey uses sensors to determine orientation, he fails to use this information for adaptive beamforming and for identifying specific items and objects that must be avoided in the antenna radiation pattern (as is required in the claims). Thus, Dorsey is much more limited, and unable to adapt to physical surroundings as contemplated in the present application.

In addition, claims 16, 20, and 24 of the present invention require the ability to transmit in one direction and receive in another direction. In an embodiment, the antenna pattern could put a null or dead zone towards the user's face when transmitting (as is shown in Figure 8), so that energy is not radiated towards the user's eye or brain, but the reception could point to the user's face to receive signals that might reflect off the person, for example. Nothing like this is contemplated in Dorsey.

It is natural to find that Dorsey, or any other reference, would not anticipate or contemplate the present invention. The inventor, himself, has been a pioneer in the world of cellular communications above 10 GHz, and is widely recognized as the pioneer who proved the viability of millimeter wave mobile communications that has just recently been adopted for the 5G global cellular standard. The inventor has been honored by the National Academy of Inventors, and is the first career academic to be named to the Wireless Hall of Fame as a 2019 inductee, partly due to his pioneering work at frequencies above 10 GHz.

Conclusion

In short, Dorsey certainly does not perform the steps required in claims 1, 4, or 8, and certainly does not perform those steps multiple times to address the changing environment and changing situations as is required in claims 36 and 7, nor does it contemplate transmitting and receiving patterns being different as required in claims 16, 20, and 24. For example, when a user is walking through a city or switching the device from hand to hand, his or her relative position in 3D space to the steerable antenna changes, and the invention allows for steering the beam to new directions as these changes occur. Furthermore, the relative position of surrounding buildings can change with movement of the user, and the invention allows for accounts for these changes. Moreover, even when the device is stationary, changes in the 3D environment can change with time (e.g., passing trucks and busses; changes in the weather, etc.), and the claimed invention accounts for and addresses those changes by steering the beam to different directions. By contrast, Dorsey simply shows using a bunch of antennas at fixed locations, and turning those antennas on and off. No beam steering occurs and no mechanism to address changing conditions based on the 3D environment is suggested. As such, the rejection is in error and reversal respectfully requested.

ARGUMENT IVE. REJECTIONS UNDER 35 U.S.C. §103

Claims 25, 28, and 31 were rejected as being obvious over U.S. Patent Publication 2009/0295648 to Dorsey in view of printouts for "Duplexing Techniques", VistaMAX, WiMax, IEEE 802.16-2004, and streakwave.com.

All rejections are in error. The claimed invention is significantly more than the predictable use of prior art elements according to their established function. As indicated by the Supreme Court in *KSR International v. Teleflex 550 US* (2007) citing *In re Kahn* 441 F.3d 977,988 (CAFC 2006) rejections on obviousness ground cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

Time division duplexing is discussed on, for example, page 19 of the application. The claimed configuration allows for accounting changes in the orientation of the device to the user and/or close by objects (e.g., buildings, etc.) to be accounted for, for example, when a user is walking in a city environment. Only the applicant's methodology and system provides for the time division duplexing required in the claims and the repetitive sensing, determining and adjusting required in the claims.

As discussed in detail above in Argument IVD, Rejections under 35 U.S.C. §102, Dorsey never discusses or contemplates in any way the concept or teachings that would allow someone to intentionally create radiation patterns that intentionally avoid a person or object, and which can continue to alter its pattern over time. The "Duplexing Techniques", VistaMAX, WiMax, IEEE 802.16-2004, and streakwave.com have not been relied upon as teaching these and other features of the invention. Therefore, one of ordinary skill in the art having fully knowledge of Dorsey, "Duplexing Techniques", VistaMAX, WiMax, IEEE 802.16-2004, and streakwave.com, would not have the features required in dependent claims 25 28, and 31 (nor any other claim at issue in the present application) to be obvious. Dorsey's antenna diversity method, which simply selects one of a plurality of redundant antennas, would not lead one of ordinary skill art having full knowledge of

"Duplexing Techniques", VistaMAX, WiMax, IEEE 802.16-2004, and streakwave.com to develop a system that is able to alter the antenna pattern to provide exclusion zones as claimed. At best, the secondary references provide some level of background in time division duplexing, but providing that background information does not make the claims as a whole obvious to one of ordinary skill in the art. What the background references cited by the Examiner do not show is any system, whereby the relationship of the wireless device and a user or other structure is detected in three dimensional space, the determination of zones or spans of directions in the three dimensional space, and the adjustment of the one or beams of the steerable antenna to radiate in one or more directions which are not in the zones or spans of directions.

Conclusion

Only the Applicant has taught a method and system which requires (1) detecting in three dimensional space, using sensors which allow for it (not proximity sensors), the relationship between the wireless device and a user or the wireless device and another structure, (2) determining zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to the steerable antenna, and (3) adjusting one or beams of the steerable antenna to radiate in one or more directions which are not in the zones or spans. Only the Applicant shows doing this multiple times as conditions vary with time. The Applicant teaches the use of a variety of sensors to determine the spatial orientation and relative location/positions of the user or obstructions in order to steer beam radiation patterns in desirable directions using a steerable antenna. The references of record simply are not designed to do what is taught and claimed by the Applicant. As such, the rejection is in error and reversal respectfully requested.

ARGUMENT IVF REJECTION OTHER THAN 35 U.S.C. §§ 101, 102, 103 AND 112

There are no rejections other than 35 U.S.C. §§101, 102, 103, and 112

V. CLAIMS APPENDIX

The text of the claims involved in the appeal are:

1. A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna, comprising the steps of:

detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, an orientation of said wireless device relative to either or both said user and said structure;

determining zones or spans of directions in the three dimensional space corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna; and

adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts one or more beam radiation patterns for direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space, and

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz.

3. The method of claim 1, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer; and

detecting relative position of the user or structure with at least one capacitive sensor.

4. A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, configured to detect in a three dimensional space an orientation of said wireless device relative to either or both said user and said structure;

one or more processors communicatively coupled to said one or more sensors;

at least one steerable antenna communicatively coupled to said one or more processors

wherein said at least one steerable antenna is configured to adjust a beam radiation pattern so as to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,

wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space;

using said signals, computing zones or spans of directions corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna in the three dimensional space; and

adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space,

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions, and

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving over-the-air signals.

5. The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

6. The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound sensors or transducers.

7. The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.

8. A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, an orientation of said wireless device relative to either or both said user and said structure;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;

at least one steerable antenna that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module, said at least one steerable antenna being configured for adjustably radiating one or

more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space,

wherein said at least one steerable antenna is configured to adjustably steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space,

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving signals.

9. The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

10. The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound transducers.

11. The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.

12. The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

14. The method of claim 1 further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

15. The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

16. The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.

18. The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

19. The wireless device of claim 4 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

20. The steerable antenna system of claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.

22. The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

23. The steerable antenna system of claim 8 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO,

phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

24. The method of claim 1,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

25. The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna.

26. The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

27. The wireless device of claim 4,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver used to receive said over-the-air signals.

28. The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver.

29. The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

30. The steerable antenna system of claim 8,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver.

31. The steerable antenna system of claim 30 wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said receiver.

32. The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

33. The method of claim 1 wherein the at least one steerable antenna operates on multiple bands.

34. The wireless device of claim 4 wherein the at least one steerable antenna operates on multiple bands.

35. The steerable antenna system of claim 8 wherein the at least one steerable antenna operates on multiple bands.

36. The method of claim 1, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.

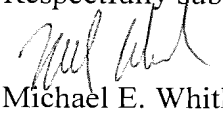
37. The wireless device of claim 4 wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time.

VI. EVIDENCE APPENDIX

No evidence is submitted

Samsung Ex. 1002, Page 120 of 679

Respectfully submitted,



Michael E. Whitham
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Tel. (703) 787-9400
Fax. (703) 787-7557
Customer No. 30743

Electronic Acknowledgement Receipt

EFS ID:	36377514
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	21-JUN-2019
Filing Date:	14-AUG-2013
Time Stamp:	16:21:32
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	Appeal Brief Filed	08610010pa_6_21_19.pdf	1334477 e3cf08ea122bded98f91d158b863bdf6526547ea	no	45

Warnings:

Information:	
Total Files Size (in bytes):	1334477

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/AIA/31 (03-14)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD

Docket Number (Optional): 08610010PA

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, EFS-Web transmitted to the USPTO, or deposited with the United States Postal Service with sufficient postage in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, on Alexandria, VA 22313-1450" [37 CFR 1.8(a)]

on _____.

Signature _____

Typed or printed name _____

In re Application of	
Rappaport	
Application Number: 13/966,853	Filed: August 14, 2013
For: Steerable Antenna Device	
Art Unit: 3648	Examiner: Seraydaryan

Applicant hereby **appeals** to the Patent Trial and Appeal Board from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 800

☑ Applicant asserts small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by 50%, and the resulting fee is: $ 400

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Therefore, the fee shown above is reduced by 75%, and the resulting fee is: $ _____
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

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

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 50-2041.

☐ Payment made via EFS-Web.

☑ A petition for an extension of time under 37 CFR 1.136(a) (PTO/AIA/22 or equivalent) is enclosed.
For extensions of time in reexamination proceedings, see 37 CFR 1.550.

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.

I am the

☐ applicant

☑ attorney or agent of record
Registration number 32,635

☐ attorney or agent acting under 37 CFR 1.34
Registration number _____

Signature _____

Typed or printed name Michael E. Whitham

Telephone Number 703-787-9400

Date April 22, 2019

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 41.20(b)(1) and 41.31. 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, 1.14 and 41.6. 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.

Electronic Patent Application Fee Transmittal

Application Number:	13966853
Filing Date:	14-Aug-2013
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham
Attorney Docket Number:	08610010PA

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
NOTICE OF APPEAL	2401	1	400	400
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Extension - 3 months with $0 paid	2253	1	700	700
Miscellaneous:				
			Total in USD ($)	**1100**

Electronic Acknowledgement Receipt

EFS ID:	35785309
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	22-APR-2019
Filing Date:	14-AUG-2013
Time Stamp:	10:35:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1100
RAM confirmation Number	042219INTEFSW10354000
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		08610010pa_4_22_19.pdf	102447 a2bf14371e918032c6a1a715ad615aeaa2c24028	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Extension of Time	1	1
	Notice of Appeal Filed	2	2

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32242 315517577a19d9f6442f5fadd0f28600227052c9	no	2

Warnings:

Information:

Total Files Size (in bytes):	134689

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/AIA/22 (03-13)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 08610010PA

Application Number: 13/966,853

Filed: August 14, 2013

For: Steerable Antenna Device

Art Unit: 3648

Examiner: Seraydaryan

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☐ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☑ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$ 700
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☑ Applicant asserts small entity status. See 37 CFR 1.27.

☐ 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.

☐ A check in the amount of the fee is enclosed.

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

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 50-2014.

☑ Payment made via EFS-Web.

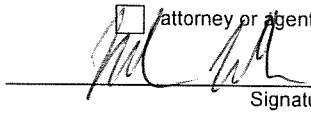
WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 32,635.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.



Signature

August 22, 2019
Date

Michael E. Whitham
Typed or printed name

703-787-9400
Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). 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 6 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: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 10/30/2018

W&C IP
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

EXAMINER	
SERAYDARYAN, HELENA H	
ART UNIT	**PAPER NUMBER**
3648	
MAIL DATE	**DELIVERY MODE**
10/30/2018	PAPER

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.

Office Action Summary	Application No. 13/966,853	Applicant(s) Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	Art Unit 3648	AIA Status No

-- 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 09/14/2018.

☐ 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) 1,3-12,14-16,18-20 and 22-37 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) 1,3-12,14-16,18-20 and 22-37 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

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

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed 09/14/2018, with respect to claims 1, 4 and 8 have been fully considered.

2. Applicant's amendment of claims 1, 4, 8 and 37 overcomes the rejection of claims 1, 3-12, 14-16, 18-20, and 22-37 under 35 USC § 112, second paragraph. The rejection is withdrawn.

3. Applicant's arguments regarding the rejection of amended claims 1, 4 and 8 under 35 USC § 102 are not persuasive. Upon further consideration, a new ground(s) of rejection is made in view of Dorsey (US 20090295648). Dorsey teaches the amended limitation of "adjusting one or more radiation patterns" in [0045-0046, 0050, 0062, 0065, 0069]. The switching of antenna elements corresponds to steering the antenna and adjusting the beam radiation pattern. Switching the beam from one antenna element to some other antenna element creates nulls and dead zones in some directions, while radiating the energy in some other zones or spams of directions. Moreover, according to Dorsey the antenna may be implemented as an array of antennas. Antennas may be formed of multiple antenna elements that make up an electronically steerable antenna array [0046].

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of pre-AIA 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) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

Claims 1, 3-16, 18-20, and 22-24, 26-27, 29-30, 32-37 are rejected under pre-AIA 35 U.S.C. 102(a) as being anticipated by Dorsey (US 20090295648).

As per Claim 1, Dorsey teaches a method for avoiding radiation of a user or structure by a wireless device (10) (Par. 0007-0008) having at least one steerable antenna (e.g. 100, 101, 102) (Par. 0046, 0060), comprising the steps of:

detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors or motion detectors, an orientation of one or more parameters of either said wireless device relative to either or both said user and said structure (e.g. 41, 110, 112, 116, 114, 16, 200-202) (Par. 0031-0032, 0040, 0047, 0061);

determining zones or spans of directions in the three dimensional space corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna (e.g. processor 36 is responsive to sensors for controlling antenna pattern) (Par. 0045-0046, 0050, 0062, 0065, 0069); and

adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of

directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the one or more beam radiation patterns for direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space (e.g. switching circuitry 54, switching the antenna elements corresponds to adjusting the beam radiation pattern) (Par. 0045-0046, 0050, 0062, 0065, 0069; additionally, electronically switching antenna elements corresponds to an electronically steerable antenna), and

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz (Par. 0023, 0036).

Dorsey discloses the limitation of detecting the orientation of the wireless device relative to the user or a structure in three dimensional space in view of the fact that both the wireless device and the user (or structure) exist in three dimensional space.

As per Claim 3, Dorsey teaches the method set forth above, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor (Par. 0047, 0061, 0068);

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer;

and detecting relative position of the user or structure with at least one capacitive sensor (Par. 0027, 0058).

As per Claim 4, Dorsey teaches a wireless device (10) for avoiding radiation of a user or structure (Par. 0007-0008), comprising:

one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors or motion detectors configured to detect in a three dimensional space an orientation of said wireless device relative to either or both said user and said structure (e.g. 41, 110, 112, 116, 114, 16, 200-202) (Par. 0031-0032, 0040, 0047, 0061);

one or more processors (36) communicatively coupled to said one or more sensors (Par. 0036);

at least one steerable antenna communicatively coupled to said one or more processors (e.g. 100, 101, 102) (Par. 0046),

wherein said at least one steerable antenna is configured to adjust a beam radiation pattern so as to steer or direct its energy in particular directions while providing nulls or dead zones in other directions (e.g. processor 36 is responsive to sensors for controlling antenna pattern) (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz (Par. 0023, 0036); and

a non-transitory computer readable medium (storage 34) comprising executable instructions (Par. 0035-0036) that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space (Par. 0031-0032, 0040, 0047, 0061);

using said signals, computing zones or spans of directions corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069); and

adjusting one or more beam radiation patterns of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions (Par. 0045-0046, 0050, 0062, 0065, 0069), and

wherein said at least one steerable antenna operates on one or multiple bands; and a receiver for receiving over-the-air signals (56) (Par. 0023, 0030, 0036, 0058, 0060).

Dorsey discloses the limitation of detecting the orientation of the wireless device relative to the user or a structure in three dimensional space in view of the fact that both the wireless device and the user (or structure) exist in three dimensional space.

As per Claim 5, Dorsey teaches the wireless device set forth above, wherein said steerable antenna comprises a plurality of steerable antennas (Par. 0046, 0060).

As per Claim 6, Dorsey teaches the wireless device set forth above, wherein said one or more sensors includes one or more light detectors (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 7, Dorsey teaches the wireless device set forth above, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 8, Dorsey teaches a steerable antenna system (e.g. 100, 101, 102) (Par. 0046, 0060) for avoiding radiation of a user or structure by a wireless device (10) (Par. 0007-0008), comprising:

one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, an

orientation of said wireless device relative to either or both said user and said structure (e.g. 41, 110, 112, 116, 114, 16, 200-202) (Par. 0031-0032, 0040, 0047, 0061);

a computation module (processor 36) communicatively coupled to said one or more sensors configured to determine zones or spans of directions (Par. 0036);

at least one steerable antenna (e.g. 100, 101, 102) (Par. 0046, 0060) that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module (Par. 0023, 0036), said at least one steerable antenna being configured for adjustably radiating one or more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space (e.g. processor 36 is responsive to sensors for controlling antenna pattern) (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna is configured to adjustably steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna operates on one or multiple bands (Par. 0023, 0030, 0036, 0060); and

a receiver for receiving signals (56) (Par. 0045, 0049).

Dorsey discloses the limitation of detecting the orientation of the wireless device relative to the user or a structure in three dimensional space in view of the fact that both the wireless device and the user (or structure) exist in three dimensional space.

As per Claim 9, Dorsey teaches the antenna system set forth above, wherein said at least one steerable antenna comprises a plurality of steerable antennas (Par. 0046, 0060).

As per Claim 10, Dorsey teaches the antenna device set forth above, wherein said one or more sensors includes one or more light detectors (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 11, Dorsey teaches the antenna device set forth above, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 12, Dorsey teaches the method set forth above, wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 13, Dorsey teaches the method set forth above, wherein said signals received in said receiving step are 10 GHz or above (Par. 0023, 0036).

As per Claim 14, Dorsey teaches the method set forth above, the method further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 15, Dorsey teaches the method set forth above wherein said at least one antenna or said another antenna uses beamsteering (Par. 0046, 0060).

As per Claim 16, Dorsey teaches the wireless device set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 18, Dorsey teaches the wireless device set forth above, wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 19, Dorsey teaches the wireless device set forth above wherein said at least one steerable antenna or said receiver uses beamsteering (Par. 0046, 0060).

21. **As per Claim 20**, Dorsey teaches the antenna system set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 22, Dorsey teaches the antenna system set forth above wherein said receiver using said at least one steerable antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 23, Dorsey teaches the antenna system set forth above wherein said at least one steerable antenna or said receiver uses beamsteering (Par. 0046, 0060).

As per Claim 24, Dorsey teaches the method set forth above,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 26, Dorsey teaches the method set forth above, wherein said step of receiving signals with said at least one steerable antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 27, Dorsey teaches the wireless device set for the above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver to receive said over-the-air signals (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 29, Dorsey teaches the wireless device set forth above, wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 30, Dorsey teaches an antenna system set forth above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 32, Dorsey teaches the antenna system set forth above, wherein that said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 33, Dorsey teaches the method set forth above, wherein the at least one steerable antenna operates on multiple bands (Par. 0023, 0030, 0036, 0060).

As per Claim 34, Dorsey teaches the wireless device set forth above, wherein the at least one steerable antenna operates on multiple bands (Par. 0023, 0030, 0036, 0060).

As per Claim 35, Dorsey teaches the antenna system set forth above, wherein the at least one steerable antenna operates on multiple bands (Par. 0023, 0030, 0036, 0060).

As per Claim 36, Dorsey teaches the method set forth above, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time (Par. 0067-0069, 0075).

As per Claim 37, Dorsey teaches the wireless device set forth above, wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time (Par. 0067-0069, 0075).

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 25, 28 and 31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Dorsey (US 20090295648) and further in view of D1 ("Duplexing Techniques", VistaMAX, WiMAX, IEEE 802.16-2004; https://www.streakwave.com/vecima/vistamax_dplxtech%20_wp_02.pdf).

As per Claim 25, Dorsey teaches the method set forth above, but does not teach the method further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna.

Dorsey teaches that the communication can be performed based on WiMAX standard (Par. 0023).

According to D1, WiMAX specifies two alternate duplexing techniques, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) (Page 2, first paragraph).

At the time of the invention it would have been obvious for one of ordinary skill in the art to have selected the Time Division Duplexing of D1 to provide communication as the use of a single channel allows for a simple Tx/Rx switch in the equipment, reducing cost and price to the end-user (D1: page 2, second paragraph).

As per Claim 28, Dorsey teaches the wireless device set forth above, but does not teach that said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver.

Dorsey teaches that the communication can be performed based on WiMAX standard (Par. 0023).

According to D1, WiMAX specifies two alternate duplexing techniques, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) (Page 2, first paragraph).

At the time of the invention it would have been obvious for one of ordinary skill in the art to have selected the Time Division Duplexing of D1 to provide communication as the use of a single channel allows for a simple Tx/Rx switch in the equipment, reducing cost and price to the end-user (D1: page 2, second paragraph).

As per Claim 31, Dorsey teaches the steerable antenna system set forth above, but does not teach that the antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said receiver.

Dorsey teaches that the communication can be performed based on WiMAX standard (Par. 0023).

According to D1, WiMAX specifies two alternate duplexing techniques, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) (Page 2, first paragraph).

At the time of the invention it would have been obvious for one of ordinary skill in the art to have selected the Time Division Duplexing of D1 to provide communication as the use of a single channel allows for a simple Tx/Rx switch in the equipment, reducing cost and price to the end-user (D1: page 2, second paragraph).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, THIS ACTION IS MADE FINAL. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HELENA SERAYDARYAN whose telephone number is (571)270-0706. The examiner can normally be reached on M-T, 7:30-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire can be reached on (571)270-5144. 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 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.

/HELENA SERAYDARYAN/

Examiner, Art Unit 3648

/Gregory C. Issing/
Primary Examiner, Art Unit 3646

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

CPC - Searched*		
Symbol	**Date**	**Examiner**
H01Q1/245	4/11/2016	H.S.
H01Q1/245 (updated)	11/2/2016	H.S.
H01Q1/245 (updated)	07/19/2017	HS
H01Q1/245 (updated)	11/07/2017	HS
H01Q1/245 (updated)	05/29/2018	HS
H01Q1/245 (updated)	10/22/2018	HS

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
342	368	4/1/2016	H.S.
342	368 (updated)	11/2/2016	H.S.
342	368 (updated)	7/19/2017	HS
342	368 (updated)	11/07/2017	HS
342	368 (updated)	05/29/2018	HS
342	368 (updated)	10/22/2018	HS

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor Name Search in PALM	4/1/2016	H.S.
Inventor Name Search in EAST	4/1/2016	H.S.
Text Search in EAST	4/11/2016	H.S.
Consulted with Primary G. Issing	4/1/2016	H.S.
Consulted with G. Issing	11/2/2016	H.S.
Consulted with G. Issing	7/19/2017	HS
Consulted with G. Issing	10/18/2018	HS

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

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

CLAIMS

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

CLAIM		DATE								
Final	Original	04/12/2016	11/02/2016	07/19/2017	11/07/2017	05/29/2018	10/22/2018			
	1	✓	✓	✓	✓	✓	✓			
	2	✓	-	-	-	-	-			
	3	✓	✓	✓	✓	✓	✓			
	4	✓	✓	✓	✓	✓	✓			
	5	✓	✓	✓	✓	✓	✓			
	6	✓	✓	✓	✓	✓	✓			
	7	✓	✓	✓	✓	✓	✓			
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	10	✓	✓	✓	✓	✓	✓			
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	28		✓	✓	✓	✓	✓			
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	31		✓	✓	✓	✓	✓			
	32		✓	✓	✓	✓	✓			
	33			✓	✓	✓	✓			
	34			✓	✓	✓	✓			
	35			✓	✓	✓	✓			
	36				✓	✓	✓			
	37				✓	✓	✓			

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	65	H01Q1/245.cpc. and @pd>"20180614"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/10/22 09:13
L3	24	342/368.ccls. and @pd>"20180614"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/10/22 09:13
S1	104	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2016/04/01 13:02
S2	218	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:02
S3	1	S2 and ((steerable adj antenna) with sensors)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S4	1748	342/368.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S5	3044	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S6	2704	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S7	4870	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S8	6373	H01Q3/26.cpc.	US-PGPUB;	AND	ON	2016/04/11

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT			16:46
S10	23279	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S11	196	steer$4 with sensor with phone	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:47
S14	36859	S5 or S6 or S7 or S8 or S10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S16	775	steer$4 with sensor with (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S17	11	S16 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S18	6	S14 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S19	3	"52780741".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/11 16:51
S20	1533	S14 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S21	452	S20 and (cellphone or phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S22	77	S20 and (cellphone or phone)S21 and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S23	1	S22 and (steer$4 or redirect$4)	US-PGPUB;	AND	ON	2016/04/11

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT			16:55
S24	73	S22 and (steer$4 or redirect$4 or direct$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:56
S25	1	2014-T60821.NRAN.	DERWENT	AND	ON	2016/04/11 16:57
S26	19336	((steer$4 or redirect$4 or direct or direction or directionality) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S27	41	S14 and S26	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S28	25566	((steer$4 or redirect$4 or direct or direction or directionality or pattern) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:33
S29	79	S14 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:34
S30	27	H01Q1/245.cpc. and steer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:35
S31	277	H01Q1/245.cpc. and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:49
S32	1058	steer$4 with antenna with mobile	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/12 09:08
S33	5	"9529117".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/12 09:34
S34	2	(US-20080242349-$).did. or (US-6456856-$).did.	US-PGPUB; USPAT	AND	ON	2016/04/12 10:53
S35	40	342/368.ccls. and @pd>"20160506"	US-PGPUB; USPAT; USOCR;	AND	ON	2016/11/02 16:57

			FPRS; EPO; JPO; DERWENT			
S36	91	H01Q1/245.cpc. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:59
S37	13356	(multiple or dual) near2 (frequency adj2 band)	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S38	5187	S37 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S39	4852	S38 and communicat$4	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:46
S40	3177	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S41	2962	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S42	5154	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S43	6655	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S44	25291	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S45	39574	S40 or S41 or S42 or S43 or S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S46	705	S39 and S45	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:48
S47	1	("2013/0328723").URPN.	USPAT	AND	ON	2016/11/14 14:56
S48	224	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR;	AND	ON	2016/11/14 16:59

			FPRS; EPO; JPO; DERWENT			
S49	89	S48 and GHz and (dual or multiple)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S50	29	("2010/0060531").URPN.	USPAT	AND	ON	2016/11/15 10:28
S51	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 10:42
S52	38	("2003/0210203").URPN.	USPAT	AND	ON	2016/11/15 10:59
S53	21	S52 and GHz	USPAT	AND	ON	2016/11/15 10:59
S54	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S55	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S56	16	("2009/0011806").URPN.	USPAT	AND	ON	2016/11/15 11:11
S59	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 11:12
S60	55	("5229975" | "5274844" | "5541609" | "5729238" | "5805067" | "5924020" | "5956626" | "5995862").PN. OR ("6456856").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:19
S61	4	("2008/0242349").URPN.	USPAT	AND	ON	2016/11/15 11:27
S62	24	("2008/0018543").URPN.	USPAT	AND	ON	2016/11/15 11:28
S63	0	("2013/0342416").URPN.	USPAT	AND	ON	2016/11/15 11:32
S64	4	("2009/0124306").URPN.	USPAT	AND	ON	2016/11/15 11:33
S65	9	("20070008235" | "20080204240" | "20130135171" | "5983119" | "7492254" | "8106836").PN. OR ("8649833").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:35
S66	3	("2010/0081491").URPN.	USPAT	AND	ON	2016/11/15 11:38
S67	0	("2008/0150798").URPN.	USPAT	AND	ON	2016/11/15 11:39
S68	6	("2007/0057843").URPN.	USPAT	AND	ON	2016/11/15 11:40
S69	46	("4352109" | "4518968" | "4700194" | "4868576" | "5257033" | "5612705").PN. OR ("6421016").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:41
S71	7	(mmw or (milimeter adj wave)) same (multi?band or (multiple adj band) or (dual adj band) or dual-band) same antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:09
S72	23	(mmw or (milimeter adj wave)) same2 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same2 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:10
S73	19	S72 and GHz	US-PGPUB;	AND	ON	2017/06/21

			USPAT; USOCR			10:11
S74	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:13
S76	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:14
S77	46	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:15
S78	4	("2014/0321282").URPN.	USPAT	AND	ON	2017/06/21 10:52
S79	2	US-6556836-$.did.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 08:04
S80	2	"25301096".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/18 08:07
S81	4	("2002/0164957").URPN.	USPAT	AND	ON	2017/07/18 09:12
S82	4401	(millimeter adj wave) same (cellular or mobile or cellphone or communication)	USPAT	AND	ON	2017/07/18 09:34
S84	944	S82 and dual	USPAT	AND	ON	2017/07/18 09:34
S85	184	((millimeter adj wave) same wireless) and (multiband or (dual adj band))	USPAT	AND	ON	2017/07/18 13:54
S86	563	(cellphone or (cellular or mobile) adj phone) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:40
S87	563	(cellphone or ((cellular or mobile) adj phone)) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:49
S88	2	"40137022".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/19 11:04
S89	0	H01Q1/245.cpc. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15
S90	0	342/368.ccls. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15

S91	60	H01Q1/245.cpc. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24
S92	32	342/368.ccls. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24
S94	3994	sensor near10 (three adj dimensions)	US-PGPUB; USPAT; USOCR	AND	ON	2018/04/26 10:06
S95	1206	S94 and phone	US-PGPUB; USPAT; USOCR	AND	ON	2018/04/26 10:07
S97	2	us-20090295648-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:34
S99	2	"WO 2012066562"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:41
S100	2	us-20040204027-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:43
S101	7620701	WO "2012066562"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:09
S102	4611	S101 and prasad.inv.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:09
S103	9	((Muthukumar) near2 (Prasad)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/16 10:10
S104	9	S101 and S103	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/16 10:11
S105	7	S102 and SAR and proximity	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:16
S106	9	((Muthukumar) near2 (Prasad)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:46
S107	1	"wo 2012/176217"	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:47
S108	9	"wo 2012176217"	US-PGPUB;	AND	ON	2018/05/23

			USPAT; USOCR			15:47
S109	15	"wo 2012176217"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/23 15:48
S110	96	H01Q1/245.cpc. and @pd>"20171115"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/29 13:08
S111	39	342/368.ccls. and @pd>"20171115"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/29 13:09
S112	2	"41379128".FMID.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 07:11
S113	72	("20050090288" | "20050124305" | "20060161871" | "20060205368" | "20060232468" | "5463406" | "5905467" | "6285893" | "6456856" | "6862433" | "6959209" | "6978121").PN. OR ("8159399").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/07 07:11
S114	2	"41379128".FMID.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 07:12
S115	8104	343/702.ccls.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:21
S117	952	343/876.ccls.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S118	2324	H01Q1/2266.cpc.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S119	5174	H01Q3/24.cpc.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S120	15520	S115 or S117 or S118 or S119	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S121	839	S120 and sensors	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S122	812	S121 and antenna	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S123	306	S122 and orientation	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23

10/22/2018 9:17:01 AM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/966,853	Filing Date 08/14/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $40 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $210 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	09/14/2018	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 33	Minus	** 33	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 6	= 0		x $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

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

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

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Rappaport

Serial No. 13/966,853

Filed: August 14, 2013

For: STEERABLE ANTENNA DEVICE

Confirmation No. 2489

Group Art Unit: 3648

Examiner: Seraydaryan

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

AMENDMENT UNDER 37 C.F.R. 1.111

Dear Sir:

In response to the office action mailed June 14, 2018, please amend the above-identified application as follows:

Listing of the Claims begins on page 2

Remarks begins on page 10

Listing of the Claims

Below is a complete listing of the claims including the status of each:

1. (currently amended) A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna, comprising the steps of:

detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors, ~~or other sensors used for computational determination of spatial orientation in three dimensional space,~~ an orientation of said wireless device relative to either or both said user and said structure;

determining zones or spans of directions in the three dimensional space corresponding with one or more directions of either or both said user ~~or~~ and said structure relative to said at least one steerable antenna; and

adjusting one or more beam radiation patterns ~~beams~~ of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the one or more beam radiation patterns for direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space, and

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz.

2. (canceled)

3. (previously presented) The method of claim 1, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer; and

detecting relative position of the user or structure with at least one capacitive sensor.

4. (currently amended) A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors~~, or other sensors used for computational determination of spatial orientation in three dimensional space~~ configured to detect in a three dimensional space an orientation of said wireless device relative to either or both said user and said structure;

one or more processors communicatively coupled to said one or more sensors;

at least one steerable antenna communicatively coupled to said one or more processors

wherein said at least one steerable antenna is configured to adjust a beam radiation pattern so as to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,

wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space;

using said signals, computing zones or spans of directions corresponding with one or more directions of either or both said user and said ~~or~~ structure relative to said at least one steerable antenna in the three dimensional space; and

adjusting one or more beam radiation patterns ~~beams~~ of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space,

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions, and

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving over-the-air signals.

5. (previously presented) The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

6. (previously presented) The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound sensors or transducers.

7. (previously presented) The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.

8. (currently amended) A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or motion

detectors~~other sensors used for computational determination of spatial orientation in three dimensional space~~, an orientation of said wireless device relative to either or both said user and said structure;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;

at least one steerable antenna that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module, said at least one steerable antenna being configured for adjustably radiating one or more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space,

wherein said at least one steerable antenna is configured to adjustably steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space,

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving signals.

9. (previously presented) The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

10. (previously presented) The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound transducers.

11. (previously presented) The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.

12. (previously presented) The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

13. (canceled)

14. (previously presented) The method of claim 1 further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

15. (previously presented) The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

16. (previously presented) The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.

17. (canceled)

18. (previously presented) The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

19. (previously presented) The wireless device of claim 4 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining,

MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

20. (previously presented) The steerable antenna system of claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.

21. (canceled)

22. (previously presented) The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

23. (previously presented) The steerable antenna system of claim 8 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

24. (previously presented) The method of claim 1,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

25. (previously presented) The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna.

26. (previously presented) The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

27. (previously presented) The wireless device of claim 4,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver used to receive said over-the-air signals.

28. (previously presented) The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver.

29. (previously presented) The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

30. (previously presented) The steerable antenna system of claim 8,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver.

31. (previously presented) The steerable antenna system of claim 30 wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said receiver.

32. (previously presented) The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

33. (previously presented) The method of claim 1 wherein the at least one steerable antenna operates on multiple bands.

34. (previously presented) The wireless device of claim 4 wherein the at least one steerable antenna operates on multiple bands.

35. (previously presented) The steerable antenna system of claim 8 wherein the at least one steerable antenna operates on multiple bands.

36. (previously presented) The method of claim 1, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.

37. (currently amended) The wireless device of claim 4 wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time.

REMARKS

Claims 1, 4, 8, and 37 have been amended. The application includes claims 1, 3-12, 14-16, 18-20, and 22-37.

Claim 37 has been amended address the indefiniteness rejection, and now parallels claim 36 in structure. To simplify matters and to advance the application to grant claims 1, 4, and 8 have been amended to eliminate a reference to other sensors, thereby fully addressing the indefiniteness rejection of these claims and their dependent claims.

The undersigned notes with appreciation the withdrawal of the previous grounds of rejection based on prior art.

Claims 1, 3-16, 18-20, 22-24, 26, 27, 29, 30, and 32-27 have been rejected as being anticipated by newly cited U.S. Patent Publication 2009/0295648 to Dorsey. Claims 25, 28, and 31 were rejected as being obvious over Dorsey in view of "Duplexing Techniques". Both of these rejections are traversed in view of the amendments above.

The Examiner has equated having multiple antennas that turn on and off to be "steerable". Clearly, the Examiner has recognized that Dorsey, in fact, does not teach sensing and characterizing the three dimensional space around a wireless device, and adjusting a beam radiation pattern so as to steer or direct its energy in particular directions while providing nulls or dead zones in other directions.

Rather, what Dorsey describes purportedly is an improvement antenna diversity systems (see title of Dorsey). As explained in paragraph [0005] having redundant antennas in one device, was known before Dorsey, and having the mobile device switch from one redundant antenna to another was known (this is a diversity system). What Dorsey purportedly identifies and claims are ways to switch from one redundant antenna to another, without having to wait for the performance with first antenna to degrade before the switch occurs.

As explained on page 7-8 of the present application, in conjunction with Figure 2,

"Instead of requiring different antennas for the different RF bands, the present invention allows for the use of a single antenna 28 for multiple bands (or multiple antennas, at least one of which can be used for multiple bands, and at least one of which may be a steerable antenna, where a steerable antenna may steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and may be used on one or more bands). By providing the ability to use just a single antenna 28, the problem of mounting, locating, and feeding the antenna can be greatly reduced, so long as a desired antenna efficiency can be maintained for all bands of interest."

As explained on pages 16 and 17 of the application it is explained that the beam steering performed involves adjusting the beam radiation pattern. As indicated on page 16

"Having information as to the presence and relative location of a user or a user's body, and/or other surroundings, an antenna system of the portable wireless device can steer away from the detected user and/or other surroundings a primary beam or beams formed by the portable wireless device to avoid radiating the user."

By contrast, in Dorsey, the focus on selecting or coupling energy to only one antenna is clearly taught throughout (see [0007] "for coupling a desire one of the antennas", and the continuous mention of an antenna diversity system which is designed for selecting only one particular antenna, as taught in Figure 8 (72, 78), the Abstract, and elsewhere). Dorsey specifically discusses diversity as a mechanism for selecting only one antenna, or activating only one antenna, from a plurality of redundant antennas (See [0007] and [0008], where only "an antenna" and not an array or combination of antennas is ever contemplated for the specific purpose of excluding certain spatial zones and radiating in other spatial zones, as is required in the claims of the instant application. See also [0009] of Dorsey which discusses activating a single antenna for a desired signal strength when another antenna drops out.

While 101, 102, 103 and paragraphs [0046] and [0060] of Dorsey suggest that the single antenna may be antenna arrays, there is never any teaching given in Dorsey where the device is interacting with the 3D environment to properly steer the

signal in particular directions while avoiding other directions. Dorsey simply teaches that a particular selection diversity criteria (a threshold for selection) must be reached for proper reception or selection (this is consistently discussed in Dorsey, for example, in paragraphs [0005], [0007], [0008], [0069], and [0070], and elsewhere). Review of these paragraphs reveals no concept of avoiding radiation to a person or structure, and merely seeks to address having wireless communications activities be "most successful," or selecting a single antenna to "less likely interfere with the antenna" (also see paragraph [0047]). Wholly absent from Dorsey is any teaching of altering the antenna radiation pattern for specific exclusionary zones. This feature is only taught by the applicant, and the claims have been amended to clearly highlight the changes in the beam radiation pattern that are made based on the three dimensional space, as well as to highlight steering one or more beam radiation patterns in one or more directions away from the exclusionary zones.

Even with reference to paragraph [0060] of Dorsey where beam steering arrays are mentioned, it must be recognized that in Dorsey, only a single antenna or a single beamforming array (briefly in [0046] and [0060]) are contemplated for selection, and, importantly, Dorsey never contemplates using a combination of antennas to create a site specific antenna pattern or phased array pattern that can be altered based on changing conditions in the channel. Rather, according to the teachings of Dorsey, in practicing the Dorsey invention it is either a single redundant antenna (beam steering or not) or a single redundant array that is used to avoid "interference" with the selected antenna. Dorsey never describes using antennas or antenna arrays, alone or in combination, to create radiation patterns with a specific intent of avoiding some zones and accentuating others, as is taught in the present application and now clearly highlighted in the claims. In Figure 8 of Dorsey, there is shown a single antenna element being selected in a diversity scheme (see 72, 78 which selects only a single antenna). This clearly fits Dorsey's stated goal to enhance antenna selection diversity (see Abstract, [0001], [0013], [0018] Figure 3, and Figure 8) instead of beamforming or adjustment of the beam, as is done in the present application. While Dorsey uses sensors to determine orientation, he fails to use this

information for adaptive beamforming and for identifying specific items and objects that must be avoided in the antenna radiation pattern. Thus, Dorsey is much more limited, and unable to adapt to physical surroundings as contemplated in the present application.

With reference to Figure 9 of Dorsey, it can be seen that Dorsey is concerned with simply selecting antennas to avoid interference due to multiple radios being used (e.g., Bluetooth and WLAN and GPS antennas discussed in paragraphs [0076]-[0082] of Dorsey along with Cellular in Figure 9). Thus, Dorsey does not contemplate interacting with the 3-D environment to create adjustable beams to specifically target certain zones and avoid other zones in the radiation pattern as is required in the claims. Dorsey also does not contemplate making multiple adjustments to the beam direction and beam avoidance direction as parameters change over time as required in dependent claims 36 and 37. Simply put, Dorsey teaches selecting antennas, and does not contemplate the unique challenges of mobile systems operating at above 10 GHz, as taught in the current application, where beamforming will be needed to adjust the radiation patterns for exclusionary zones while accentuating others. For background, the Examiner should also note that the Federal Communications Commission did not make mobile mmWave spectrum (above 10 gHz) available until 2016 (See attached April 19, 2018 article in FierceWireless entitled "Special Report-Millimeter wave spectrum has come a long, long way").

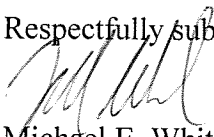
Furthermore, it would not have been possible for someone skilled in the art to take Dorsey's antenna diversity method, which simply selects one of a plurality of redundant antennas, and to develop a system that is able to alter the antenna pattern to provide exclusion zones as claimed. Importantly, Dorsey never discusses or contemplates in any way the concept or teachings that would allow someone to intentionally create radiation patterns that intentionally avoid a person or object, and which can continue to alter its pattern over time. Furthermore, the "Duplexing Techniques" has not been relied on for this feature and does not show this feature. Thus, the claimed invention is not anticipated by Dorsey, nor is it obvious over Dorsey in combination with "Duplexing Techniques".

In view of the above, it is respectfully requested that the application be reconsidered, that claims 1, 3-12, 14-16, 18-20, and 22-37 be allowed, and that the application be passed to issue.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

A provisional petition is hereby made for any extension of time necessary for the continued pendency during the life of this application. Please charge any fees for such provisional petition and any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,



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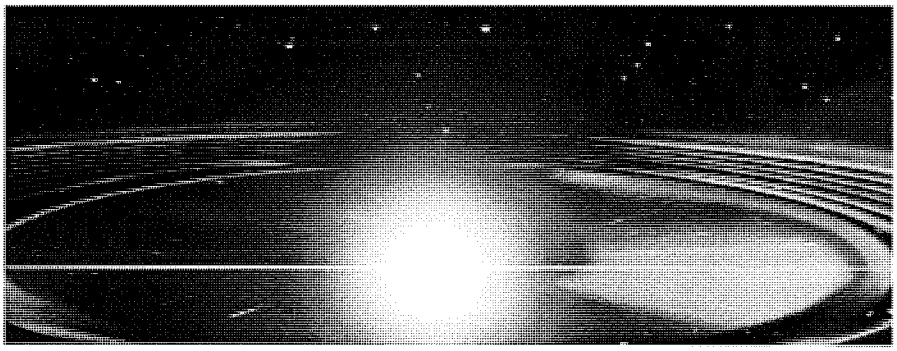
Special Report—Millimeter wave spectrum has come a long, long way

by Monica Alleven | Apr 19, 2018 9:00am



The 28 GHz band is queued to go up for auction on Nov. 14, to be followed by the 24 GHz band (Pixabay)

The 5 Most Influential Data Visualizations of All Time

Some old-school telecom folks will admit to being highly skeptical of millimeter wave spectrum. But with two upcoming mmWave auctions planned for this year and a bevy of mmWave spectrum swapping hands in the secondary markets, it's clearly taken on a new life.

One of its strong points is the sheer amount that's available. The FCC voted unanimously in July 2016 on the historic Spectrum Frontiers plan to free up vast amounts of spectrum for 5G. The move effectively quadrupled the amount of radio bandwidth ever made available to the mobile industry. The U.S. made a name for itself as a leader in mmWave and it was off to the races.

One of the pioneers in millimeter wave research, Ted Rappaport, founding director of NYU Wireless, called the 2016 FCC vote an "historic moment, a turning point, as the Renaissance of wireless begins." The professor and his students conducted ground-breaking research into the spectrum that was once deemed undesirable, proving that 5G mmWave cellular could work.

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In 2017, the FCC took further steps (PDF) to make more millimeter wave spectrum available for terrestrial wireless use, noting that while mmWave bands feature short transmission paths and high propagation losses, those features can be useful in developing high capacity networks because cells can be placed close to each other without causing interference to each other. Plus, where longer paths are desired, the extremely short wavelengths of mmWave signals make it feasible for very small antennas to concentrate signals into highly focused beams with enough gain to overcome propagation losses. The short wavelengths of mmWave signals also make it possible to build dynamic beam-forming antennas that are small enough to fit into handsets.

Although millimeter wave spectrum had been around—some of its early use cases are for microwave backhaul and fixed wireless access—it wasn't seen as worthwhile spectrum for commercial mobile uses until more recently. The 28 GHz and other high bands were intended for Local Multipoint Distribution Service (LMDS) use in the late 1990s, but those businesses failed to gain much traction and the licenses mostly laid fallow.

In fact, in large part because those LMDS businesses didn't transpire, the licenses came available again on the secondary market. Verizon last year won a bidding war with AT&T over the licenses held by Straight Path, and AT&T ended up acquiring licenses that were held by FiberTower.

mmWave in motion

The 28 GHz band in particular has been the focus of many academic research projects, industry prototyping and field trials. It has the capacity to accommodate a range of high data rate applications, and there are no federal allocations in

About the Author

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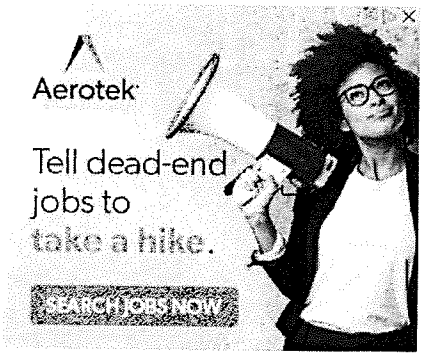
Editor



the band. It's one of the bands queued to go up for auction on Nov. 14, to be followed by the 24 GHz band.

RELATED: FCC kicks off comment period on 28 GHz, 24 GHz auctions

Verizon is by far the largest holder of mmWave licenses today, and according to T-Mobile's estimates, Verizon has 76% of the 28 GHz spectrum in the top 50 markets. T-Mobile holds 12% and 10% belongs to the "other" category, leaving just 2% available for auction in the top markets. So, it would seem, that auction won't take too long.

Some cellular industry stakeholders would like to see all the mmWave bands auctioned together. T-Mobile has argued that including the 37 GHz, 39 GHz and 47 GHz bands along with the 24 GHz band would foster more competition. The reasoning is that if more spectrum gets teed up faster, then manufacturers will direct their attention to technology development in those bands.

To be clear, well-respected engineers still point out mmWave's limitations. They say it's not ideal for mobility, and because it's never been deployed on a wide commercial scale in the real world, their hesitations could ring true.

The tides are changing

However, Verizon and AT&T both have tested mmWave extensively in field trials and report that they were pleasantly surprised to find their earlier preconceptions were overblown. Beamforming, massive MIMO and other techniques are being applied to steer signals around obstacles or use them to bounce off of them. Massive MIMO has been likened to having a bunch of flashlights targeting a group of users rather than a single floodlight.

Verizon revealed last fall that its engineers had observed that millimeter wave propagates a little better than expected in terms of line of sight and elevation. They assumed they could get to the 6th floor of an apartment or office building, but their tests showed they were able to get up as high as the 19th floor, and they saw better penetration through various wall materials and latency under 10 milliseconds.

More recently, AT&T said that after years of research, it's confident it has all the answers it needs to deploy a mobile 5G network that works for

people all over the country. Its engineers observed no impacts on 5G millimeter wave signal performance due to rain, snow or other weather events, for example, in Kalamazoo, Michigan, and observed a latency rate of 9-12 milliseconds in Waco, Texas.

Engineers are taking mobility very seriously. Last year, Qualcomm Technologies announced it had achieved a 5G data connection on a 5G modem chipset for mobile devices—with an emphasis on "mobile." Similar to the days when cynics challenged whether Qualcomm's CDMA invention would work, the company said it would prove that mobility can be accomplished at millimeter-wave frequencies, something a lot of people wouldn't happen soon, if at all.

RELATED: Editor's Corner—Facebo proves 60 GHz isn't just for backhau

There are plenty of examples of mmW spectrum being used by a variety of pl Facebook already built a sizable 60 GH San Jose, California, and the 60 GHz e growing. Concerns about oxygen abso longer looming.

I'm glad I have Medicare Part D to cover my prescriptions. My premiums even went down this year!

In New York City, a much smaller com **Skywire** uses what's called lightly licensed 70-80 GHz spectrum for a fixed wireless service, reaching neighborhoods that don't have adequate broadband from other sources. And it's not just urban areas. In a paper titled "Millimeter Wave Wireless Communications: New Results for Rural Connectivity," NYU Wireless researchers described in detail the measurements and models that validate rural millimeter wave path loss models.

RELATED: NYU Wireless research shows real potential for millimeter wave in rural areas

To be sure, a lot of spectrum bands are in play at the FCC. Commissioner Jessica Rosenworcel has identified open dockets in the 3.5 GHz, 3.7-4.2 GHz, 6 GHz, 24 GHz, 28 GHz, 32 GHz, 37 GHz, 39 GHz, 42 GHz, 47 GHz, 50 GHz, 70 GHz and 80 GHz, among others.

Meanwhile, the commission is seeking to unleash new spectrum in frequencies above 95 GHz—"way, way up there" spectrum that some see as going overboard. But FCC Chairman Ajit Pai said the point is the U.S. must be open to new technologies that haven't even been developed. "While we don't know precisely how far the laws of physics will permit us to go, we do know there's potential and

interest. Engineers and entrepreneurs need to have the ability to push the envelope," he said.

Pai noted that the skeptics have been proven wrong before. So, who knows how far engineers will push the envelope in the next 10 years?

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First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
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Attorney Docket Number:	08610010PA
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Time Stamp:	14:58:08
Application Type:	Utility under 35 USC 111(a)

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1		08610010pa_9_14_18.pdf	788848 66e25ce4de4d4d6c81cc488110c1f3f7830666c1	yes	19

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 06/14/2018

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EXAMINER	
SERAYDARYAN, HELENA H	

ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
06/14/2018	PAPER

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.

Office Action Summary	Application No. 13/966,853	Applicant(s) Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	Art Unit 3648	AIA Status No

-- 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 04/13/2018.

☐ 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) 1,3-12,14-16,18-20 and 22-37 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) 1,3-12,14-16,18-20 and 22-37 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

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

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

In view of the Appeal Brief filed on 04/13/2018, PROSECUTION IS HEREBY REOPENED. A new rejection is set forth below.

To avoid abandonment of the application, appellant must exercise one of the following two options:

(1) file a reply under 37 CFR 1.111 (if this Office action is non-final) or a reply under 37 CFR 1.113 (if this Office action is final); or,

(2) initiate a new appeal by filing a notice of appeal under 37 CFR 41.31 followed by an appeal brief under 37 CFR 41.37. The previously paid notice of appeal fee and appeal brief fee can be applied to the new appeal. If, however, the appeal fees set forth in 37 CFR 41.20 have been increased since they were previously paid, then appellant must pay the difference between the increased fees and the amount previously paid.

A Supervisory Patent Examiner (SPE) has approved of reopening prosecution by signing below:

/VLADIMIR MAGLOIRE/
Supervisory Patent Examiner, Art Unit 3648

Response to Arguments

1. Applicant's arguments, see Appeal Brief, filed 04/13/2018, with respect to claims 1, 4 and 8 have been fully considered.

2. Applicant's arguments regarding the rejection of claims 1, 4 and 8 under 35 USC § 103 are persuasive. The Finality of the Office Action filed 11/15/2017 is withdrawn. A new Non-Final Rejection is made in view of Dorsey (US 20090295648). Dorsey teaches use of sensors to determine the orientation of wireless device relative to a user or a structure in 3D space [0031-0032, 0040, 0047, 0061] and steering the antennas to radiate in directions avoiding radiation towards the user or a structure [0045-0046, 0050, 0062, 0065, 0069]. Electronically switching antenna elements in Dorsey corresponds to an electronically steerable antenna.

Dorsey discloses the limitation of detecting the orientation of the wireless device relative to the user or a structure in three dimensional space in view of the fact that both the wireless device and the user (or structure) exist in three dimensional space. There are multiple sensors positioned at different locations on the device that can determine the orientation of the user or a structure relative to the device in three dimensional space. Multiple proximity sensors may detect touch and/or proximity of user's skin relative to the wireless device. The sensors may determine if the user touches the device at the top or the bottom part, from the front or the back or from a side of the case. The sensors can determine how a user's hand is positioned on the device and how the user is holding the device. Light sensors may determine the intensity of light to which the device is exposed. By determining changes in the intensity

of received light, the device may determine in which orientation a user or structure is relative to the device. The acceleration sensors may determine the orientation of the wireless device relative to the ground. When the person presses some keys on the device, the orientation of user's finger relative to the device can be determined. Capacitive touch sensors in touchpad can also determine the orientation of the user's finger relative to the device.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1, 3-12, 14-16, 18-20, 22-37 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

As per Claims 1, 4 and 8, the scope of "other sensors" is not clear since the metes and bounds are not clearly and distinctly set forth in the claims and in its broadest reasonable interpretation includes sensors not envisioned in the specification at the time of filing.

As per Claims 37, claim language "said executable instructions cause said steps of receiving, using, and adjusting to be *performed multiple times change over time*" is

unclear as it is unclear whether the instructions change over time; the language is grammatically incorrect.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of pre-AIA 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) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

Claims 1, 3-16, 18-20, and 22-24, 26-27, 29-30, 32-37 are rejected under pre-AIA 35 U.S.C. 102(a) as being anticipated by Dorsey (US 20090295648).

As per Claim 1, Dorsey teaches a method for avoiding radiation of a user or structure by a wireless device (10) (Par. 0007-0008) having at least one steerable antenna (e.g. 100, 101, 102) (Par. 0046, 0060), comprising the steps of:

detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, an orientation of one or more parameters of either said wireless device relative to either or both said user and said structure (e.g. 41, 110, 112, 116, 114, 16, 200-202) (Par. 0031-0032, 0040, 0047, 0061);

determining, using said one or more parameters, zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna (e.g. processor 36 is responsive to sensors for controlling antenna pattern) (Par. 0045-0046, 0050, 0062, 0065, 0069); and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space (e.g. switching circuitry 54) (Par. 0045-0046, 0050, 0062, 0065, 0069; additionally, electronically switching antenna elements corresponds to an electronically steerable antenna), and

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz (Par. 0023, 0036).

Dorsey discloses the limitation of detecting the orientation of the wireless device relative to the user or a structure in three dimensional space in view of the fact that both the wireless device and the user (or structure) exist in three dimensional space.

As per Claim 3, Dorsey teaches the method set forth above, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor (Par. 0047, 0061, 0068);

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer;

and detecting relative position of the user or structure with at least one capacitive sensor (Par. 0027, 0058).

As per Claim 4, Dorsey teaches a wireless device (10) for avoiding radiation of a user or structure (Par. 0007-0008), comprising:

one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space configured to detect in a three dimensional space an orientation of said wireless device relative to either or both said user and said structure (e.g. 41, 110, 112, 116, 114, 16, 200-202) (Par. 0031-0032, 0040, 0047, 0061);

one or more processors (36) communicatively coupled to said one or more sensors (Par. 0036);

at least one steerable antenna communicatively coupled to said one or more processors (e.g. 100, 101, 102) (Par. 0046),

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions (e.g. processor 36 is responsive to sensors for controlling antenna pattern) (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz (Par. 0023, 0036); and

a non-transitory computer readable medium (storage 34) comprising executable instructions (Par. 0035-0036) that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space (Par. 0031-0032, 0040, 0047, 0061);

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069); and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions (Par. 0045-0046, 0050, 0062, 0065, 0069), and

wherein said at least one steerable antenna operates on one or multiple bands; and a receiver for receiving over-the-air signals (56) (Par. 0023, 0030, 0036, 0058, 0060).

Dorsey discloses the limitation of detecting the orientation of the wireless device relative to the user or a structure in three dimensional space in view of the fact that both the wireless device and the user (or structure) exist in three dimensional space.

As per Claim 5, Dorsey teaches the wireless device set forth above, wherein said steerable antenna comprises a plurality of steerable antennas (Par. 0046, 0060).

As per Claim 6, Dorsey teaches the wireless device set forth above, wherein said one or more sensors includes one or more light detectors (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 7, Dorsey teaches the wireless device set forth above, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 8, Dorsey teaches a steerable antenna system (e.g. 100, 101, 102) (Par. 0046, 0060) for avoiding radiation of a user or structure by a wireless device (10) (Par. 0007-0008), comprising:

one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure (e.g. 41, 110, 112, 116, 114, 16, 200-202) (Par. 0031-0032, 0040, 0047, 0061);

a computation module (processor 36) communicatively coupled to said one or more sensors configured to determine zones or spans of directions (Par. 0036);

at least one steerable antenna (e.g. 100, 101, 102) (Par. 0046, 0060) that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module (Par. 0023, 0036), said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space (e.g. processor 36 is responsive to sensors for controlling antenna pattern) (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space (Par. 0045-0046, 0050, 0062, 0065, 0069),

wherein said at least one steerable antenna operates on one or multiple bands (Par. 0023, 0030, 0036, 0060); and

a receiver for receiving signals (56) (Par. 0045, 0049).

Dorsey discloses the limitation of detecting the orientation of the wireless device relative to the user or a structure in three dimensional space in view of the fact that both the wireless device and the user (or structure) exist in three dimensional space.

As per Claim 9, Dorsey teaches the antenna system set forth above, wherein said at least one steerable antenna comprises a plurality of steerable antennas (Par. 0046, 0060).

As per Claim 10, Dorsey teaches the antenna device set forth above, wherein said one or more sensors includes one or more light detectors (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 11, Dorsey teaches the antenna device set forth above, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound (Par. 0031-0032, 0040, 0047, 0061).

As per Claim 12, Dorsey teaches the method set forth above, wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 13, Dorsey teaches the method set forth above, wherein said signals received in said receiving step are 10 GHz or above (Par. 0023, 0036).

As per Claim 14, Dorsey teaches the method set forth above, the method further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 15, Dorsey teaches the method set forth above wherein said at least one antenna or said another antenna uses beamsteering (Par. 0046, 0060).

As per Claim 16, Dorsey teaches the wireless device set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable

antenna (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 18, Dorsey teaches the wireless device set forth above, wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 19, Dorsey teaches the wireless device set forth above wherein said at least one steerable antenna or said receiver uses beamsteering (Par. 0046, 0060).

21. **As per Claim 20**, Dorsey teaches the antenna system set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 22, Dorsey teaches the antenna system set forth above wherein said receiver using said at least one steerable antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 23, Dorsey teaches the antenna system set forth above wherein said at least one steerable antenna or said receiver uses beamsteering (Par. 0046, 0060).

As per Claim 24, Dorsey teaches the method set forth above,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 26, Dorsey teaches the method set forth above, wherein said step of receiving signals with said at least one steerable antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 27, Dorsey teaches the wireless device set for the above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver to receive said over-the-air signals (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 29, Dorsey teaches the wireless device set forth above, wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 30, Dorsey teaches an antenna system set forth above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver (Par. 0049, 0073-0075, transmission pattern may be changed based on received signal quality).

As per Claim 32, Dorsey teaches the antenna system set forth above, wherein that said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0045-0046, 0050, 0062, 0065, 0069).

As per Claim 33, Dorsey teaches the method set forth above, wherein the at least one steerable antenna operates on multiple bands (Par. 0023, 0030, 0036, 0060).

As per Claim 34, Dorsey teaches the wireless device set forth above, wherein the at least one steerable antenna operates on multiple bands (Par. 0023, 0030, 0036, 0060).

As per Claim 35, Dorsey teaches the antenna system set forth above, wherein the at least one steerable antenna operates on multiple bands (Par. 0023, 0030, 0036, 0060).

As per Claim 36, Dorsey teaches the method set forth above, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time (Par. 0067-0069, 0075).

As per Claim 37, Dorsey teaches the wireless device set forth above, wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times change over time (Par. 0067-0069, 0075).

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 25, 28 and 31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Dorsey (US 20090295648) and further in view of D1 ("Duplexing Techniques", VistaMAX, WiMAX, IEEE 802.16-2004; https://www.streakwave.com/vecima/vistamax_dplxtech%20_wp_02.pdf**).**

As per Claim 25, Dorsey teaches the method set forth above, but does not teach the method further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna.

Dorsey teaches that the communication can be performed based on WiMAX standard (Par. 0023).

According to D1, WiMAX specifies two alternate duplexing techniques, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) (Page 2, first paragraph).

At the time of the invention it would have been obvious for one of ordinary skill in the art to have selected the Time Division Duplexing of D1 to provide communication as the use of a single channel allows for a simple Tx/Rx switch in the equipment, reducing cost and price to the end-user (D1: page 2, second paragraph).

As per Claim 28, Dorsey teaches the wireless device set forth above, but does not teach that said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver.

Dorsey teaches that the communication can be performed based on WiMAX standard (Par. 0023).

According to D1, WiMAX specifies two alternate duplexing techniques, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) (Page 2, first paragraph).

At the time of the invention it would have been obvious for one of ordinary skill in the art to have selected the Time Division Duplexing of D1 to provide communication as the use of a single channel allows for a simple Tx/Rx switch in the equipment, reducing cost and price to the end-user (D1: page 2, second paragraph).

As per Claim 31, Dorsey teaches the steerable antenna system set forth above, but does not teach that the antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said receiver.

Dorsey teaches that the communication can be performed based on WiMAX standard (Par. 0023).

According to D1, WiMAX specifies two alternate duplexing techniques, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) (Page 2, first paragraph).

At the time of the invention it would have been obvious for one of ordinary skill in the art to have selected the Time Division Duplexing of D1 to provide communication as the use of a single channel allows for a simple Tx/Rx switch in the equipment, reducing cost and price to the end-user (D1: page 2, second paragraph).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HELENA SERAYDARYAN whose telephone number is (571)270-0706. The examiner can normally be reached on M-Th, 7:30-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire can be reached on (571)270-5144. 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 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.

/HELENA H SERAYDARYAN/
Examiner, Art Unit 3648

/VLADIMIR MAGLOIRE/
Supervisory Patent Examiner, Art Unit 3648

Notice of References Cited	Application/Control No. 13/966,853	Applicant(s)/Patent Under Reexamination Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	Art Unit 3648	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-20090295648-A1	12-2009	Dorsey; John G.	H01Q1/2266	343/702
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Duplexing Techniques, VistaMAX, WiMAX, IEEE 802.16-2004; https://www.streakwave.com/vecima/vistamax_dplxtech%20_wp_02.pdf (Year: 2004)
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	**Art Unit**
	HELENA H SERAYDARYAN	3648

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

CLAIMS

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

CLAIM		DATE								
Final	Original	04/12/2016	11/02/2016	07/19/2017	11/07/2017	05/29/2018				
	1	✓	✓	✓	✓	✓				
	2	✓	-	-	-	-				
	3	✓	✓	✓	✓	✓				
	4	✓	✓	✓	✓	✓				
	5	✓	✓	✓	✓	✓				
	6	✓	✓	✓	✓	✓				
	7	✓	✓	✓	✓	✓				
	8	✓	✓	✓	✓	✓				
	9	✓	✓	✓	✓	✓				
	10	✓	✓	✓	✓	✓				
	11	✓	✓	✓	✓	✓				
	12		✓	✓	✓	✓				
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	14		✓	✓	✓	✓				
	15		✓	✓	✓	✓				
	16		✓	✓	✓	✓				
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	30		✓	✓	✓	✓				
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	32		✓	✓	✓	✓				
	33			✓	✓	✓				
	34			✓	✓	✓				
	35			✓	✓	✓				
	36				✓	✓				
	37				✓	✓				

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

CPC - Searched*		
Symbol	Date	Examiner
H01Q1/245	4/11/2016	H.S.
H01Q1/245 (updated)	11/2/2016	H.S.
H01Q1/245 (updated)	07/19/2017	HS
H01Q1/245 (updated)	11/07/2017	HS
H01Q1/245 (updated)	05/29/2018	HS

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
342	368	4/1/2016	H.S.
342	368 (updated)	11/2/2016	H.S.
342	368 (updated)	7/19/2017	HS
342	368 (updated)	11/07/2017	HS
342	368 (updated)	05/29/2018	HS

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor Name Search in PALM	4/1/2016	H.S.
Inventor Name Search in EAST	4/1/2016	H.S.
Text Search in EAST	4/11/2016	H.S.
Consulted with Primary G. Issing	4/1/2016	H.S.
Consulted with G. Issing	11/2/2016	H.S.
Consulted with G. Issing	7/19/2017	HS

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	104	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2016/04/01 13:02
S2	218	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:02
S3	1	S2 and ((steerable adj antenna) with sensors)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S4	1748	342/368.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S5	3044	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S6	2704	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S7	4870	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S8	6373	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S10	23279	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S11	196	steer$4 with sensor with phone	US-PGPUB;	AND	ON	2016/04/11

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT			16:47
S14	36859	S5 or S6 or S7 or S8 or S10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S16	775	steer$4 with sensor with (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S17	11	S16 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S18	6	S14 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S19	3	"52780741".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/11 16:51
S20	1533	S14 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S21	452	S20 and (cellphone or phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S22	77	S20 and (cellphone or phone)S21 and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S23	1	S22 and (steer$4 or redirect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:55
S24	73	S22 and (steer$4 or redirect$4 or direct$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:56
S25	1	2014-T60821.NRAN.	DERWENT	AND	ON	2016/04/11

						16:57
S26	19336	((steer$4 or redirect$4 or direct or direction or directionality) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S27	41	S14 and S26	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S28	25566	((steer$4 or redirect$4 or direct or direction or directionality or pattern) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:33
S29	79	S14 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:34
S30	27	H01Q1/245.cpc. and steer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:35
S31	277	H01Q1/245.cpc. and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:49
S32	1058	steer$4 with antenna with mobile	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/12 09:08
S33	5	"9529117".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/12 09:34
S34	2	(US-20080242349-$).did. or (US-6456856-$).did.	US-PGPUB; USPAT	AND	ON	2016/04/12 10:53
S35	40	342/368.ccls. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:57
S36	91	H01Q1/245.cpc. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:59
S37	13356	(multiple or dual) near2 (frequency adj2 band)	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45

S38	5187	S37 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S39	4852	S38 and communicat$4	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:46
S40	3177	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S41	2962	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S42	5154	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S43	6655	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S44	25291	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S45	39574	S40 or S41 or S42 or S43 or S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S46	705	S39 and S45	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:48
S47	1	("2013/0328723").URPN.	USPAT	AND	ON	2016/11/14 14:56
S48	224	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S49	89	S48 and GHz and (dual or multiple)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S50	29	("2010/0060531").URPN.	USPAT	AND	ON	2016/11/15 10:28
S51	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 10:42

S52	38	("2003/0210203").URPN.	USPAT	AND	ON	2016/11/15 10:59
S53	21	S52 and GHz	USPAT	AND	ON	2016/11/15 10:59
S54	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S55	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S56	16	("2009/0011806").URPN.	USPAT	AND	ON	2016/11/15 11:11
S59	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 11:12
S60	55	("5229975" | "5274844" | "5541609" | "5729238" | "5805067" | "5924020" | "5956626" | "5995862").PN. OR ("6456856").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:19
S61	4	("2008/0242349").URPN.	USPAT	AND	ON	2016/11/15 11:27
S62	24	("2008/0018543").URPN.	USPAT	AND	ON	2016/11/15 11:28
S63	0	("2013/0342416").URPN.	USPAT	AND	ON	2016/11/15 11:32
S64	4	("2009/0124306").URPN.	USPAT	AND	ON	2016/11/15 11:33
S65	9	("20070008235" | "20080204240" | "20130135171" | "5983119" | "7492254" | "8106836").PN. OR ("8649833").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:35
S66	3	("2010/0081491").URPN.	USPAT	AND	ON	2016/11/15 11:38
S67	0	("2008/0150798").URPN.	USPAT	AND	ON	2016/11/15 11:39
S68	6	("2007/0057843").URPN.	USPAT	AND	ON	2016/11/15 11:40
S69	46	("4352109" | "4518968" | "4700194" | "4868576" | "5257033" | "5612705").PN. OR ("6421016").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:41
S71	7	(mmw or (milimeter adj wave)) same (multi?band or (multiple adj band) or (dual adj band) or dual-band) same antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:09
S72	23	(mmw or (milimeter adj wave)) same2 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same2 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:10
S73	19	S72 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:11
S74	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:13
S76	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:14

S77	46	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:15
S78	4	("2014/0321282").URPN.	USPAT	AND	ON	2017/06/21 10:52
S79	2	US-6556836-$.did.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 08:04
S80	2	"25301096".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/18 08:07
S81	4	("2002/0164957").URPN.	USPAT	AND	ON	2017/07/18 09:12
S82	4401	(millimeter adj wave) same (cellular or mobile or cellphone or communication)	USPAT	AND	ON	2017/07/18 09:34
S84	944	S82 and dual	USPAT	AND	ON	2017/07/18 09:34
S85	184	((millimeter adj wave) same wireless) and (multiband or (dual adj band))	USPAT	AND	ON	2017/07/18 13:54
S86	563	(cellphone or (cellular or mobile) adj phone) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:40
S87	563	(cellphone or ((cellular or mobile) adj phone)) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:49
S88	2	"40137022".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/19 11:04
S89	0	H01Q1/245.cpc. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15
S90	0	342/368.ccls. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15
S91	60	H01Q1/245.cpc. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24
S92	32	342/368.ccls. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24

S94	3994	sensor near10 (three adj dimensions)	US-PGPUB; USPAT; USOCR	AND	ON	2018/04/26 10:06
S95	1206	S94 and phone	US-PGPUB; USPAT; USOCR	AND	ON	2018/04/26 10:07
S97	2	us-20090295648-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:34
S99	2	"WO 2012066562"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:41
S100	2	us-20040204027-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/10 15:43
S101	7620701	WO "2012066562"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:09
S102	4611	S101 and prasad.inv.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:09
S103	9	((Muthukumar) near2 (Prasad)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/16 10:10
S104	9	S101 and S103	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/16 10:11
S105	7	S102 and SAR and proximity	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2018/05/16 10:16
S106	9	((Muthukumar) near2 (Prasad)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:46
S107	1	"wo 2012/176217"	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:47
S108	9	"wo 2012176217"	US-PGPUB; USPAT; USOCR	AND	ON	2018/05/23 15:47
S109	15	"wo 2012176217"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/23 15:48
S110	96	H01Q1/245.cpc. and @pd>"20171115"	US-PGPUB; USPAT; USOCR; FPRS; EPO;	AND	ON	2018/05/29 13:08

			JPO; DERWENT			
S111	39	342/368.ccls. and @pd>"20171115"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2018/05/29 13:09
S112	2	"41379128".FMID.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 07:11
S113	72	("20050090288" | "20050124305" | "20060161871" | "20060205368" | "20060232468" | "5463406" | "5905467" | "6285893" | "6456856" | "6862433" | "6959209" | "6978121").PN. OR ("8159399").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/07 07:11
S114	2	"41379128".FMID.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 07:12
S115	8104	343/702.ccls.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:21
S117	952	343/876.ccls.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S118	2324	H01Q1/2266.cpc.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S119	5174	H01Q3/24.cpc.	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:22
S120	15520	S115 or S117 or S118 or S119	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S121	839	S120 and sensors	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S122	812	S121 and antenna	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23
S123	306	S122 and orientation	US-PGPUB; USPAT; FPRS	OR	OFF	2018/06/07 08:23

6/7/2018 12:20:10 PM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

In re patent application of

Rappaport

Serial No. 13/966,853

Filed: August 14, 2013

For: STEERABLE ANTENNA DEVICE

Confirmation No. 2489

Group Art Unit: 3648

Examiner: Seraydaryan

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

APPELLANT'S BRIEF UNDER 37 C.F.R. §41.37

This brief is in furtherance of the Notice of Appeal, filed in this case on February 15, 2018.

This brief contains these items under the following headings, and in the order set forth below (37 C.F.R. §41.37(c)):

I. REAL PARTY IN INTEREST

II. RELATED APPEALS AND INTERFERENCES

III. SUMMARY OF CLAIMED SUBJECT MATTER

IV. ARGUMENTS

☐ ARGUMENT IVA. REJECTIONS UNDER 35 U.S.C. §101

☐ ARGUMENT IVB. REJECTIONS UNDER 35 U.S.C. §112, FIRST PARAGRAPH

☐ ARGUMENT IVC. REJECTIONS UNDER 35 U.S.C. §112, SECOND PARAGRAPH

☐ ARGUMENT IVD. REJECTIONS UNDER 35 U.S.C. §102

☑ ARGUMENT IVE. REJECTIONS UNDER 35 U.S.C. §103

☐ ARGUMENT IVF. REJECTION OTHER THAN 35 U.S.C. §§ 101, 102, 103 AND 112

V. CLAIMS APPENDIX

VI. EVIDENCE APPENDIX

I. REAL PARTY IN INTEREST

The real party in interest in the appeal is:

☐ the party named in the caption of this brief.

☑ the following party: Theodore S. Rappaport

II. RELATED APPEALS AND INTERFERENCES

With respect to other appeals, interferences or judicial proceedings that will directly affect, or be directly affected by, or have a bearing on the Board's decision in this appeal:

☑ there are no related appeals, interferences or judicial proceedings related to, which directly affect or may be directly affected by or have a bearing on the Board's decision in this pending Appeal.

☐ these are as follows:

III. SUMMARY OF CLAIMED SUBJECT MATTER

The invention as defined in the claims on appeal pertains to a method for avoiding radiation of a user by a wireless device or avoiding structures that may be an impediment to radio waves by a wireless device. The devices claimed and the systems used for practicing the method include at least one steerable antenna. In operation, the method and device direct signals in particular directions while nulls or dead zones are provided in the spans or zones where energy is not desired or useful. Figure 8, by example, shows beams of energy being directed away from a user. However, as explained in the application, the beams can also be steered away from the walls of buildings which a user might be walking next to in order to have a better signal. Alternatively, the invention could be practiced with a fixed or mobile wireless device which steers energy such that the radiation from the device avoids a particular structure and instead beams towards another structure or direction.

One of the features of the invention is that it allows for smooth operation as environmental parameters change over time. For example, a person walking down a city street or an automobile driving down a street may have buildings to his or her side when on the city block, but no buildings to the side when crossing a street. As another example, a person walking down a street may change hands for holding a radio device and/or change how he or she is holding the device with his or her hands based on conditions in the street. These changes would necessarily change the orientation of the purpose to the device and/or the orientation of the device to surrounding buildings. The invention takes these changes into account by a process where it determines zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to the at least one steerable antenna, and then adjusts one or more beams of the at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space. Thus, the at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions. As conditions change during use of the device, the device adjusts the direction of energy to one or more of the particular

directions suited for the particular environmental conditions while avoiding the zones or spans of directions in the three dimensional space that are unsuitable for the environmental conditions at the particular period of time.

The present invention operates at frequencies of 10 GHz to 500 GHz and where the wavelengths are limited to much smaller wavelengths than those used previously. This permits the fabrication of multiple element antenna arrays that can provide distinct pattern nulls (lower signal power) in some directions and provide relatively higher signal power in particular directions. The invention is readily implementable with a cellphone or other wireless device. The present invention contemplates the ability to provide pattern differentiation in a time-varying environment which could not have practically been implemented and would not have been thought necessary or even commercially viable in prior mobile devices.

Support for the claims on appeal is found in the specification as originally filed as follows:

1. A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna, comprising the steps of:	Concept of wireless device with steerable antenna: page 7, line 21, to page 8, line 4. Wireless device 10 and antenna 28: Fig. 2 Wireless portable device with steerable antenna: page 20, lines 4-27. Antenna elements 75 and antenna patterns/beams 80: Fig. 8
detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers,

detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;	range finders: page 18, lines 25-31. Gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Sensors used for computational determination of spatial orientation in 3D space: page 18, lines 16-19 Detecting in 3D space, Orientation of wireless device relative to user, structure: page 20, lines 4-27.
determining zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and	Determining zones or spans of directions in 3D space: page 17, lines 1-4 Spatial and avoidance zones relative to a human user: page 19, lines 1-19. Directions of user or structure relative to steerable antenna: Page 20, lines 4-27; fig. 8, elements person 74 (identified as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one	Beam patterns may be adjusted: p 16, line 28 to page 17, line 1. Steerable antenna: page 15, lines 10-15. Radiate directions not in zones/ spans of directions: page 17, lines 1-4.

steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space, and	Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts…while avoiding: page 17, lines 1-4.
wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz.	One/multiple bands and radiates: page 14, lines 7-14. 10-500 GHz: page 14, lines 15-18.

3. The method of claim 1, wherein said detecting step comprises one or more of:	Detecting: page 19, lines 22-25. Fig. 7: sensors 70 detect one/more parameters which cause detection.
capturing one or more images with at least one camera;	Cameras: page 16, lines 9-11, 14-16 and 20-25. Also page 17, lines 1-4.
detecting ambient light or blockage thereof with at least one light sensor;	Light detectors…determine intensity: page 17, line 27, to page 18, line 5, and as claimed in original claim 3.
detecting motion of said wireless device with at least one gyroscope;	Gyroscopes: page 16, lines 9-13. Detecting device w/ gyroscope: page 17, lines 18-26.

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer; and	Microphones; ultrasound transducers, sensors or range finders: page 18, lines 24-31. User/structure: Page 20, lines 4-27; fig. 8, elements person 74 (identified as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
detecting relative position of the user or structure with at least one capacitive sensor.	Capacitive detectors....relative location of a user: page 16, lines 9-19. Fig. 2, sensor 29, and also Figs. 7 and 8, sensor 70 of device 71 relative to user 74.

4. A wireless device for avoiding radiation of a user or structure, comprising:	Avoid radiation: page 18, lines 1-5, 20-23. User/structure: page 20, lines 7-15.
one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space configured to detect in a three dimensional space an	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 25-31. gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Sensors used for computational

orientation of said wireless device relative to either or both said user and said structure;	determination of spatial orientation in 3D space: page 18, lines 16-19 Detecting in 3D space, Orientation of wireless device relative to user, structure: page 20, lines 4-27.
one or more processors communicatively coupled to said one or more sensors;	Processor: page 17, lines 5-17. Fig. 2, processor 27. Coupled to sensor(s): page 19, line30 to page 20, line 3.
at least one steerable antenna communicatively coupled to said one or more processors	Steerable antenna: page 15, lines 10-15. Coupled to sensor(s): page 19, line30 to page 20, line 3.
wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,	Steerable antenna: page 15, lines 10-15. Radiate directions not in zones/ spans of directions: page 17, lines 1-4. Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts…while avoiding: page 17, lines 1-4.
wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz; and	One/multiple bands and radiates: page 14, lines 7-14. 10-500 GHz: page 14, lines 15-18.
a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause	Software: page 17, lines 5-17. Processor(s): page 17, lines 5-17.

said one or more processors to perform the steps of:	
receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space;	Receiving signals: page 12, line 9, to page 7, line 11. Orientation in space: page 16, lines 22-25.
using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space; and adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space,	Computing zones/spans: page 7, line 26 to page 8, line 4; Fig. 2. Steerable antenna: page 15, lines 10-15. Radiate directions not in zones/ spans of directions: page 17, lines 1-4. Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts…while avoiding: page 17, lines 1-4.
wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions, and	Radiates based on signals determined on execution of executable instructions (software): page 17, lines 5-17
wherein said at least one steerable antenna operates on one or multiple bands; and	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.

a receiver for receiving over-the-air signals.	Over the air signaling received by transceiver(s): page 10, lines 5-6.
5. The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas.	Multiple antenna elements: antenna elements 75 and 75B, shown in Figs. 7 and 8; described on page 19, line 22-23, as steerable.
6. The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound sensors or transducers.	Cameras, gyroscopes, light detectors, capacitive detectors, microphones: page 17, lines 18-23. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 24-31.
7. The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.	Light: page 17, lines 27-28. Follow movement (motion and video): page 20, lines 23-27. Orientation: page 16, lines 22-25. Capacitance: 17, lines 18-22. Audio (sound)/ultrasound: page 18, lines 24-31.
8. A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:	Steerable antenna system in a wireless device: page 7, line 21, to page 8, line 4. Avoid radiation: page 18, lines 1-5, 20-23.

	User/structure: Page 20, lines 4-27; fig. 8, elements person 74 (identified as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 25-31. Gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Sensors used for computational determination of spatial orientation in 3D space: page 18, lines 16-19 Detecting in 3D space, Orientation of wireless device relative to user, structure: page 20, lines 4-27.
a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;	Fixed or mobile wireless devices (computation module): page 7, lines 19-26. Built-in sensors (coupled to sensors): page 16, lines 6-13. Configured to determine zones/spans:

	page 17, lines-5-26/
at least one steerable antenna that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space,	One/multiple bands and radiates: page 14, lines 7-14. 10-500 GHz: page 14, lines 15-18. Coupled to computation module: processor: page 17, lines 5-17; also Fig. 2, processor 27. Coupled to sensor(s): page 19, line30 to page 20, line 3. Radiate directions not in zones/ spans of directions: page 17, lines 1-4. Particular directions, providing nulls or dead zones: page 8, lines 2-4. Adjusts…while avoiding: page 17, lines 1-4.
wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space,	Detecting in 3D space: Cameras, gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 25-31. Gyroscopes, light detectors, capacitance sensors, motion detectors: page 17, lines 18-22. Sensors used for computational determination of spatial orientation in 3D space: page 18, lines 16-19 Detecting in 3D space, Orientation of

	wireless device relative to user, structure: page 20, lines 4-27.
wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space,	Determining zones or spans of directions in 3D space: page 17, lines 1-4 Spatial and avoidance zones relative to a human user: page 19, lines 1-19. Directions of user or structure relative to steerable antenna: Page 20, lines 4-27; fig. 8, elements person 74 (identified as user's body, head and torso in line 14), user's hand in line 12, user's fingers in 73 line 14 and antenna elements 75.
wherein said at least one steerable antenna operates on one or multiple bands; and	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.
a receiver for receiving signals.	Over the air signaling received by transceiver(s): page 10, lines 5-6.

9. The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas.	Multiple antenna elements (plurality of steerable antennas): Fig. 8, antenna patterns/beams 80; described on page 20, lines 6-21.

10. The steerable antenna device of claim 8, wherein said one or more sensors includes one or more	Cameras, gyroscopes, light detectors, capacitive detectors, microphones: page 17, lines 18-23.

cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound transducers.	Audio sensors, microphones, ultrasound sensors or transducers, range finders: page 18, lines 24-31.

11. The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.	Light: page 17, lines 27-28. Follow movement (motion and video): page 20, lines 23-27. Orientation: page 16, lines 22-25. Capacitance: 17, lines 18-22. Audio (sound)/ultrasound: page 18, lines 24-31.

12. The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.	Different beam patterns on transmit than on receive: page 19, lines 3-10, particularly line 10.

14. The method of claim 1 further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

15. The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam	Beamforming, beamsteering, beam selection, antenna selection, adaptive beamforming, beam selection, multibeam combining, MiMO,

or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.	phasing: page 17, lines 5-17. MiMO and beam switchable array; antennas in a lumped, distributed, passive, active or hybrid manner: page 21, lines 4-18.

16. The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

18. The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

19. The wireless device of claim 4 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam	Beamforming, beamsteering, beam selection, antenna selection, adaptive beamforming, beam selection, multibeam combining, MiMO, phasing: page 17, lines 5-17. MiMO and beam switchable array; antennas in a lumped, distributed,

switchable array, active combining, passive combining, and hybrid antenna structure.	passive, active or hybrid manner: page 21, lines 4-18.

20. The steerable antenna system of claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

22. The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

23. The steerable antenna system of claim 8 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive	Beamforming, beamsteering, beam selection, antenna selection, adaptive beamforming, beam selection, multibeam combining, MiMO, phasing: page 17, lines 5-17. MiMO and beam switchable array; antennas in a lumped, distributed, passive, active or hybrid manner: page 21, lines 4-18.

combining, and hybrid antenna structure.	

24. The method of claim 1,	
wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

25. The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna.	Time division duplexing: page 19, lines 6-19

26. The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

27. The wireless device of claim 4,	
wherein a directional radiating pattern of said one or more beams	Pattern of beam(s) radiated is different from a receiving pattern:

radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver used to receive said over-the-air signals.	page 19, lines 1-19. Over the air signaling received by transceiver(s): page 10, lines 5-6.

28. The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver.	Time division duplexing: page 19, lines 6-19

29. The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.	Directions: page 19, lines 1-3. Zones/spans of directions of user/structure: page 20, lines 4-22.

30. The steerable antenna system of claim 8,	
wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

receiving pattern used by said at least one steerable antenna or said receiver.	

31. The steerable antenna system of claim 30 wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said receiver.	Time division duplexing: page 19, lines 6-19

32. The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.	Pattern of beam(s) radiated is different from a receiving pattern: page 19, lines 1-19.

33. The method of claim 1 wherein the at least one steerable antenna operates on multiple bands.	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.

34. The wireless device of claim 4 wherein the at least one steerable antenna operates on multiple bands.	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.

35. The steerable antenna system of claim 8 wherein the at least one steerable antenna operates on multiple bands.	Steerable Antenna: page 15, lines 10-15. Band(s): page 20, lines 16-21.

36. The method of claim 1, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.	Time division duplexing: page 19, lines 6-19

37. The wireless device of claim 4 wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times changes over time.	Time division duplexing: page 19, lines 6-19. The claim will be corrected on remand to the Examiner in the same manner as claim 36.

ARGUMENT IVA. REJECTION UNDER 35 U.S.C. §101

There are no rejections under 35 U.S.C. §101.

ARGUMENT IVB. REJECTIONS UNDER 35 U.S.C. §112, FIRST PARAGRAPH

There are no rejections under 35 U.S.C. §112, first paragraph.

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ARGUMENT IVC. REJECTIONS UNDER 35 U.S.C. §112, SECOND PARAGRAPH

Claim 37 was rejected for indefiniteness. On remand to the Examiner claim 37 will be amended in the same manner as claim 36; thereby, addressing the issue raised by the Examiner.

ARGUMENT IVD. REJECTIONS UNDER 35 U.S.C. §102

There are no rejections under 35 U.S.C. §102.

ARGUMENT IVE. REJECTIONS UNDER 35 U.S.C. §103

Claims 1, 3-13, 15-17, 19-21, 23-25, 27-28, and 30-31 were rejected as being obvious over a combination of U.S. Patent 6,456,856 to Werling in view of U.S. Patent Publication 2008/0318619 to Rofougaran, U.S. Patent Publication 2007/0247385 to Brown, and U.S. Patent Publication 2004/0217909 to Maarala (page 4 of the November 15, 2017 office action). However, it appears that the Examiner meant to include U.S. Patent Publication 2010/0060531 to Rappaport in the combination (see top of page 16 of the office action), and it is unclear whether claim 21 (see page 18 of the office action), claim 25 (see page 19 of the office action), claim 28 (see pages 19 and 20 of the office action), and claim 31 (see page 20 of the office action) should be included in rejection, In addition, it is unclear whether claims 33-37 should be included in the rejection (see pages 20-23 of the office action). For purposes of this appeal the undersigned will treat claims 1, 3-13, 15-17, 19-21, 23-25, 27, 28, 30, 31, and 33-37 as being rejected as being obvious over a combination of Werling/Rofougaran/Brown/Maarala/Rappaport.

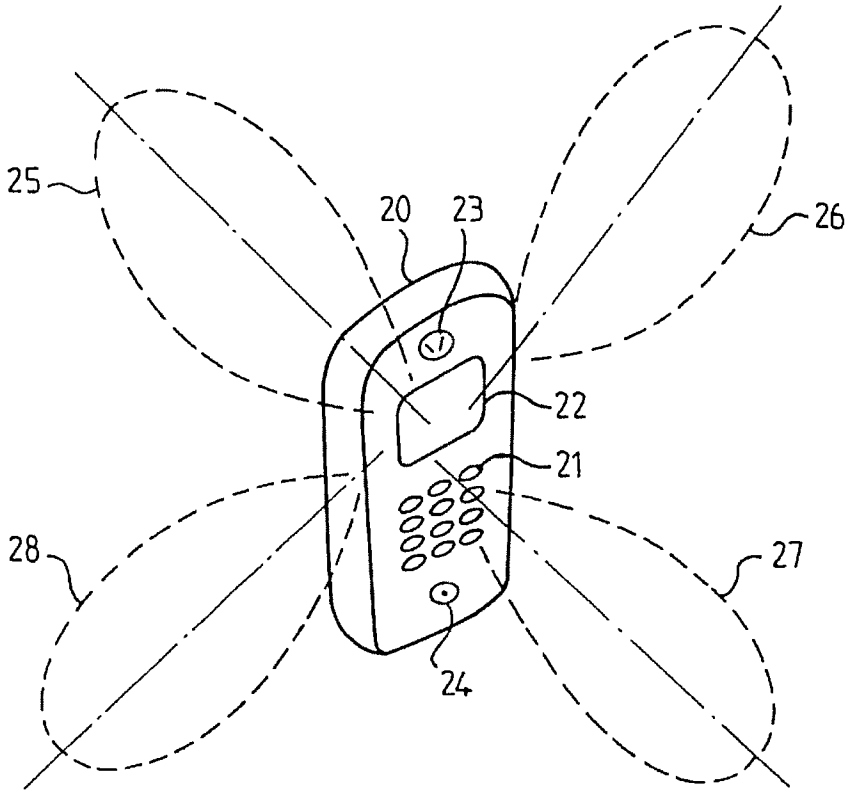
Claims 25, 28 and 31 were rejected as being obvious over Werling/Rofougaran/Maarala/Brown in view of Smulders (IEEE Communications January 2002) (see page 23 of the office action). Claims 14, 18, 22, 26, 29, and 32 were rejected as being obvious over Werling/Rofougaran/Brown/Maarala in view of U.S. Patent Publication 2006/0084395 to Kezys (see page 26 of the office action).

All rejections are in error. The claimed invention is significantly more than the predictable use of prior art elements according to their established function. As indicated by the Supreme Court in *KSR International v. Teleflex 550 US* (2007) citing *In re Kahn* 441 F.3d 977,988 (CAFC 2006) rejections on obviousness ground cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

Each of the rejections puts together five different references to come up with the conclusion of obviousness. While the final rejection reaches 31 pages in length it

fails to provide good reasons why the claims as presented herein would be obvious to one of ordinary skill in the art. It should be recognized that the invention is solving different problems in a different way than the prior art.

Central to all of the rejections is the Examiner's reliance on Werling. As can be seen from the drawing figure, Werling is concerned with a telephone which



includes switches for selectively activating and deactivating directional antennas to modify the radiation pattern (see Abstract). The first paragraph in column 3 explains that a proximity sensor, such as a heat sensor or humidity sensor, detect the presence of a person. As explained by example in column 4, lines 4-10, when a person is detected, the antenna which produces lobe 27 can be powered down. In this example, the lobe 27 is angled toward the user's head while in use, but the other lobes are angled away from the user's head.

Some of the take aways are,

Werling is not using a steerable antenna. Rather, Werling is powering up or

down different directional antennas;

Werling is not detecting using sensors which can identify the orientation of a user or a structure and the wireless device in three dimensional space (rather, the passages in Werling cited by the Examiner (col. 2, lines 17-25; col 3, lines 1-8) pertain to proximity sensors). That is Werling is sensing, for example, whether a person's head is close to one part of the wireless device or another, not what the orientation of the wireless device and, e.g., the person's head are in three dimensional space);

Werling is not determining zones or spans of directions in the three dimensional space corresponding to one or more directions of the user or structure relative to the at least one steerable antenna (Notably in item 11, on page 4 of the November 15, 2017 office action, the Examiner drops the term "three dimensional" used in the claims). In addition, the Examiner referenced Column 3, lines 8-14 which pertains to comparing coefficients determined by proximity sensors, not zones or spans of directions in three dimensional space. That is, Werling is sensing what is near a portion of the wireless device, e.g., a person or air, and is not determining zones or spans of directions);

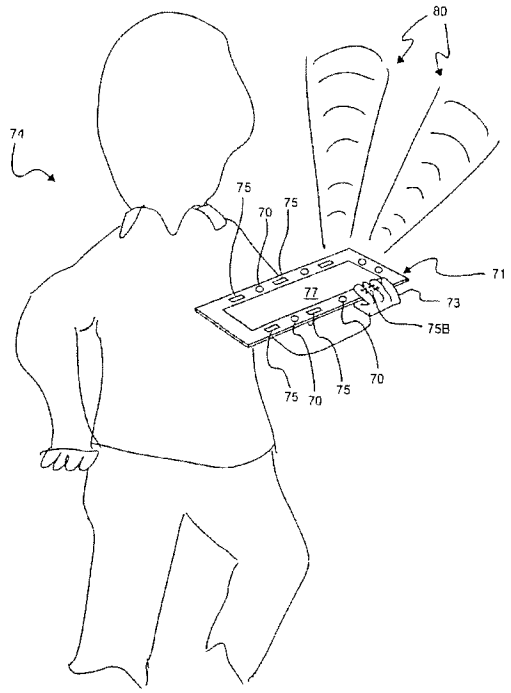
Werling is not adjusting the one or more beams of the at least one steerable antenna to radiate in one or more directions which are not in the zones or spans of directions in the three dimensional space. Since Werling merely detects proximity without regard for direction, Werling clearly does not make adjustments to a steerable antenna to not radiate in specific zones or spans of directions. As noted above, when Werling's proximity sensor detects a person's head in the proximity of one antenna, Werling powers down the antenna where the person's head is located. That is, unlike the claimed invention, Werling is not steering or directing energy in particular directions while providing nulls or dead zones in other directions, wherein the adjustments direct energy to the one or more particular directions while avoiding zones or spans of the three dimensional space.

The passages of Werling cited by the Examiner pertain to powering down or attenuating antennas when a person's head is in proximity to that particular section of

the wireless device where particular antennas are located, without any ability to steer the beam or alter it with changing orientations of the person or the environment. Only the applicant teaches steering or directing energy in particular directions while providing nulls or dead zones in other directions in three dimensional space and making adjustments over time to direct energy to the one or more particular directions while avoiding zones or spans of the three dimensional space as the particular directions and zones or spans change over time.

Furthermore, none of the other references are relied upon by the Examiner for showing any of these features, and, in fact, do not show these features.

Werling is much more simplistic than the claimed invention, and correspondingly less robust. With Werling, one could fool the proximity sensor simply by turning it over and pressing the case from the underside (i.e., the person's fingers would be the same distance away, e.g. would yield the same proximity and produce the same proximity coefficient, but the determined antennas to power up and power down would likely be exactly opposite to what is needed). As the PTAB will recognize, a person may hold a wireless device a multiplicity of different ways while walking, and the user's relative position in three dimensional space will change. In contrast to all art cited by the Examiner, the claimed invention provides the ability to adjust the beam direction accordingly under these changing conditions. In operation, the method and device of the claimed invention direct signals in particular directions while nulls or dead zones are provided in the spans or zones where energy is not desired or useful. Figure 8, by example, shows the beams of energy being directed away from a user (i.e., the beams are directed in directions which are not in the spans or zones which correspond with the direction of the user relative to the wireless device).



With the claimed invention, if the wireless device were moved, or the user changes hands for holding the device, different zones or spans of directions would be determined, and adjustments would be made such that the steerable antenna radiates in directions which are not in those spans or zones. As required in claims 36 and 37, only the applicant teaches the steps of detecting, determining, and adjusting being performed multiple times as one or more parameters change over time.

Moreover, as explained in the application, with the present invention the beams can also be steered away from the walls of buildings which a user might be walking next to in order to have a better signal. In addition, embodiments of the invention could be used by a fixed or mobile wireless device to steer energy such that the radiation avoids a particular structure and instead beams towards another structure or direction. Werling does not contemplate this feature, as well.

Rofougaran was cited as teaching communication with a wireless device where at least one antenna that radiates on one more frequencies in the 10-500 GHz range and operates on multiple bands (see page 5 of the November 15, 2017 office action).

While these features may or may not be applicable to the Werling device as concluded by the Examiner, it should be clear that Rofougaran does not have a steerable antenna, does not detect spans or zones in three dimensional space, and does not adjust beams to radiate in particular directions which are not in the zones or spans. Thus, any combination of Werling and Rofogaran would wholly lack the central features of the claimed invention.

The Examiner has acknowledged on page 5 of the November 15, 2017 office action that any combination of Werling and Rofougaran does not have the types of sensors specified in the independent claims 1, 4, and 8 (e.g., cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space configured to detect in a three dimensional space an orientation of said wireless device relative to either or both said user and said structure). For this the Examiner relies on Maraala. Maraala is directed to a wireless device with a planar antenna (see Title). Notably, paragraph [0024] discusses the sensors being used for "proximity" detection. Thus, much like the temperature and humidity sensors of Werling, Maraala makes measurements as to what is nearby the edges of the planar antenna. What Maraala clearly is <u>not</u> doing is detecting the relationship of the wireless device and a user or other structure in three dimensional space, so that zones or spans of directions in the three dimensional space can be determined, and adjusting the one or beams of the steerable antenna to radiate in one or more directions which are not in the zones or spans of directions. Hence, any combination of Werling, Rofougaran, and Maraala would wholly lack the salient features of the claimed invention. As explained on page 18 of the application in the last two paragraphs, the invention contemplates that the sensors, either alone or with other sensor inputs (e.g. sensor fusion, e.g., camera inputs together with inputs from other sensors) are used to determine how to orient the one or more beams of the device to avoid radiating in the direction of the user. That is, only the applicant teaches determining orientation of objects (e.g., a person or a structure relative to the mobile equipment) and adapting to the particular orientation and distance in 3D

space. By contrast, Werling and Maraala describe proximity only, and do not describe looking for the positions of persons or objects in three dimensional space, and adapting to changes in the relative positions of the persons or objects to the mobile device over time.

With respect to dependent claim 3, in the office action of November 15, 2017, at page 7, the Examiner highlights Maraala's teaching of detecting ambient light or blockage thereof. The Examiner also highlights this with respect to dependent claim 7 on page 11 of the November 15, 2017 office action. However, as noted above, this is a proximity sensing function contemplated by Maraala, and Maraala in no way suggests detecting spans or directions in three dimensional space and steering radiation in directions which are not in those spans or directions.

The Examiner has acknowledged on page 6 of the office action of November 15, 2017 that the combination of Werling, Rofougaran and Maraala do not teach a steerable antenna, and the Examiner relies on Brown for showing a steerable antenna. Of course, steerable antennas in and of themselves are not new. Brown shows but one example of a steerable antenna. What Brown does not show is any system (such as for the devices of Figures 2 and 11 cited by the Examiner), whereby the relationship of the wireless device and a user or other structure is detected in three dimensional space, the determination of zones or spans of directions in the three dimensional space, and the adjustment of the one or beams of the steerable antenna to radiate in one or more directions which are not in the zones or spans of directions. Hence, any combination of Werling, Rofougaran, Maraala and Brown would lack the salient features of the independent claims.

Rappaport is mentioned on page 16 of the office action of November 15, 2017. However, wholly lacking from Rappaport are Figures 7 and 8 of the present application. In short, there is no teaching in Rappaport concerning the identification of the user or structure in three dimensional space with the wireless device with the determination of spans or zones where radiation is not desired, and the steering of the antenna to direct radiation not in those spans or zones. Hence, any combination of Werling, Rofougaran, Maraala, Brown and Rappaport would not make any of the

claims obvious to one of ordinary skill in the art.

In rejecting claims 25, 28, and 31, the Examiner has relied on the article to Smulders for time division multiplexing. Like Brown which shows but one example of a steerable antenna, time division multiplexing is not new, and Smulders merely provides a discussion of the same. What Smulders does not show is any system, whereby the relationship of the wireless device and a user or other structure is detected in three dimensional space, the determination of zones or spans of directions in the three dimensional space, and the adjustment of the one or beams of the steerable antenna to radiate in one or more directions which are not in the zones or spans of directions. Hence, any combination of Werling, Rofougaran, Maraala, Brown, and Smulders would lack the salient features of the independent claims.

In rejecting claims 14, 18, 22, 26, 29 and 32, the Examiner has relied on Kezys receiving signals within one or more zones or spans. This of course is not a correct assessment of Kezys, because Kezys, unlike the claimed invention, does not determine the zones or spans in three dimensional space which correspond with one or more directions of the user or structure relative to the at least one steerable antenna, as is required in the claims. With reference to Figures 6A and 6B of Kezys it can be seen that Kezys is detecting the proximity of the left or right hand on the wireless device, and using the other antenna (the one not covered by the hand) to transmit or receive. At no point does Kezys detect the three dimensional spatial position of the user or other structure and the mobile device, determine zones or spans in the three dimensional space that correspond with directions of the user or structure relative to the steerable antenna, and then adjust the beams from the steerable antenna to radiate in one or more directions that are not in those zones or spans. As such, any combination of Werling, Rofougaran, Brown, Maarala and Kezys would not make the claimed invention obvious to one of ordinary skill in the art.

Conclusion

Having this background and **evidence in the case, the Examiner has reasoned that the claimed invention would be obvious to one of ordinary skill in**

the art in view of the cited references. This reasoning is not well grounded, and the conclusion is simply in error.

Only the Applicant has taught a method and system which requires (1) detecting in three dimensional space, using sensors which allow for it (not proximity sensors), the relationship between the wireless device and a user or the wireless device and another structure, (2) determining zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to the steerable antenna, and (3) adjusting one or beams of the steerable antenna to radiate in one or more directions which are not in the zones or spans. Only the Applicant shows doing this multiple times as conditions vary with time.

In the office action of November 15, 2017 the Werling reference was the most important reference. As discussed in detail above, the teachings of Werling have been misinterpreted. Werling teaches proximity detection using either a temperature or humidity sensor. Proximity, of course, is a measure of "nearness", without regard for the particular directionality or orientation of the "nearness". The proximity detection taught in Werling is provided by sensors that yield a scalar measurement signal (e.g. a particular "coefficient" produced by the sensor, as taught in Werling, Column 4, lines 50-60, without the benefit of any direction data or orientation information). Proximity detection using sensors and coefficients in Werling thus give readings that are one dimensional in nature (see Figure 4 of Werling). That is, what is being detected in Werling is if the user is touching the device, and Werling teaches a simple one-dimensional proximity measurement based on a one-dimensional parameter for either a temperature or humidity sensor. If he or she touches the device or is very close to it, his or her presence is determined via heat or humidity using a single-dimensional parameter (a simple coefficient), and Werling then contemplates turning off some antennas corresponding to the touchpad sensor of the device, while keeping power on the other antennas.

Werling does not teach how the orientation of the user with the device could be determined, and in fact, nothing in Werling could distinguish if a user was holding

the device from the front or the back or using a side grip, since there is only a one-dimensional proximity sensor measurement (see Figure 4 of Werling and the one-dimensional parameters and coefficients taught by Werling). A person could touch the Werling device using an outstretched finger, but the Werling device would have no way of discerning if the finger was coming from above the phone, or was coming from the backside of the phone, or from an arbitrary angle in relation to the phone. Similarly, the temperature or humidity of the front of a hand could be identical to the back of a hand, or identical to the person's neck, and Werling's sensors would have no way of knowing the specific body part or the orientation of the person in relation to the device. Werling would only sense the one-dimensional presence (e.g. proximity) of the body part touching the device, or being very near the device, and hence could not possibly detect the orientation of the person's hand, arm or body in relation to the device.

Similarly, if determining the proximity of a user's head, Werling can only detect if the head is touching the device, or is very near the device, but would have no way of knowing if it was the user's ear or forehead or chin or eyelid that was touching the case. Werling thus could not possibly know or compute the spatial orientation of the user's head or what part of the head was touching the phone. Werling only knows that something was close or touching the touchpad, based on the one-dimensional proximity sensing that is used.

This is very different from the present invention that uses cameras, gyroscopes, and/or other sensors to determine the spatial orientation and relative locations/positions of the user or obstructions in order to steer beams in space as a person changes its orientation in relation to the device. Simply put, Werling does not teach the ability of determining or using the spatial orientation of the user or surroundings relative to the device in three dimensional space. None of the other references provide these features, either.

Based on the arguments stated above, the combination of cited references would not make the claimed invention obvious. Based on the required analysis under *Graham v. John Deere*, *KSR v. Teleflex* and the objective standard demanded under

35 U.S.C. §103, the rejection is clearly in error and reversal of the rejections is therefore respectfully requested.

ARGUMENT IVF REJECTION OTHER THAN 35 U.S.C. §§ 101, 102, 103 AND 112

There are no rejections other than 35 U.S.C. §§101, 102, 103, and 112

V. CLAIMS APPENDIX

The text of the claims involved in the appeal are:

1. A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna, comprising the steps of:

detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;

determining zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space, and

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz.

3. The method of claim 1, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer; and

detecting relative position of the user or structure with at least one capacitive sensor.

4. A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space configured to detect in a three dimensional space an orientation of said wireless device relative to either or both said user and said structure;

one or more processors communicatively coupled to said one or more sensors;

at least one steerable antenna communicatively coupled to said one or more processors

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,

wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space;

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space,

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions, and

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving over-the-air signals.

5. The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

6. The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound sensors or transducers.

7. The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.

8. A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;

at least one steerable antenna that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space,

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space,

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving signals.

9. The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

10. The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, gyroscopes, light or motion detectors, capacitive sensors, microphones, and ultrasound transducers.

11. The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, motion, orientation, video, capacitance, ultrasound, and sound.

12. The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

14. The method of claim 1 further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

15. The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

16. The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.

18. The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

19. The wireless device of claim 4 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

20. The steerable antenna system of claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.

22. The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

23. The steerable antenna system of claim 8 wherein said at least one steerable antenna or said receiver uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

24. The method of claim 1,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

25. The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna.

26. The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

27. The wireless device of claim 4,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver used to receive said over-the-air signals.

28. The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver.

29. The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

30. The steerable antenna system of claim 8,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver.

31. The steerable antenna system of claim 30 wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said receiver.

32. The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

33. The method of claim 1 wherein the at least one steerable antenna operates on multiple bands.

34. The wireless device of claim 4 wherein the at least one steerable antenna operates on multiple bands.

35. The steerable antenna system of claim 8 wherein the at least one steerable antenna operates on multiple bands.

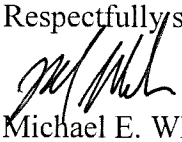
36. The method of claim 1, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.

37. The wireless device of claim 4 wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times change over time.

VI. EVIDENCE APPENDIX

No evidence is submitted

Respectfully submitted,



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Electronic Acknowledgement Receipt

EFS ID:	32339931
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	13-APR-2018
Filing Date:	14-AUG-2013
Time Stamp:	18:13:21
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	Appeal Brief Filed	08610010pa_4_13_18.pdf	1307680 6b7c3f6519d5666452b250009d12bef88e3da046	no	48

Warnings:

Information:	
Total Files Size (in bytes):	1307680

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/AIA/31 (03-14)
Approved for use through 07/31/2016. OMB 0651-0031
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NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD

Docket Number (Optional): 08610010pa

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on _____.

Signature _____

Typed or printed name _____

In re Application of: Rappaport

Application Number	Filed
13/966853	August 14, 2013

For: STEERABLE ANTENNA DEVICE

Art Unit	Examiner
3648	Seraydaryan

Applicant hereby **appeals** to the Patent Trial and Appeal Board from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 800

☑ Applicant asserts small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by 50%, and the resulting fee is: $ 400

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Therefore, the fee shown above is reduced by 75%, and the resulting fee is: $ _____
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

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

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 50-2041.

☑ Payment made via EFS-Web.

☐ A petition for an extension of time under 37 CFR 1.136(a) (PTO/AIA/22 or equivalent) is enclosed.
For extensions of time in reexamination proceedings, see 37 CFR 1.550.

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.

I am the

☐ applicant

☑ attorney or agent of record
Registration number 32,635

☐ attorney or agent acting under 37 CFR 1.34
Registration number _____

Signature _____

Typed or printed name Michael E. Whitham

Telephone Number 703-787-9400

Date February 15, 2018

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 41.20(b)(1) and 41.31. 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, 1.14 and 41.6. 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.

Electronic Patent Application Fee Transmittal

Application Number:	13966853
Filing Date:	14-Aug-2013
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham
Attorney Docket Number:	08610010PA

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
NOTICE OF APPEAL	2401	1	400	400
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**400**

Electronic Acknowledgement Receipt

EFS ID:	31807352
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	15-FEB-2018
Filing Date:	14-AUG-2013
Time Stamp:	16:48:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$400
RAM confirmation Number	021618INTEFSW16494700
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	Notice of Appeal Filed	08610010pa_2_15_18.pdf	49685 9ffa2b11059e43067860bf183800a4a29bd1b8b8	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30387 7cbb1abf8379e2a1be0653c1699db75e1673a4ee	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	80072		

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

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

New International Application Filed with the USPTO as a Receiving Office

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

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L18	60	H01Q1/245.cpc. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24
L19	32	342/368.ccls. and @pd>"20170726"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/11/07 14:24
S1	104	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2016/04/01 13:02
S2	218	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:02
S3	1	S2 and ((steerable adj antenna) with sensors)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S4	1748	342/368.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S5	3044	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S6	2704	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S7	4870	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S8	6373	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S10	23279	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46

S11	196	steer$4 with sensor with phone	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:47
S14	36859	S5 or S6 or S7 or S8 or S10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S16	775	steer$4 with sensor with (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S17	11	S16 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S18	6	S14 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S19	3	"52780741".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/11 16:51
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S21	452	S20 and (cellphone or phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S22	77	S20 and (cellphone or phone)S21 and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S23	1	S22 and (steer$4 or redirect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:55
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S25	1	2014-T60821.NRAN.	DERWENT	AND	ON	2016/04/11 16:57
S26	19336	((steer$4 or redirect$4 or direct or direction or directionality) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S27	41	S14 and S26	US-PGPUB; USPAT; USOCR; FPRS;	AND	ON	2016/04/11 17:27

			EPO; JPO; DERWENT			
S28	25566	((steer$4 or redirect$4 or direct or direction or directionality or pattern) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:33
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S30	27	H01Q1/245.cpc. and steer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:35
S31	277	H01Q1/245.cpc. and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:49
S32	1058	steer$4 with antenna with mobile	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/12 09:08
S33	5	"9529117".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/12 09:34
S34	2	(US-20080242349-$).did. or (US-6456856-$).did.	US-PGPUB; USPAT	AND	ON	2016/04/12 10:53
S35	40	342/368.ccls. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:57
S36	91	H01Q1/245.cpc. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:59
S37	13356	(multiple or dual) near2 (frequency adj2 band)	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S38	5187	S37 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S39	4852	S38 and communicat$4	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:46
S40	3177	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S41	2962	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S42	5154	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48

S43	6655	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S44	25291	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S45	39574	S40 or S41 or S42 or S43 or S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S46	705	S39 and S45	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:48
S47	1	("2013/0328723").URPN.	USPAT	AND	ON	2016/11/14 14:56
S48	224	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S49	89	S48 and GHz and (dual or multiple)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S50	29	("2010/0060531").URPN.	USPAT	AND	ON	2016/11/15 10:28
S51	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 10:42
S52	38	("2003/0210203").URPN.	USPAT	AND	ON	2016/11/15 10:59
S53	21	S52 and GHz	USPAT	AND	ON	2016/11/15 10:59
S54	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S55	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S56	16	("2009/0011806").URPN.	USPAT	AND	ON	2016/11/15 11:11
S59	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 11:12
S60	55	("5229975" | "5274844" | "5541609" | "5729238" | "5805067" | "5924020" | "5956626" | "5995862").PN. OR ("6456856").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:19
S61	4	("2008/0242349").URPN.	USPAT	AND	ON	2016/11/15 11:27
S62	24	("2008/0018543").URPN.	USPAT	AND	ON	2016/11/15 11:28
S63	0	("2013/0342416").URPN.	USPAT	AND	ON	2016/11/15 11:32
S64	4	("2009/0124306").URPN.	USPAT	AND	ON	2016/11/15 11:33
S65	9	("20070008235" | "20080204240" | "20130135171" | "5983119" | "7492254" | "8106836").PN. OR ("8649833").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:35

S66	3	("2010/0081491").URPN.	USPAT	AND	ON	2016/11/15 11:38
S67	0	("2008/0150798").URPN.	USPAT	AND	ON	2016/11/15 11:39
S68	6	("2007/0057843").URPN.	USPAT	AND	ON	2016/11/15 11:40
S69	46	("4352109" | "4518968" | "4700194" | "4868576" | "5257033" | "5612705").PN. OR ("6421016").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:41
S71	7	(mmw or (milimeter adj wave)) same (multi?band or (multiple adj band) or (dual adj band) or dual-band) same antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:09
S72	23	(mmw or (milimeter adj wave)) same2 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same2 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:10
S73	19	S72 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:11
S74	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:13
S76	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:14
S77	46	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:15
S78	4	("2014/0321282").URPN.	USPAT	AND	ON	2017/06/21 10:52
S79	2	US-6556836-$.did.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 08:04
S80	2	"25301096".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/18 08:07
S81	4	("2002/0164957").URPN.	USPAT	AND	ON	2017/07/18 09:12
S82	4401	(millimeter adj wave) same (cellular or mobile or cellphone or communication)	USPAT	AND	ON	2017/07/18 09:34
S84	944	S82 and dual	USPAT	AND	ON	2017/07/18 09:34
S85	184	((millimeter adj wave) same wireless) and (multiband or (dual adj band))	USPAT	AND	ON	2017/07/18 13:54
S86	563	(cellphone or (cellular or mobile) adj phone) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:40
S87	563	(cellphone or ((cellular or mobile) adj phone)) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:49
S88	2	"40137022".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/19 11:04

S89	0	H01Q1/245.cpc. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15
S90	0	342/368.ccls. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15

11/7/2017 2:31:54 PM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

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

CLAIMS

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

CLAIM		DATE								
Final	Original	04/12/2016	11/02/2016	07/19/2017	11/07/2017					
	1	✓	✓	✓	✓					
	2	✓	-	-	-					
	3	✓	✓	✓	✓					
	4	✓	✓	✓	✓					
	5	✓	✓	✓	✓					
	6	✓	✓	✓	✓					
	7	✓	✓	✓	✓					
	8	✓	✓	✓	✓					
	9	✓	✓	✓	✓					
	10	✓	✓	✓	✓					
	11	✓	✓	✓	✓					
	12		✓	✓	✓					
	13		✓	-	-					
	14		✓	✓	✓					
	15		✓	✓	✓					
	16		✓	✓	✓					
	17		✓	-	-					
	18		✓	✓	✓					
	19		✓	✓	✓					
	20		✓	✓	✓					
	21		✓	-	-					
	22		✓	✓	✓					
	23		✓	✓	✓					
	24		✓	✓	✓					
	25		✓	✓	✓					
	26		✓	✓	✓					
	27		✓	✓	✓					
	28		✓	✓	✓					
	29		✓	✓	✓					
	30		✓	✓	✓					
	31		✓	✓	✓					
	32		✓	✓	✓					
	33			✓	✓					
	34			✓	✓					
	35			✓	✓					
	36				✓					
	37				✓					

Notice of References Cited	Application/Control No. 13/966,853	Applicant(s)/Patent Under Reexamination Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	Art Unit 3648	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-20040217909-A1	11-2004	Maarala, Mika	H01Q1/243	343/765
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

CPC - Searched*		
Symbol	Date	Examiner
H01Q1/245	4/11/2016	H.S.
H01Q1/245 (updated)	11/2/2016	H.S.
H01Q1/245 (updated)	07/19/2017	HS
H01Q1/245 (updated)	11/07/2017	HS

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
342	368	4/1/2016	H.S.
342	368 (updated)	11/2/2016	H.S.
342	368 (updated)	7/19/2017	HS
342	368 (updated)	11/07/2017	HS

* 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
Inventor Name Search in PALM	4/1/2016	H.S.
Inventor Name Search in EAST	4/1/2016	H.S.
Text Search in EAST	4/11/2016	H.S.
Consulted with Primary G. Issing	4/1/2016	H.S.
Consulted with G. Issing	11/2/2016	H.S.
Consulted with G. Issing	7/19/2017	HS

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/966,853	Rappaport, Theodore S.
	Examiner	Art Unit
	HELENA H SERAYDARYAN	3648

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

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/HELENA SERAYDARYAN/ Examiner.Art Unit 3648

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 11/15/2017

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EXAMINER	
SERAYDARYAN, HELENA H	

ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
11/15/2017	PAPER

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.

Office Action Summary	Application No. 13/966,853	Applicant(s) Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	Art Unit 3648	AIA Status No

-- 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 10/26/2017 .

☐ 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) See Continuation Sheet 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) 1,3-12,14-16,18-20 and 22-37 is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

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

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____ .

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____ .

4) ☐ Other: _____ .

Continuation of Disposition of Claims* 5) Claim(s) is/are pending in the application: 1,3-12,14-16,18-20 and 22-37

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments, see Remarks, filed 10/16/2017, with respect to newly amended claims 1, 4 and 8 have been fully considered.

2. Applicant's amendment of the claims 19, 22, 23, 25, 26, 28 and 31 overcomes the rejection of the claims under 35 USC § 112, second paragraph. The rejection is withdrawn.

3. A new rejection is added to newly added claim 37 under 35 USC § 112, second paragraph due to clarity issues.

4. Applicant's arguments regarding the rejection of amended claims 1, 4 and 8 under 35 USC § 103 are persuasive. Upon further consideration, a new ground(s) of rejection is made in view of Werling (US 6456856), Rofougaran (US 20080318619), Brown (US 20070247385) and Maarala (US 20040217909) necessitated by Applicant's amendment of claims 1, 4 and 8.

Claim Rejections - 35 USC § 112

5. 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.

6. Claim 37 is 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.

7. As per Claims 37, claim language "said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times change over time" is unclear as it is unclear whether the instructions change over time.

Claim Rejections - 35 USC § 103

8. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

10. **Claims 1, 3-13, 15-17, 19-21, 23-25, 27-28, and 30-31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rofougaran (US 20080318619), Brown (US 20070247385) and Maarala (US 20040217909).**

11. **As per Claim 1**, Werling teaches a method for avoiding radiation of a user or structure by a wireless device having at least one antenna (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2; Fig. 1, array 12-15; Col. 2, Lines 54-62; Col. 3, Lines 51-55), comprising the steps of:

detecting in a space, using one or more sensors an orientation of (Fig. 1, Item 18) said wireless device relative to either or both said user and said structure (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

determining zones or spans of directions in the space corresponding with one or more directions of said user or structure relative to said at least one antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one antenna to radiate in one or more directions which are not in said zones or spans of directions in the space, wherein said at least one antenna is configured to direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the space (Col. 3, Lines 15-22, 27-32, 51-55; Col. 4, Lines 4-10, 25-33).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands.

However Rofougaran teaches a method of communication with a wireless device (Par. 0005, 0007), wherein the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Rofougaran method to increase the data rate capabilities (Rofougaran: Par. 0036).

But Werling, as modified by Rofougaran, does not teach that the one or more sensors are cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in space, wherein the space is a three dimensional space.

However, Maarala teaches a method for avoiding radiation of a user or structure by a wireless device (Par. 0006-0009), the one or more sensors are cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors (light sensors), motion detectors, or other sensors used for computational determination of spatial orientation in space, and wherein the space is a three dimensional space (Par. 0024).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling and Rofougaran with the property of the method of Maarala to detect any surfaces nearby the apparatus (Maarala: Par. 0024).

Werling, as modified by Rofougaran and Maarala, teaches phased directional antennas but does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran and Maarala with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

12. **As per Claim 3**, Werling, as modified by Rofougaran, Maarala and Brown teaches the method set forth above, but does not teach that said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to the orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer;

and detecting relative position of the user or structure with at least one capacitive sensor.

However, Maarala teaches that said detecting step comprises detecting ambient light or blockage thereof with at least one light sensor (Par. 0024, optical sensors).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling, Rofougaran, Maarala and Brown with the property of the method of Maarala to detect any surfaces nearby the apparatus (Maarala: Par. 0024).

13. **As per Claim 4**, Werling, as modified by Rofougaran, Maarala and Brown, teaches a wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect in a space an orientation of said wireless device relative to either or both said user and structure (Fig. 1, Item 18; Col. 3, Lines 1 - 14; Col. 4, Lines 53-57; ambient temperature);

one or more processors communicatively coupled to said one or more sensors (Col. 3, Lines 1-14; Fig. 1, control element 17);

at least one antenna communicatively coupled to said one or more processors (Fig. 1, Items 12-15; Col. 2, Lines 56-59; Col. 3, Lines 45-55);

wherein said at least one antenna is configured to direct its energy in particular directions while providing nulls or dead zones in other directions (Col. 3, Lines 15-22, 27-32, 51-55; Col. 4, Lines 4-10, 25-33);

a non-transitory computer readable medium comprising executable instructions (Col. 2, Lines 59- 65; Fig. 1, control element 17) that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said orientation in the space (Fig. 1, Item 18; Col. 3, Lines 1 -14; Col. 4, Lines 53-57);

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one antenna in the space (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the space (Col. 3, Lines 15-22, 27-32),

wherein said at least one antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions (Col. 3, Lines 15-22, 27-32, 51-55; Col. 4, Lines 4-10, 25-33),

and

a receiver for receiving over-the-air signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands.

However Rofougaran teaches a wireless device (Par. 0003, 0017), wherein the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Rofougaran's device to increase the data rate capabilities (Rofougaran: Par. 0036).

But Werling, as modified by Rofougaran, does not teach that one or more sensors are selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in space, wherein the space is three dimensional space.

However, Maarala teaches a wireless device for avoiding radiation of a user or structure (Par. 0006-0009), wherein the one or more sensors are selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors (light sensors), motion detectors, or other sensors used for computational determination of spatial orientation in space, and wherein the space is a three dimensional space (Par. 0024).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling and Rofougaran with the property of the device of Maarala to detect any surfaces nearby the apparatus (Maarala: Par. 0024).

Werling, as modified by Rofougaran and Maarala, teaches phased directional antennas but does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran and Maarala with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

14. **As per Claim 5**, Werling, as modified by Rofougaran, Maarala and Brown, teaches the wireless device set forth above, wherein said antenna comprises a plurality of antennas, said plurality of antennas forming an antenna array (Fig. 1, array 12-15; Col. 2, Lines 54-62; Claim 3; Col. 3, Lines 41-44, 51-54, "phased-array type").

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

15. **As per Claim 6**, Werling teaches the wireless device set forth above, but does not teach that said one or more sensors includes one or more light detectors.

However, Maarala teaches that one or more sensors includes one or more light detectors (Par. 0024, optical sensors).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling and Rofougaran with the property of the device of Maarala to detect any surfaces nearby the apparatus (Maarala: Par. 0024).

16. **As per Claim 7**, Werling teaches the wireless device set forth above, but does not teach that said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

But Maarala teaches that said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound (Par. 0024, optical sensors).

17. **As per Claim 8**, Werling teaches an antenna system for avoiding radiation of a user or structure by a wireless device (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2), comprising:

one or more sensors (Fig. 1, Item 18) configured to detect in a space using one or more sensors an orientation of said wireless device relative to either or both said user and said structure (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions (Col. 3, Lines 1-14; Fig. 1, control element 17);

at least one antenna (Fig. 1, array 12-15; Col. 2, Lines 54-62; claim 3; Col. 3, Lines 41-44, 51-54, "phased-array type") communicatively coupled to said computation module, said at least one antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions in the space (Col. 3, Lines 15-22, 27-32),

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one antenna in the space (Col. 3, Lines 8-14), wherein said at least one antenna is configured to direct its energy in particular directions while providing nulls or dead zones in other directions in the space (Col. 3, Lines 15-22, 27-32, 51-55; Col. 4, Lines 4-10, 25-33),

a receiver for receiving signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

But Werling does not teach that the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands.

However Rofougaran teaches a system for communication (Par. 0005, 0007), wherein the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Rofougaran's system to increase the data rate capabilities (Rofougaran: Par. 0036).

But Werling, as modified by Rofougaran, does not teach that the one or more sensors are cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in space, wherein the space is a three dimensional space.

However, Maarala teaches a method for avoiding radiation of a user or structure by a wireless device (Par. 0006-0009), the one or more sensors are cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors (light sensors), motion detectors, or other sensors used for computational determination of spatial orientation in space, and wherein the space is a three dimensional space (Par. 0024).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling and Rofougaran with the property of the system of Maarala to detect any surfaces nearby the apparatus (Maarala: Par. 0024).

Werling, as modified by Rofougaran and Maarala, teaches phased directional antennas but does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran and Maarala

with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

18. **As per Claim 9**, Werling, as modified by Rofougaran, Maarala and Brown, teaches the antenna system set forth above, wherein said at least one antenna comprises a plurality of antennas (Fig. 1, arrays 12-15; Col. 2, Lines 54-62; claim 3; Col. 3, Lines 41-44, 51-54, "phased-array type").

Werling, as modified by Rofougaran, Maarala and Brown, does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

19. **As per Claim 10**, Werling, as modified by Rofougaran, Maarala, and Brown, teaches the antenna device set forth above, but does not teach that said one or more sensors includes one or more light detectors.

However, Maarala teaches that said one or more sensors includes one or more light detectors (Par. 0024).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling, Rofougaran, Maarala and Brown with

the property of the system of Maarala to detect any surfaces nearby the apparatus (Maarala: Par. 0024).

20. **As per Claim 11**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the antenna device set forth above, but does not teach that said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

However, Maarala teaches that said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound (Par. 0024).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling, Rofougaran, Maarala and Brown with the property of the system of Maarala to detect any surfaces nearby the apparatus (Maarala: Par. 0024).

21. **As per Claim 12**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above, wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Col. 3, Lines 19-21, 37-41).

22. **As per Claim 13**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above, but does not teach that said signals received in said receiving step are 10 GHz or above.

However Rappaport teaches that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling, Rofougaran, Maarala and Brown with the property of Rappaport's method as wireless devices evolve to millimeter wave (mmWave) carrier frequencies (Rappaport: Par. 0039).

23. **As per Claim 15**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above wherein said at least one antenna or said another antenna uses phasing (Col. 3, Lines 41-44, 51-54, "phased-array type").

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

24. **As per Claim 16**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the wireless device set forth above wherein a directional radiating pattern of

said one or more beams radiated from said at least one antenna is different from a receiving pattern of said at least one antenna (Col. 3, Lines 19-21, 37-41).

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

25. **As per Claim 19**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the wireless device set forth above wherein said at least one antenna or said receiver uses phasing (Col. 3, Lines 41-44, 51-54, "phased-array type").

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

26. **As per Claim 20**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the antenna system set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one antenna is different from a receiving pattern of said at least one antenna (Col. 3, Lines 19-21, 37-41).

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

27. **As per Claim 23**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the antenna system set forth above wherein said at least one antenna or said receiver uses phasing (Col. 3, Lines 41-44, 51-54, "phased-array type").

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and

Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

28. **As per Claim 24**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

29. **As per Claim 27**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the wireless device set for the above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one antenna is different from a receiving pattern used by said at least one antenna or said receiver to receive said over-the-air signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

30. **As per Claim 30**, Werling teaches an antenna system set forth above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one antenna is different from a receiving pattern used by said at least one antenna or said receiver (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

31. **As per Claim 33**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above, but does not teach that the at least one antenna operates on multiple bands.

However, Rofougaran teaches that at least one antenna operates on multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling, Rofougaran, Maarala and Brown with the property of Rofougaran's method to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

32. **As per Claim 34**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the wireless device set forth above, but does not teach that the at least one antenna operates on multiple bands.

However, Rofougaran teaches that at least one antenna operates on multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling, Rofougaran, Maarala and Brown with the property of Rofougaran's device to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

33. **As per Claim 35**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the antenna system set forth above, but does not teach that the at least one antenna operates on multiple bands.

However, Rofougaran teaches that at least one antenna operates on multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling, Rofougaran, Maarala and Brown with the property of Rofougaran's system to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling, as modified by Rofougaran, Maarala, and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

34. **As per Claim 36**, Werling, as modified by Rofougaram, Maarala and Brown, teaches the method set forth above, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41-61; Fig. 4).

35. **As per Claim 37**, Werling, as modified by Rofougaran, Maarala and Brown teaches the wireless device set forth above, wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41-61; Fig. 4).

36. **Claims 25, 28 and 31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rofougaran (US 20080318619), Maarala (US 20040217909), Brown (US 20070247385) and Smulders ("Exploiting the 60 GHz Band for Local Wireless Multimedia Access: Prospects and Future Directions", IEEE Communications Magazine; January 2002).**

37. **As per Claim 25**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above, but does not teach it further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna.

However, Smulders teaches a method of wireless communication (Page 140, Introduction), the method further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said another antenna (Page 145; "Dual-Band Operation", column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling, Rofougaran, Maarala and Brown with the property of Smulders method for cost reduction, processing efficiency and power efficiency (Smulders: Page 145; "Dual-Band Operation", column 2, last paragraph).

Werling, as modified by Rofougaran, Maarala, Brown and Smulders does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala, Brown and Smulders with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

38. **As per Claim 28**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the wireless device set forth above, but does not teach that said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and using over-the-air signals received by at least one of said at least one antenna or said receiver.

However, Smulders teaches a device for wireless communication (Page 140, Introduction), wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and using over-the-air signals received by at least one of said at least one antenna or said another antenna (Page 145; "Dual-Band Operation", column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling, Rofougaran, Maarala and Brown with the property of Smulders device for cost reduction, processing efficiency and power efficiency (Smulders: Page 145; "Dual-Band Operation", column 2, last paragraph).

Werling, as modified by Rofougaran, Maarala, Smulders and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala, Smulders and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

39. **As per Claim 31**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the steerable antenna system set forth above, but does not teach that the antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said receiver.

However, Smulders teaches a system for wireless communication (Page 140, Introduction), wherein the antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said another antenna (Page 145; "Dual-Band Operation", column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling, Rofougaran, Maarala and Brown with the property of Smulders system for cost reduction, processing efficiency and power efficiency (Smulders: Page 145; "Dual-Band Operation", column 2, last paragraph).

40. **Claims 14, 18, 22, 26, 29 and 32 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rofougaran (US 20080318619), Brown (US 20070247385), Maarala (US 20040217909) and Kezys (US 20060084395)**

41. **As per Claim 14**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above, but does not teach the method further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a method for avoiding radiation of a user or structure by a wireless device (Par. 0002, 0016), the method comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling, Rofougaran, Maarala and Brown with the step of Smulders method to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

42. **As per Claim 18**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the wireless device set forth above, but does not teach that said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a wireless device for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling, Rofougaran, Maarala, and Brown with the property of Smulders device to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

43. **As per Claim 22**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the antenna system set forth above but does not teach that said receiver using

said at least one antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a system for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver using said at least one antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling, Rofougaran, Maarala and Brown with the property of Smulders system to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

Werling, as modified by Rofougaran, Maarala, Smulders and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala, Smulders and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

44. **As per Claim 26**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the method set forth above, but does not teach that said step of receiving

signals with said at least one antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a method for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said step of receiving signals with said at least one antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling, Rofougaran, Maarala and Brown with the property of Smulders method to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

Werling, as modified by Rofougaran, Maarala, Kezys and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Maarala, Kezys and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

45. **As per Claim 29**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the wireless device set forth above, but does not teach that said receiver

receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a wireless device for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling, Rofougaran, Maarala and Brown with the property of Smulders device to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

46. **As per Claim 32**, Werling, as modified by Rofougaran, Maarala, and Brown teaches the antenna system set forth above, but does not teach that said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a system for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling, Rofougaran, Maarala and Brown with the property of Smulders system to provide overall high antenna system efficiency for the

common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

Werling, as modified by Rofougaran, Maarala, Kezys and Brown does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling, Rofougaran, Kezys and Brown with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, THIS ACTION IS MADE FINAL. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HELENA SERAYDARYAN whose telephone number is (571)270-0706. The examiner can normally be reached on M-Th, 7:30-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tashiana Adams can be reached on (571)270-5228. 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 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.

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/966,853	Filing Date 08/14/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **10/26/2017**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 33	Minus	** 31	= 2	X $40 =	80
Independent (37 CFR 1.16(h))	* 3	Minus	***6	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**80**

AMENDMENT

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** 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 number found in the appropriate box in column 1.

LIE
TRINA STEPTOE

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Rappaport	Confirmation No. 2489
Serial No. 13/966,853	Group Art Unit 3648
Filed August 14, 2013	Examiner Seraydaryan
For STEERABLE ANTENNA DEVICE	

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

AMENDMENT UNDER 37 C.F.R. 1.111

Sir:

The applicant and the undersigned thank the Examiner for the interview which took place on October 19, 2017. This amendment makes the substance of the interview of record in the application.

In response to the office action mailed July 26, 2017, please amend the application as follows:

Amendments to the Claims: begin on page 2

Remarks: begin on page 10

Listing of the Claims:

The following is a complete listing of all the claims in the application, with an indication of the status of each:

1. (currently amended) A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna, comprising the steps of:

detecting in a three dimensional space, using one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors[[,]]used for computational determination of spatial orientation in three dimensional space, an orientation of ~~one or more parameters of either~~ said wireless device relative to either or both said user and said structure ~~or pertaining to said user's or said structure's physical relationship to said wireless device~~;

determining~~, using said one or more parameters,~~ zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions in the three dimensional space, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions in the three dimensional space, and

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz~~, and~~

~~wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time~~.

2. (canceled)

3. (currently amended) The method of claim 1, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to the ~~one or more of the proximity of a user or~~ orientation of the user or structure with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer~~;~~

~~detecting heat from a human user with at least one heat sensor~~; and

detecting relative position of the user or structure ~~touch or proximity of a user's skin or clothing~~ with at least one capacitive sensor.

4. (currently amended) A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space configured to detect in a three dimensional space ~~one or more parameters of either~~ an orientation of said wireless device relative to either or both said user and said structure ~~or pertaining to a user's or structure's physical relationship to said wireless device~~;

one or more processors communicatively coupled to said one or more sensors;

at least one steerable antenna communicatively coupled to said one or more processors

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,

wherein said at least one steerable antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space ~~one or more parameters~~;

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions in the three dimensional space,

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions, and

wherein said at least one steerable antenna operates on one or multiple bands~~, and~~

~~wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time~~; and

a receiver for receiving over-the-air signals.

5. (previously presented) The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

6. (currently amended) The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, ~~heat sensors,~~ gyroscopes, light or motion detectors, capacitive sensors ~~detectors~~, microphones, and ultrasound sensors or transducers.

7. (currently amended) The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, ~~temperature,~~ motion, orientation, video, capacitance, ultrasound, and sound.

8. (currently amended) A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect in a three dimensional space using one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, an orientation of ~~at least one parameter of either~~ said wireless device relative to either or both said user and said structure ~~or pertaining to a user's or structure's physical relationship to said wireless device~~;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;

at least one steerable antenna that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions in the three dimensional space,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space,

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions in the three dimensional space,

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving signals.

9. (previously presented) The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

10. (currently amended) The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, ~~heat sensors,~~ gyroscopes, light or

motion detectors, capacitive sensors ~~detectors~~, microphones, and ultrasound transducers.

11. (currently amended) The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, ~~temperature,~~ motion, orientation, video, capacitance, ultrasound, and sound.

12. (previously presented) The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

13. (Canceled)

14. (previously presented) The method of claim 1 further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

15. (previously presented) The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

16. (previously presented) The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna.

17. (canceled)

18. (previously presented) The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

19. (currently amended) The wireless device of claim 4 wherein said at least one steerable antenna or said receiver ~~another antenna~~ uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

20. (currently amended) The steerable antenna system of claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna ~~or said another antenna used by said receiver to receive said signals~~.

21. (canceled)

22. (currently amended) The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or said receiver ~~another antenna~~ receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

23. (currently amended) The steerable antenna system of claim 8 wherein said at least one steerable antenna or said receiver ~~another antenna~~ uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

24. (previously presented) The method of claim 1,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

25. (currently amended) The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna ~~or said another antenna~~.

26. (currently amended) The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna ~~or another antenna~~ receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

27. (currently amended) The wireless device of claim 4,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said receiver ~~another antenna~~ used ~~by said receiver~~ to receive said over-the-air signals.

28. (currently amended) The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said receiver ~~another antenna~~.

29. (Previously presented) The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

30. (Currently amended) The steerable antenna system of claim 8,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said ~~another antenna used by said~~ receiver ~~to receive said signals~~.

31. (currently amended) The steerable antenna system of claim 30 wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said receiver ~~another antenna~~.

32. (previously presented) The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

33. (previously presented) The method of claim 1 wherein the at least one steerable antenna operates on multiple bands.

34. (previously presented) The wireless device of claim 4 wherein the at least one steerable antenna operates on multiple bands.

35. (previously presented) The steerable antenna system of claim 8 wherein the at least one steerable antenna operates on multiple bands.

36. (new) The method of claim 1, and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time.

37. (new) The wireless device of claim 4 wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times change over time.

REMARKS

Claims 1, 3, 4, 6, 7, 8, 10, 11, 19, 22, 23, 25, 26, 27, 28, 31, and 32, have been amended, and claims 36 and 37 have been added. The application includes claims 1, 3-12, 14-16, 18-20, and 22-37.

The application has been simplified by canceling a number of claims to accelerate the application to grant. The applicant reserves the right to pursue additional claims supported by the patent specification in one or more continuing applications, including those canceled in this action.

As discussed at the interview, claims 19, 22, 23, 25-28, and 31-32, have been amended to reference the "receiver" recited in the independent claim or to simply eliminate reference to "another antenna". This amendment overcomes the rejection of claims 19, 22, 23, 25, 26, 28, and 31 for indefiniteness.

Claims 1, 3-13, 15-17, 19-21, 23-25, 27-28, and 30-31 were rejected as being obvious over a combination of U.S. Patent 6,456,856 to Werling in view of U.S. Patent Publication 2008/0318619 to Rofougaran and U.S. Patent Publication 2007/0247385 to Brown. Claims 25, 28 and 31 were rejected as being obvious over Werling/Rofougaran/Brown in view of Smulders (IEEE Communications January 2002). Claims 14, 18, 22, 26, 29, and 32 were rejected as being obvious over Werling/Rofougaran/Brown in view of U.S. Patent Publication 2006/0084395 to Kezys. These rejections are traversed in view of the amendments above.

As discussed at the interview, and to simplify matters for allowance, independent claims have been amended to specify that the spatial positions of the wireless device relative to either the user or the structure are being determined in a three dimensional space. In operation, the method and device direct signals in particular directions while nulls or dead zones are provided in the spans or zones where energy is not desired or useful. Figure 8, by example, shows the beams of energy being directed away from a user. However, as explained in the application and discussed during the interview, the beams can also be steered away from the walls of buildings which a user might be walking next to in order to have a better signal, or embodiments of the invention could be used by a fixed or mobile

wireless device to steer energy such that the radiation avoids a particular structure and instead beams towards another structure or direction.

At the interview, the Examiner noted that the Werling reference was the most important reference. The undersigned noted that Werling teaches proximity detection using either a temperature or humidity sensor. Proximity, of course, is one dimensional in nature (see Figure 4 of Werling). That is, what is being detected in Werling is if the user is touching the device, and Werling teaches a simple one-dimensional proximity measurement based on a one-dimensional parameter for either a temperature or humidity sensor. If he or she touches the device, his or her presence is determined via heat or humidity, and Werling then contemplates turning off some antennas corresponding to the touchpad sensor of the device, while keeping power on the other antennas. Werling does not teach how the orientation of the user with the device could be determined, and in fact, in the interview, the applicant pointed out that nothing in Werling could distinguish if a user was holding the device from the front or the back or from the side, since there is only a one-dimensional proximity sensor measurement (see Figure 4 of Werling and the one-dimensional parameters taught by Werling). A person could touch the Werling device using an outstretched finger, but the Werling device would have no way of discerning if the finger was coming from above the phone, or was coming from the backside of the phone, or from an arbitrary angle in relation to the phone. Werling would just sense the one-dimensional presence of the fingertip touching the device, or being very near the device, and hence could not possibly detect the orientation of the person's arm or body in relation to the device. Similarly, if determining the proximity of a user's head, Werling can only detect if the head is touching the device, or is very near the device, but would have no way of knowing if it was the user's ear or forehead or chin or eyelid that was touching the case. Werling thus could not know the spatial orientation of the user's head or what part of the head was touching the phone. Werling only knows that something was close or touching the touchpad, based on the one-dimensional proximity sensing that is used. This is very different from the present invention that uses cameras and/or other sensors to determine the spatial orientation and relative locations/positions of the user or obstructions in order to steer beams in

space. Simply put, Werling does not teach the ability of determining or using the spatial orientation of the user or surroundings relative to the device in three dimensional space. The applicant believes the Examiner acknowledged these facts at the interview.

The Examiner further acknowledged at the interview that Werling does not have a steerable antenna (hence the reliance on the secondary references to Rofougaran and Brown). In order to better distinguish the claimed invention, and based on the interview with the Examiner, the applicant has eliminated from the claims the requirement of temperature sensors or temperature sensing, and has specified the use of different sensors not contemplated by the Werling/Rofougaran/Brown combination (e.g., cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, motion detectors, or other sensors used for computational determination of spatial orientation in three dimensional space, see paragraph [0050], [0051], and [0054] of the published application). In addition, as discussed at the interview, the claim has been amended to specify determination of the relative position of the device and the user or structure in three dimensional space (see paragraph [0057] of the published application).

Werling does not determine where a user or structure is relative to the wireless transmitting/receiving device in three dimensional space. It further follows that Werling also does not make computations of any type as to where to direct a beam or where not to direct a beam in three dimensional space. Both features are taught in the present application and required in the claims. As discussed with the Examiner, and as noted in the prosecution history of the present invention, the features of the present invention would not have been anticipated or obvious, and these were not contemplated by Werling or the other cited references.

As discussed during the interview, Werling is much more simplistic than the claimed invention, and correspondingly less robust. With Werling, one could fool the proximity sensor simply by turning it over and pressing the case from the underside (i.e., the person's fingers would be the same distance away, but the determined antennas to power up and power down would likely be exactly

opposite to what is needed). As the Examiner will recognize, a person may hold a wireless device a multiplicity of different ways while walking, and the user's relative position in three dimensional space will change, and the patent application teaches the ability to adjust the beam direction accordingly under these conditions, whereas Werling did not contemplate this concept, nor make it obvious in combination with the other references. Furthermore, as discussed during the interview, only the present application teaches accounting for structures when determining spans or zones. That is, in some embodiments, the invention will allow for taking into account buildings close to the device, so that the transmit/ receive pattern is directed away from a wall for better communication, or aimed at a different direction to take advantage of reflections in the environment. Werling failed to contemplate this feature, as well.

As discussed during the interview, Rofougaran has nothing to do with a sensing system that couples to adaptive antennas for adapting the formed beams to the time varying propagation environment. Rofougaran only teaches a mmw communication device with an adaptive antenna. Paragraph [0036] only describes using more than one mmwave transceiver to increase data rate. In addition, as discussed at the interview, Brown describes the fabrication of a phased array but has no teaching or even vague inference whatsoever regarding the present invention's ability to use a steerable antenna to work with a mobile or fixed device to adapt the radiated beam patterns to avoid persons or objects. Paragraphs 0003 and 0040 and Figures 2 and 11 do not at all consider the radiating pattern of the antenna and how it interacts with the environment, persons, or the ability to shift the beam pattern to avoid or radiate certain zones or directions based on the location of specific obstructions or the desire to reflect or scatter off of objects.

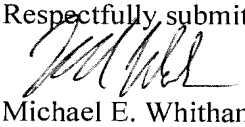
In short, none of Werling, Brown, or Rofougaran teach or contemplate a mobile or fixed device or system that senses relative orientations in three dimensional space and adapts the beam steering such that it avoids people or objects. Smulders and Kezys were discussed at length in the previous amendment, and also lack this feature. This is only taught in the patent application.

Based on the amendments, claims 1, 3-12, 14-16, 18-20, and 22-37 are in immediate condition for allowance. Reconsideration and allowance is requested.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

A provisional petition is hereby made for any extension of time necessary for the continued pendency during the life of this application. Please charge any fees for such provisional petition and any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,



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Electronic Acknowledgement Receipt

EFS ID:	30773706
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	26-OCT-2017
Filing Date:	14-AUG-2013
Time Stamp:	16:31:26
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		08610010pa_10_26_17.pdf	519621 8537dff7cc78dcf3065808c55c98fe56a2e74a34	yes	14

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	9
	Applicant Arguments/Remarks Made in an Amendment	10	14
Warnings:			
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 10/25/2017

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SERAYDARYAN, HELENA H	

ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
10/25/2017	PAPER

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.

Applicant-Initiated Interview Summary	**Application No.** 13/966,853	**Applicant(s)** Rappaport, Theodore S.	
	Examiner HELENA H SERAYDARYAN	**Art Unit** 3648	**AIA Status** No

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

(1) HELENA H. SERAYDARYAN.

(2) _____.

(3) MICHAEL WITHAM.

(4) THEODORE RAPPAPORT.

Date of Interview: 19 October 2017.

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

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

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

Claim(s) discussed: 1.

Identification of prior art discussed: Werling, Brown.

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

See Continuation Sheet.

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

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

☑ Attachment

/HELENA H SERAYDARYAN/ Examiner, Art Unit 3648	/TASHIANA R ADAMS/ Supervisory Patent Examiner, Art Unit 3648

Summary of Record of Interview Requirements

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

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

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

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

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

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

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

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

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

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

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

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

Examiner to Check for Accuracy

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

Continuation of Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: During the interview applicant argued that Werling does not teach claim 1 limitations "determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna" and "adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions." Examiner explained, that Weling discloses the limitations in [Col. 4, Lines 5-10], describing how the the antenna radiation is controlled to not point the radiation to the user's head. Brwon teaches that instead of a number of controlled antennas, a steerable antenna may be used.Applicant also argued that the references do not teach that the "steps of detecting, determining, and adjusting are performed multiple times as said one or parameters change over time." Examiner explained that diagram of Fig. 4 teaches the limitation. Applicant agreed to further amend the claim limitation to overcome the prior art. No agreement was obtained about the allowability of the claims.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Rappaport

Serial No. 13/966,853

Filed August 14, 2013

For STEERABLE ANTENNA DEVICE

Confirmation No. 2489

Group Art Unit 3648

Examiner Seraydaryan

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

TOPICS FOR DISCUSSION AT INTERVIEW OF OCTOBER 19, 2017

Claim 1 requires

1. (HIGHLIGHTED) A method for avoiding radiation of a user or structure by a wireless device having **at least one steerable antenna**, comprising the steps of:

detecting, using one or more sensors, one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device;

determining, using said one or more parameters, zones or spans of **directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna**; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are **not in said zones or spans of directions**, wherein said at least one steerable antenna is configured to steer or **direct its energy in particular directions while providing nulls or dead zones in other directions**, and wherein said adjusting step **adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions**,

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz, and

wherein said steps of detecting, determining, and adjusting are **performed multiple times as said one or more parameters change over time**.

The claim is not obvious over a combination of U.S. Patent 6,456,856 to Werling in view of U.S. Patent Publication 2008/0318619 to Rofougaran and U.S. Patent Publication 2007/0247385 to Brown as none of the references include the highlighted subject matter.

Werling is the principle reference relied upon in the office action. Werling does not teach that at least one antenna is a steerable antenna. Further, Werling teaches nothing about the determination of a relationship of the wireless device and physical users or objects, such that zones or spans of direction can be computed, and further makes no teaching about the adjustment of the steerable antenna to radiate in one or more directions that are not in the computed zones or spans of directions. Finally, Werling does not show or describe making changes over time. In short, Werling merely teaches how to change the power to one or more directional antenna elements if the case is touched.

Rofougaran has nothing to do with a sensing system that couples to adaptive antennas for adapting the formed beams to the time varying propagation environment. Rofougaran only teaches a mmw communication device with an adaptive antenna. Paragraph [0036] only describes using more than one mmwave transceiver to increase data rate.

Brown describes the fabrication of a phased array but has no teaching or even vague inference whatsoever regarding the present invention's ability to use a steerable antenna to work with a mobile or fixed device to adapt the radiated beam patterns to avoid persons or objects. Paragraphs 0003 and 0040 and Figures 2 and 11 do not at all consider the radiating pattern of the antenna and how it interacts with the environment, persons, or the ability to shift the beam pattern to avoid or radiate certain zones or directions based on the location of specific obstructions or the desire to reflect or scatter off of objects.

In short, none of Werling, Brown, or Rofougaran teach or contemplate a mobile or fixed device or system that adapts the beam steering such that it avoids people or objects, as we teach.

With regard to indefiniteness, see exemplary proposal below:

19. (currently amended) The wireless device of claim 4 wherein said at least one steerable antenna or said receiver ~~another antenna~~ uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

22. (currently amended) The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or receiver ~~another antenna~~ receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 07/26/2017

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ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
07/26/2017	PAPER

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.

Office Action Summary	Application No. 13/966,853	Applicant(s) RAPPAPORT, THEODORE S.	
	Examiner HELENA SERAYDARYAN	Art Unit 3648	AIA (First Inventor to File) Status No

-- 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 *03/22/2017*.

☐ 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) *1,3-12,14-16,18-20 and 22-35* 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) *1,3-12,14-16,18-20 and 22-35* 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 *08/14/2013* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 03/22/2017 has been entered.

Response to Arguments

3. Applicant’s arguments, see Remarks, filed 03/22/2017, with respect to newly amended claims 1, 4 and 8 have been fully considered.

4. Applicant’s arguments regarding the objection to the drawings are persuasive. The objection is withdrawn. The drawings submitted on 08/14/2013 are accepted.

5. Applicant's amendment of the claims overcomes the rejection of the claims under 112, first paragraph. The rejection is withdrawn.

6. Applicant's amendment to the claims overcomes the rejection of some of the claims under 112, second paragraph. However, the rejection is maintained for claims 19, 22, 23, 25, 26, 28 and 31 as the clarity issues have not be resolved.

7. Applicant's arguments regarding the rejection of amended claims 1, 4 and 8 under 35 USC § 103 are persuasive. Upon further consideration, a new ground(s) of rejection is made in view of Werling (US 6456856), Rofougaran (US 20080318619) and Brown (US 20070247385) necessitated by Applicant's amendment of claims 1, 4 and 8. Werling teaches a wireless device that determines the proximity of a user from sensor information and directs the radiation of the transmitted signal away from the user. Thus, the direction of the user is accounted for to determine the zones or spans of directions, and the beam is adjusted in directions different from the determined zones or spans of directions to avoid radiation to the user. Werling teaches the device comprising phased directional antennas for the communication, but does not teach that the antenna is steerable. Reference by Brown teaches use of steerable antenna for wireless communication devices. Although Werling teaches communication in GHz range, Werling does not teach that the device operates at one or more frequencies in the range of 10 GHz to 500 GHz. Rofougaran teaches wireless communication transceivers communicating at one or more frequencies in the range of 10 GHz to 500 GHz.

Claim Rejections - 35 USC § 112

8. 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.

9. Claims 19, 22, 23, 25, 26, 28 and 31 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

10. As per Claims 19, 22, 23, 25, 26, 28 and 31, the claim limitations are unclear, as there is no definition of what the “said another antenna” comprises and what the relationship of the “said another antenna” to the device or the system is.

11. Claims 19, 22, 23, 25, 26, 28 and 31 recite the limitation "said another antenna". There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 103

12. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject

matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

14. **Claims 1, 3-13, 15-17, 19-21, 23-25, 27-28, and 30-31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rofougaran (US 20080318619) and Brown (US 20070247385).**

15. **As per Claim 1**, Werling teaches a method for avoiding radiation of a user or structure by a wireless device having at least one antenna (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2; Fig. 1, array 12-15; Col. 2, Lines 54-62; Col. 3, Lines 51-55), comprising the steps of:

detecting, using one or more sensors (Fig. 1, Item 18), one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one antenna to radiate in one or more directions which are not in said zones or spans of directions, wherein said at least one antenna is configured to direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions (Col. 3, Lines 15-22, 27-32, 51-55; Col. 4, Lines 4-10, 25-33),

wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41- 61; Fig. 4; the user proximity is determined several times in a loop; the number of times of performing the method steps depends on the number of programmed iterations).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands.

However Rofougaran teaches a method of communication with a wireless device (Par. 0005, 0007), wherein the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Rofougaran method to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling teaches phased directional antennas but does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

16. **As per Claim 3**, Werling teaches the method set forth above, wherein said detecting step comprises:

detecting heat from a human user with at least one heat sensor (Col. 4, Lines 53-57; ambient temperature).

17. **As per Claim 4**, Werling teaches a wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect one or more parameters of either said wireless device or pertaining to a user's or structure's physical relationship to said

wireless device (Fig. 1, Item 18; Col. 3, Lines 1 -14; Col. 4, Lines 53-57; ambient temperature);

one or more processors communicatively coupled to said one or more sensors (Col. 3, Lines 1-14; Fig. 1, control element 17);

at least one antenna communicatively coupled to said one or more processors (Fig. 1, Items 12-15; Col. 2, Lines 56-59; Col. 3, Lines 45-55);

wherein said at least one antenna is configured to direct its energy in particular directions while providing nulls or dead zones in other directions (Col. 4, Lines ****),

a non-transitory computer readable medium comprising executable instructions (Col. 2, Lines 59- 65; Fig. 1, control element 17) that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said one or more parameters (Fig. 1, Item 18; Col. 3, Lines 1 -14; Col. 4, Lines 53-57; ambient temperature);

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32),

wherein said at least one antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions (Col. 3, Lines 15-22, 27-32, 51-55; Col. 4, Lines 4-10, 25-33),

wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41- 61; Fig. 4; the user proximity is determined several times in a loop; the number of times of performing the method steps depends on the number of programmed iterations); and

a receiver for receiving over-the-air signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands.

However Rofougaran teaches a wireless device (Par. 0003, 0017), wherein the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Rofougaran's device to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling teaches phased directional antennas but does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

18. **As per Claim 5**, Werling teaches the wireless device set forth above, wherein said antenna comprises a plurality of antennas, said plurality of antennas forming an antenna array (Fig. 1, array 12-15; Col. 2, Lines 54-62; Claim 3; Col. 3, Lines 41-44, 51-54, “phased-array type”).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

19. **As per Claim 6**, Werling teaches the wireless device set forth above, wherein said one or more sensors includes one or more heat sensors (Fig. 1, Item 18; Col. 3, Lines 1-8).

20. **As per Claim 7**, Werling teaches the wireless device set forth above, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound (Col. 2, Lines 17-25; Col. 3, Lines 1-8; ambient temperature).

21. **As per Claim 8**, Werling teaches an antenna system for avoiding radiation of a user or structure by a wireless device (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2), comprising:

one or more sensors (Fig. 1, Item 18) configured to detect at least one parameter of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions (Col. 3, Lines 1-14; Fig. 1, control element 17);

at least one antenna (Fig. 1, array 12-15; Col. 2, Lines 54-62; claim 3; Col. 3, Lines 41-44, 51-54, "phased-array type") communicatively coupled to said computation module, said at least one antenna radiating one or more beams in one or more

directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32),

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one antenna (Col. 3, Lines 8-14), wherein said at least one antenna is configured to direct its energy in particular directions while providing nulls or dead zones in other directions (Col. 3, Lines 15-22, 27-32, 51-55; Col. 4, Lines 4-10, 25-33),

a receiver for receiving signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

But Werling does not teach that the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands.

However Rofougaran teaches a system for communication (Par. 0005, 0007), wherein the at least one antenna radiates at one or more frequencies in the range of 10 GHz to 500 GHz and operates on one or multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Rofougaran's system to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling teaches phased directional antennas but does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

22. **As per Claim 9**, Werling teaches the antenna system set forth above, wherein said at least one antenna comprises a plurality of antennas (Fig. 1, arrays 12-15; Col. 2, Lines 54-62; claim 3; Col. 3, Lines 41-44, 51-54, “phased-array type”).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

23. **As per Claim 10**, Werling teaches the antenna device set forth above, wherein said one or more sensors includes one or more heat sensors (Fig. 1, Item 18; Col. 3, Lines 1-8).

24. **As per Claim 11**, Werling teaches the antenna device set forth above, wherein said one or more parameters are selected from the group consisting of light,

temperature, motion, orientation, video, capacitance, ultrasound, and sound (Col. 2, Lines 17-25; Col. 3, Lines 1-8; ambient temperature).

25. **As per Claim 12**, Werling teaches the method set forth above, wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Col. 3, Lines 19-21, 37-41).

26. **As per Claim 13**, Werling teaches the method set forth above, but does not teach that said signals received in said receiving step are 10 GHz or above.

However Rappaport teaches that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Rappaport's method as wireless devices evolve to millimeter wave (mmWave) carrier frequencies (Rappaport: Par. 0039).

27. **As per Claim 15**, Werling teaches the method set forth above wherein said at least one antenna or said another antenna uses phasing (Col. 3, Lines 41-44, 51-54, "phased-array type").

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

28. **As per Claim 16**, Werling teaches the wireless device set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one antenna is different from a receiving pattern of said at least one antenna (Col. 3, Lines 19-21, 37-41).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

29. **As per Claim 19**, Werling teaches the wireless device set forth above wherein said at least one antenna or said another antenna uses phasing (Col. 3, Lines 41-44, 51-54, “phased-array type”).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

30. **As per Claim 20**, Werling teaches the antenna system set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one antenna is different from a receiving pattern of said at least one antenna (Col. 3, Lines 19-21, 37-41).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

31. **As per Claim 23**, Werling teaches the antenna system set forth above wherein said at least one antenna or said another antenna uses phasing (Col. 3, Lines 41-44, 51-54, “phased-array type”).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

32. **As per Claim 24**, Werling teaches the method set forth above,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

33. **As per Claim 27**, Werling teaches the wireless device set for the above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one antenna is different from a receiving pattern used by said at least one antenna or said another antenna used by said receiver to receive said over-the-air signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

34. **As per Claim 30**, Werling teaches an antenna system set forth above,

wherein a directional radiating pattern of said one or more beams radiated from said at least one antenna is different from a receiving pattern used by said at least one antenna or said another antenna used by said receiver to receive said signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

35. **As per Claim 33**, Werling teaches the method set forth above, but does not teach that the at least one antenna operates on multiple bands.

However, Rofougaran teaches that at least one antenna operates on multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Rofougaran's method to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

36. **As per Claim 34**, Werling teaches the wireless device set forth above, but does not teach that the at least one antenna operates on multiple bands.

However, Rofougaran teaches that at least one antenna operates on multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Rofougaran's device to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

37. **As per Claim 35**, Werling teaches the antenna system set forth above, but does not teach that the at least one antenna operates on multiple bands.

However, Rofougaran teaches that at least one antenna operates on multiple bands (Par. 0022, 0023, 0026, 0036, 0048).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Rofougaran's system to increase the data rate capabilities (Rofougaran: Par. 0036).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown

to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

38. **Claims 25, 28 and 31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rofougaran (US 20080318619), Brown (US 20070247385) and Smulders ("Exploiting the 60 GHz Band for Local Wireless Multimedia Access: Prospects and Future Directions", IEEE Communications Magazine; January 2002).**

39. **As per Claim 25**, Werling teaches the method set forth above, but does not teach it further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said another antenna.

However, Smulders teaches a method of wireless communication (Page 140, Introduction), the method further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said another antenna (Page 145; "Dual-Band Operation", column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Smulders method for

cost reduction, processing efficiency and power efficiency (Smulders: Page 145; "Dual-Band Operation", column 2, last paragraph).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

40. **As per Claim 28**, Werling teaches the wireless device set forth above, but does not teach that said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and using over-the-air signals received by at least one of said at least one antenna or said another antenna.

However, Smulders teaches a device for wireless communication (Page 140, Introduction), wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and using over-the-air signals received by at least one of said at least one antenna or said another antenna (Page 145; "Dual-Band Operation", column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Smulders device for cost

reduction, processing efficiency and power efficiency (Smulders: Page 145; "Dual-Band Operation", column 2, last paragraph).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

41. **As per Claim 31**, Werling teaches the steerable antenna system set forth above, but does not teach that the antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said another antenna.

However, Smulders teaches a system for wireless communication (Page 140, Introduction), wherein the antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one antenna and signals received by at least one of said at least one antenna or said another antenna (Page 145; "Dual-Band Operation", column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Smulders system for cost

reduction, processing efficiency and power efficiency (Smulders: Page 145; “Dual-Band Operation”, column 2, last paragraph).

42. **Claims 14, 18, 22, 26, 29 and 32 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rofougaran (US 20080318619), Brown (US 20070247385) and Kezys (US 20060084395)**

43. **As per Claim 14**, Werling teaches the method set forth above, but does not teach the method further comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a method for avoiding radiation of a user or structure by a wireless device (Par. 0002, 0016), the method comprising a step of receiving signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the step of Smulders method to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

44. **As per Claim 18**, Werling teaches the wireless device set forth above, but does not teach that said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a wireless device for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Smulders device to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

45. **As per Claim 22**, Werling teaches the antenna system set forth above but does not teach that said receiver using said at least one antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a system for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver using said at least one antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Smulders system to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

46. **As per Claim 26**, Werling teaches the method set forth above, but does not teach that said step of receiving signals with said at least one antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a method for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said step of receiving signals with said at least one antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Smulders method to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

47. **As per Claim 29**, Werling teaches the wireless device set forth above, but does not teach that said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a wireless device for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Smulders device to

provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

48. **As per Claim 32**, Werling teaches the antenna system set forth above, but does not teach that said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a system for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Smulders system to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

Werling does not teach that the at least one antenna is a steerable antenna.

However, Brown teaches a steerable antenna that could be used in a wireless device (Par. 0003, 0040, Fig. 2 and 11).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the at least one antenna of Werling with the antenna of Brown

to have a phased array antenna that provides enhanced functionalities (Brown: Par. 0003).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HELENA SERAYDARYAN whose telephone number is (571)270-0706. The examiner can normally be reached on M-Th, 7:30-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tashiana Adams can be reached on (571)270-5228. 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 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.

/HELENA SERAYDARYAN/

Examiner, Art Unit 3648

/TASHIANA ADAMS/

Supervisory Patent Examiner, Art Unit 3648

Notice of References Cited	Application/Control No. 13/966,853	Applicant(s)/Patent Under Reexamination RAPPAPORT, THEODORE S.	
	Examiner HELENA SERAYDARYAN	Art Unit 3648	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2007/0247385 A1	10-2007	Brown; Forrest J.	H01Q13/10	343/770
*	B	US-2008/0318619 A1	12-2008	Rofougaran; Ahmadreza (Reza)	G06F13/4234	455/550.1
	C	US-				
	D	US-				
	E	US-				
	F	US-				
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	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.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	104	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2016/04/01 13:02
S2	218	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:02
S3	1	S2 and ((steerable adj antenna) with sensors)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S4	1748	342/368.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S5	3044	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S6	2704	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S7	4870	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S8	6373	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S10	23279	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S11	196	steer$4 with sensor with phone	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:47
S14	36859	S5 or S6 or S7 or S8 or S10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49

S16	775	steer$4 with sensor with (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S17	11	S16 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S18	6	S14 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S19	3	"52780741".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/11 16:51
S20	1533	S14 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S21	452	S20 and (cellphone or phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S22	77	S20 and (cellphone or phone)S21 and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S23	1	S22 and (steer$4 or redirect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:55
S24	73	S22 and (steer$4 or redirect$4 or direct$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:56
S25	1	2014-T60821.NRAN.	DERWENT	AND	ON	2016/04/11 16:57
S26	19336	((steer$4 or redirect$4 or direct or direction or directionality) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S27	41	S14 and S26	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S28	25566	((steer$4 or redirect$4 or direct or direction or directionality or pattern) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:33
S29	79	S14 and S28	US-PGPUB; USPAT; USOCR; FPRS;	AND	ON	2016/04/11 17:34

			EPO; JPO; DERWENT			
S30	27	H01Q1/245.cpc. and steer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:35
S31	277	H01Q1/245.cpc. and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:49
S32	1058	steer$4 with antenna with mobile	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/12 09:08
S33	5	"9529117".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/12 09:34
S34	2	(US-20080242349-$).did. or (US-6456856-$).did.	US-PGPUB; USPAT	AND	ON	2016/04/12 10:53
S35	40	342/368.ccls. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:57
S36	91	H01Q1/245.cpc. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:59
S37	13356	(multiple or dual) near2 (frequency adj2 band)	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S38	5187	S37 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:45
S39	4852	S38 and communicat$4	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:46
S40	3177	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S41	2962	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S42	5154	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S43	6655	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S44	25291	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48

S45	39574	S40 or S41 or S42 or S43 or S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 10:48
S46	705	S39 and S45	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/14 10:48
S47	1	("2013/0328723").URPN.	USPAT	AND	ON	2016/11/14 14:56
S48	224	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S49	89	S48 and GHz and (dual or multiple)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/14 16:59
S50	29	("2010/0060531").URPN.	USPAT	AND	ON	2016/11/15 10:28
S51	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 10:42
S52	38	("2003/0210203").URPN.	USPAT	AND	ON	2016/11/15 10:59
S53	21	S52 and GHz	USPAT	AND	ON	2016/11/15 10:59
S54	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S55	13	("2006/0084395").URPN.	USPAT	AND	ON	2016/11/15 11:05
S56	16	("2009/0011806").URPN.	USPAT	AND	ON	2016/11/15 11:11
S59	34	("2004/0214621").URPN.	USPAT	AND	ON	2016/11/15 11:12
S60	55	("5229975" | "5274844" | "5541609" | "5729238" | "5805067" | "5924020" | "5956626" | "5995862").PN. OR ("6456856").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:19
S61	4	("2008/0242349").URPN.	USPAT	AND	ON	2016/11/15 11:27
S62	24	("2008/0018543").URPN.	USPAT	AND	ON	2016/11/15 11:28
S63	0	("2013/0342416").URPN.	USPAT	AND	ON	2016/11/15 11:32
S64	4	("2009/0124306").URPN.	USPAT	AND	ON	2016/11/15 11:33
S65	9	("20070008235" | "20080204240" | "20130135171" | "5983119" | "7492254" | "8106836").PN. OR ("8649833").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:35
S66	3	("2010/0081491").URPN.	USPAT	AND	ON	2016/11/15 11:38
S67	0	("2008/0150798").URPN.	USPAT	AND	ON	2016/11/15 11:39
S68	6	("2007/0057843").URPN.	USPAT	AND	ON	2016/11/15 11:40
S69	46	("4352109" | "4518968" | "4700194" | "4868576" | "5257033" | "5612705").PN. OR ("6421016").URPN.	US-PGPUB; USPAT; USOCR	AND	ON	2016/11/15 11:41

S71	7	(mmw or (milimeter adj wave)) same (multi?band or (multiple adj band) or (dual adj band) or dual-band) same antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:09
S72	23	(mmw or (milimeter adj wave)) same2 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same2 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:10
S73	19	S72 and GHz	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:11
S74	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR	AND	ON	2017/06/21 10:13
S76	23	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band) same3 antenna	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:14
S77	46	(mmw or (milimeter adj wave)) same3 (multi?band or (multiple adj band) or (dual adj band) or dual-band)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/06/21 10:15
S78	4	("2014/0321282").URPN.	USPAT	AND	ON	2017/06/21 10:52
S79	2	US-6556836-$.did.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 08:04
S80	2	"25301096".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/18 08:07
S81	4	("2002/0164957").URPN.	USPAT	AND	ON	2017/07/18 09:12
S82	4401	(millimeter adj wave) same (cellular or mobile or cellphone or communication)	USPAT	AND	ON	2017/07/18 09:34
S84	944	S82 and dual	USPAT	AND	ON	2017/07/18 09:34
S85	184	((millimeter adj wave) same wireless) and (multiband or (dual adj band))	USPAT	AND	ON	2017/07/18 13:54
S86	563	(cellphone or (cellular or mobile) adj phone) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:40
S87	563	(cellphone or ((cellular or mobile) adj phone)) and (steerable near2 antenna)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/18 16:49
S88	2	"40137022".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2017/07/19 11:04
S89	0	H01Q1/245.cpc. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15
S90	0	342/368.ccls. and @pd>"20171123"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2017/07/19 14:15

7/19/2017 2:18:54 PM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13966853	RAPPAPORT, THEODORE S.
	Examiner	**Art Unit**
	HELENA SERAYDARYAN	3648

✓	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	04/12/2016	11/02/2016	07/19/2017						
	1	✓	✓	✓						
	2	✓	-	-						
	3	✓	✓	✓						
	4	✓	✓	✓						
	5	✓	✓	✓						
	6	✓	✓	✓						
	7	✓	✓	✓						
	8	✓	✓	✓						
	9	✓	✓	✓						
	10	✓	✓	✓						
	11	✓	✓	✓						
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	13		✓	-						
	14		✓	✓						
	15		✓	✓						
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	29		✓	✓						
	30		✓	✓						
	31		✓	✓						
	32		✓	✓						
	33			✓						
	34			✓						
	35			✓						

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13966853	RAPPAPORT, THEODORE S.
	Examiner	Art Unit
	HELENA SERAYDARYAN	3648

CPC- SEARCHED		
Symbol	Date	Examiner
H01Q1/245	4/11/2016	H.S.
H01Q1/245 (updated)	11/2/2016	H.S.
H01Q1/245 (updated)	7/19/2017	HS

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
342	368	4/1/2016	H.S.
342	368 (updated)	11/2/2016	H.S.
342	368 (updated)	7/19/2017	HS

* 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
Inventor Name Search in PALM	4/1/2016	H.S.
Inventor Name Search in EAST	4/1/2016	H.S.
Text Search in EAST	4/11/2016	H.S.
Consulted with Primary G. Issing	4/1/2016	H.S.
Consulted with G. Issing	11/2/2016	H.S.
Consulted with G. Issing	7/19/2017	HS

INTERFERENCE SEARCH

/HELENA SERAYDARYAN/ Examiner.Art Unit 3648	

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

/HELENA SERAYDARYAN/ Examiner.Art Unit 3648	

PTO/SB/30 (07-14)
Approved for use through 07/31/2016 OMB 0651-0031
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Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	13/966853
Filing Date	August 14, 2013
First Named Inventor	Rappaport
Art Unit	3648
Examiner Name	Seraydaryan
Attorney Docket Number	08610010PA

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, to any international application that does not compy with the requirements of 35 U.S.C 371, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO on page 2.)

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      ii. ☐ Other _____

   b. ☑ Enclosed

      i. ☑ Amendment/Reply

      ii. ☐ Affidavit(s)/ Declaration(s)

      iii. ☐ Information Disclosure Statement (IDS)

      iv. ☐ Other _____

2. Miscellaneous

   a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. ☐ Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 50-2041.

      i. ☑ RCE fee required under 37 CFR 1.17(e)

      ii. ☑ Extension of time fee (37 CFR 1.136 and 1.17)

      iii. ☐ Other _____

   b. ☐ Check in the amount of $ _____ enclosed

   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

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.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/mel/		
Name (Print/Type)	Michael E. Whitham	Date	March 22, 2017
		Registration No.	32,635

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature			
Name (Print/Type)		Date	

This collection of information is required by 37 CFR 1.114. 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: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Rappaport

Serial No. 13/966,853

Filed August 14, 2013

For STEERABLE ANTENNA DEVICE

Confirmation No. 2489

Group Art Unit 3648

Examiner Seraydaryan

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

PETITION FOR A ONE MONTH EXTENSION OF TIME AND AMENDMENT UNDER 37 C.F.R. 1.114

Sir:

Applicant hereby petitions for a one month extension of time to respond to the office action mailed November 23, 2016. A request for continued examination (RCE) is concurrently filed herewith. The commissioner is authorized to charge attorney's deposit account 50-2041 (Whitham, Curtis & Cook) for the extension fee, the RCE fee, and any other fee required to gain entry and consideration of this amendment.

In response to the office action mailed November 23, 2016, please amend the application as follows:

Amendments to the Claims: begin on page 2

Remarks: begin on page 12

Listing of the Claims:

The following is a complete listing of all the claims in the application, with an indication of the status of each:

1. (currently amended) A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna ~~which radiates at 10 gigahertz (GHz) or above~~, comprising the steps of:

detecting, using one or more sensors, one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device;

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna ~~which radiates at 10 GHz or above~~ to radiate in one or more directions which are not in said zones or spans of directions, wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions,

wherein said at least one steerable antenna operates on one or multiple bands and radiates at one or more frequencies in the range of 10 GHz to 500 GHz, and

wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time~~; and~~

~~receiving signals on said at least one steerable antenna or another antenna~~.

2. (canceled)

3. (original) The method of claim 1, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to one or more of the proximity of a user or orientation of user with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer;

detecting heat from a human user with at least one heat sensor; and

detecting touch or proximity of a user's skin or clothing with at least one capacitive sensor.

4. (currently amended) A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect one or more parameters of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;

one or more processors communicatively coupled to said one or more sensors;

at least one steerable antenna communicatively coupled to said one or more processors

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,

wherein said at least one steerable antenna radiates at one or more frequencies in the range of ~~at~~10 GHz to 500 GHz ~~or above~~; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said one or more parameters;

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions of said particular directions which are not in said zones or spans of directions,

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions,

wherein said at least one steerable antenna operates on one or multiple bands, and

wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time; and

a receiver for receiving over-the-air signals ~~on said at least one steerable antenna or another antenna~~.

5. (previously presented) The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

6. (original) The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, heat sensors, gyroscopes, light or motion detectors, capacitive detectors, microphones, and ultrasound sensors or transducers.

7. (original) The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

8. (currently amended) A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect at least one parameter of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;

at least one steerable antenna that radiates at one or more frequencies in the range of 10 GHz to 500 GHz communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna,

wherein said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions,

wherein said at least one steerable antenna operates on one or multiple bands; and

a receiver for receiving signals ~~on said at least one steerable antenna or another antenna~~.

9. (previously presented) The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

10. (original) The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, heat sensors, gyroscopes, light or motion detectors, capacitive detectors, microphones, and ultrasound transducers.

11. (original) The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

12. (previously presented) The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

13. (Canceled)

14. (Currently amended) The method of claim 1 further comprising a ~~wherein said~~ step of receiving signals ~~with said at least one steerable antenna or another antenna receives said signals~~ arriving from one or more directions that are within said zones or spans of directions of said user or structure.

15. (previously presented) The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

16. (currently amended) The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna ~~or said another antenna used by said receiver to receive said over-the-air signals~~.

17. (canceled)

18. (previously presented) The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

19. (previously presented) The wireless device of claim 4 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

20. (currently amended) The steerable antenna system of claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one

steerable antenna ~~or said another antenna used by said receiver to receive said signals~~.

21. (canceled)

22. (previously presented) The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

23. (previously presented) The steerable antenna system of claim 8 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

24. (Currently amended) The ~~A~~ method of claim 1, ~~for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna which radiates at 10 gigahertz (GHz) or above, comprising the steps of:~~

~~detecting, using one or more sensors, one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device;~~

~~determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and~~

~~adjusting one or more beams of said at least one steerable antenna which radiates at 10 GHz or above to radiate in one or more directions which are not in said zones or spans of directions, and~~

~~wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time;~~

~~receiving signals on said at least one steerable antenna or another antenna,~~

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

25. (previously presented) The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna.

26. (previously presented) The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

27. (currently amended) The ~~A~~ wireless device of claim 4, ~~for avoiding radiation of a user or structure, comprising:~~

~~one or more sensors configured to detect one or more parameters of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;~~

~~one or more processors communicatively coupled to said one or more sensors;~~

~~at least one steerable antenna communicatively coupled to said one or more processors,~~

~~wherein said at least one steerable antenna radiates at 10 GHz or above; and~~

~~a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:~~

~~receiving signals from said one or more sensors pertaining to said one or more parameters;~~

~~using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and~~

~~adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions,~~

~~wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions,~~

~~wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time; and~~

~~a receiver for receiving over-the-air signals on said at least one steerable antenna or another antenna,~~

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said another antenna used by said receiver to receive said over-the-air signals.

28. (Previously presented) The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said another antenna.

29. (Previously presented) The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

30. (Currently amended) The ~~A~~ steerable antenna system of claim 8, ~~for avoiding radiation of a user or structure by a wireless device, comprising:~~

~~one or more sensors configured to detect at least one parameter of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;~~

~~a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;~~

~~at least one steerable antenna communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions,~~

~~wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna; and~~

~~a receiver for receiving signals on said at least one steerable antenna or another antenna,~~

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said another antenna used by said receiver to receive said signals.

31. (previously presented) The steerable antenna system of claim 30 wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna.

32. (previously presented) The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

33. (new) The method of claim 1 wherein the at least one steerable antenna operates on multiple bands.

34. (new) The wireless device of claim 4 wherein the at least one steerable antenna operates on multiple bands.

35. (new) The steerable antenna system of claim 8 wherein the at least one steerable antenna operates on multiple bands.

REMARKS

The application has been simplified by canceling a number of claims to accelerate the application to grant. The applicant reserves the right to pursue additional claims supported by the patent specification in one or more continuing applications, including those canceled in this action.

In response to the drawing requirement, attached to this response is a drawing sheet which amends Figure 1 to include the label "Prior Art".

Claims 13, 17, 21 have been canceled. Claims 33-35 have been added. Claims 1, 4, 8, 14, 20, 24, 27, and 30 have been amended. The application now includes claims 1, 3-12, 14-16, 18-20, and 22-35.

Independent claims 1, 4, and 8 are amended to specify that the at least one steerable antenna transmits from 10 GHz to 500 GHz. This amendment addresses the enablement rejection. The Examiner's attention is directed to paragraphs [0042] and [0043] of the application which specifically discuss use of transmissions at one or more frequencies in the range of 10 GHz to 500 GHz. Furthermore, the Examiner's attention is particularly directed to Figures 7 and 8 of the application, as opposed to Figures 2-4 of the application (mentioned in the office action) for review of the steerable antenna. Furthermore, the text of paragraph [0029] makes clear that the steerable antenna is one that may steer or direct its energy in particular directions while providing nulls or dead zones in other directions. Each of independent claims 1, 4, and 8 has been amended to include this language. Moreover, Figure 8 shows a particular example of the beams being directed away from the user by a steerable antenna.

Flow diagrams are not required when the process has only three basic steps. The patent application shows in Figure 8 what is happening, and the patent specification pertaining to Figure 8 specifically describes the three step operation of the at least one steerable antenna.

To address the indefiniteness rejection, reference to "said at least one steerable antenna or another antenna" has been canceled from the mentioned claims or has been revised.

Claims 1, 3-13, 15-17, 19-21, 23-25, 27, 28, 30, and 31 were rejected as being obvious over U.S. Patent 6,456,856 to Werling in view of U.S. Patent Publication 2010/0060531 to Rappaport. Claims 25, 28, and 31 were rejected as being obvious over the Werling/Rappaport combination further in view of Smulders "Exploiting the 60 GHz Band..." IEEE Communications, 2002. Claims 14, 18, 22, 26, 29, and 32 were rejected as being obvious over Werling/Rappaport in view of U.S. Patent Publication 2006/0084395 to Kezys. These rejections are all traversed.

Rappaport, which is the parent of this continuation-in-part application, has been relied upon for showing operations at 10 GHz or more. Importantly, though, Rappaport has not been relied upon as showing a steerable antenna where the beam pattern is adjusted "to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding radiating in particular directions or spans of directions" based on the position of a user or blocking object/structure. The Examiner must realize that the teaching for such a "steerable antenna with detecting, determining, and adjusting steps being performed multiple times as said one or more parameters change over time" appears only in the present continuation-in-part application, and does not appear in the parent Rappaport cited by the Examiner.

Upon inspection, the reference Rappaport, relied upon by the examiner, clearly does not provide the teaching in the present continuation-in-part application. A simple comparison of Rappaport to the present application shows that Rappaport does not include Figures 7 and 8 of the present application or the associated text pertaining to Figures 7 and 8.

The Examiner is thus relying on the other references (other than Rappaport) as meeting most of the requirements of the claims. As shown subsequently, the other references do not meet these requirements, and these rejections are in error.

Central to the Examiner's basic premise is that Werling shows a steerable antenna. However, there is no teaching whatsoever in Werling that would show

someone skilled in the art how to enable, practice or implement the present invention. The Examiner's reasons for rejection are now traversed, as the independent claims (e.g. Claim 1, etc.) have been modified to include the specific limitation:

said at least one steerable antenna is configured to steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and wherein said adjusting step adjusts the direction of energy to one or more of said particular directions while avoiding said zones or spans of directions.

The Examiner should be satisfied that Werling, Smulders, and Kezys wholly lack the feature of being able to detect, through the use of one or more sensors, parameters that pertain to either the wireless device or the physical relationship of a user's or structure's physical relationship to the wireless device, while further being able to use those parameters to determine the directions of users or structures, and to further be able to adjust the antenna patterns of the wireless device multiple times as environmental parameters change over time, so that the antenna patterns formed through an adjusting step allow the present invention to provide energy to one or more particular directions while avoiding other particular zones or spans of directions.

While the Examiner argues that Werling teaches the use of sensors with a steerable antenna, Werling specifically **does not teach a steerable antenna as claimed herein, and does not give any teaching whatsoever** to how a steerable antenna is implemented to provide an adaptable antenna pattern as now claimed, or how antenna beam patterns would be adjusted to specifically avoid certain directions while favoring other directions in the beam pattern, by detecting parameters using one or more sensors, where one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device would be used through multiple adjustments to change the beam patterns over time, such that the beam pattern is consistently able to specifically avoid certain directions while also changing to accentuate other directions.

To prove these points, the Examiner must distinguish how Werling teaches its limited approaches to how to detect and adapt to the presence of a human being, as well as Werling's reliance upon discrete directional antennas that have fixed antenna patterns (please see Abstract, Figures 1, 2, and 3 and column 3: 1-15 of Werling). Werling uses measurements from the device to change the power levels of one or more of these fixed-pattern directional antennas. Werling does not seek to identify the physical relationship of the obstruction or user with the device, such that the wireless device can then determine a zone or span of directions that correspond with the user or obstruction. That is, Werling never teaches the use of sensors for detecting parameters for "determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna." A telling fact is that Werling never provides any diagrams that show the cellphone in the proximity of a person or obstructing object, and never teaches or shows how the multiple directional antennas in Werling would be able to provide a beam pattern that can be changed in time based on the moving positions of the user or structures or new desirable pointing locations, such that the beam pattern could avoid a user or obstruction over a zone or span while also accentuating energy in other particular directions over time. As shown below, Werling merely teaches how to change the power to one or more directional antenna elements if the case is touched. Werling completely lacks the key aspect of determining the physical relationship of users or objects from the antenna based on parameters that may be computed from sensory input while holistically adjusting the radiated antenna pattern over time to specifically avoid certain zones or spans while accentuating other directions as provided in the present invention.

Werling merely compares the sensor measurement to a table look up in memory. Werling then reduces the power at the particular antennas that are sensed (see Abstract, column 2, lines 54-68 and column 3, lines 1-15). This is an entirely rigid and somewhat passive approach where powering up and powering down an antenna is used, without any consideration for determining the relative physical relationships of objects from the cellphone such that the span of directions may be

computed for where a user or structure might or might not be in relation to the device's antenna. Werling uses proximity measurements to make a very course, almost binary, estimate of the surrounding environment (e.g. whether a finger is touching the phone or not), and then merely changes the power level applied to a particular antenna. Werling has no mechanism to steer or direct an antennas in particular directions over time while providing nulls or dead zones in other directions, and also does not teach the ability to determine zones or spans of directions from sensory data or from the wireless device that would correspond to where a user or structure might or might not be. Thus, it would not be possible for Werling to obviate the present direction which allows an adaptive beam to minimize radiation in a swath of directions while accentuating radiation in other swaths of directions based on sensory inputs.

The Werling device may appear superficially similar in terms of its purpose, but its design and operation is entirely different than that which is described and claimed in the present application. First, Werling specifically directs his invention to 3G (third generation) cellular technologies such as CDMA and UMTS (See Werling at column1, line 42). At the time of 3G and Werling, it was known to those skilled in the art that the US cellular frequencies were limited to the range of 0.9 GHz to 2.1 GHz (see generally accepted textbooks of the era, or the following websites that address 3G frequencies):

https://en.wikipedia.org/wiki/Cellular_frequencies_in_the_US

http://www.droid-life.com/2015/02/05/us-wireless-carrier-bands-gsm-cdma-wcdma-lte-verizon-att-sprint-tmobile/

https://en.wikipedia.org/wiki/UMTS_(telecommunication)

At frequencies of 1 -2 GHz, the wavelengths of radio waves are on the order of the size of a cellphone, which is in contrast to the present invention that operates at frequencies of 10 GHz to 500 GHz and where the wavelengths are limited to

much smaller wavelengths -- thereby permitting the fabrication of multiple element antenna arrays that can provide distinct pattern nulls (lower signal power) in some directions and more higher signal power in particular directions from a cellphone or other wireless device. The present invention contemplates the ability to offer pattern differentiation in a time-varying environment that could not have practically been implemented and would not have been thought necessary or even commercially viable in a mobile device at the time of Werling.

There would not have been any unmet need at the time of Werling to contemplate the ability to adaptively adjust and steer a beam pattern for avoidance of particular zones as taught in the present application. Werling would only have been needed to avoid radiating a person or wasting transmitter power on a particular antenna element if it was covered up by a person's finger, for example, without the need to determine the proximity of the user's head or the location of another nearby person, a person who was blocking the signal path, or determining the proximity where a building wall could block the signal in order to improve communication performance. Unlike frequencies in the 1-2 GHz range used by the mobile industry (3G) at the time of Werling, frequencies above 10 GHz suffer much greater attenuation due to signal blocking of users and nearby objects since diffraction loss and penetration loss is much greater as the wavelength shrinks (e.g. when moving to frequencies at or above 10 GHz). Thus, it makes perfect sense that Werling gives no teaching of the current invention—it could not have been anticipated at the time.

The Examiner seems to be relying upon a single sentence that cannot be possibly relied upon by one skilled in the art to obviate the present invention, when Werling merely mentions "gigahertz domain" (Werling, Column 3, line 44) and "phased array type" at (Werling, Column 3, line 55) using a 1994 book for mobile telephone antennas. No one could possibly know that from these brief phrases that Werling meant to teach the details of the specification and claims of the present invention. No one could reasonably infer a frequency range of "10 GHz to 500 GHz" where Werling just mentions "gigahertz domain" in conjunction with "3G"

and "UMTS" and "CDMA". Indeed, cellular networks around the world were just beginning to use or contemplate using frequencies around and slightly above 2 GHz at the time of Werling, certainly they were not considering the use of spectrum from 10 GHz to 500 GHz. Similarly, no one could possibly construe the present invention's teaching and proposed claim limitations which involve multiple adjustments from parameters determined from sensor measurements or the device that help determine the physical relationship of a user or blocking object, and then perform multiple detecting, determining, and adjusting steps, from Werling's very brief mention of "phased-array-type" antennas from a 1994 reference in Werling! The state-of-the- art at the time of Werling could not have contemplated the present invention, *since the viability of millimeter wave mobile wireless communications had not yet been accepted to be viable in cellular environments, and was not available for cellular use.* In fact, the first commercial availability of millimeter wave spectrum for the US mobile industry occurred when the Federal Communications Commission issued its July 2016 Spectrum Frontiers rulemaking that opened up mobile radio spectrum above 24 GHz in the USA. (see: https://www.fcc.gov/document/spectrum-frontiers-ro-and-fnprm)

The Examiner should note that the configuration and operation contemplated by the present invention allows for a more rapid detection of the changing physical relationship of the user or structure in relation to the device's antennas, in response to changes in a person's body position (e.g. change in head movement), changes in the environment (e.g., buildings present, buildings absent, persons blocking the signal nearby, etc.), and gives a more robust solution in that the steerable antenna can shape where transmissions are made and received in the changing environment. This is simply not taught or contemplated by Werling or by any of the other references cited by the Examiner, and would not have been part of the industry's thinking at the time of Werling, so the "jump" made by the Examiner to assume that Werling obviates the present application is simply not accurate in the absence of any such teaching of these features by Werling or the other references cited by the Examiner.

Smulders has no showing of a steerable antenna as it is described in the present invention. Rather, all Smulders does is state that phased arrays can exist at mmWave, and further shows that dual band operation of a wireless modem is possible with the use of two radios each with their own antennas (see the radios and switch between the two radios in the figure in Smulders cited by the Examiner). Smulders does not divulge any details of any antenna structure, and is also silent on the use of sensors, is silent on any determining mechanisms for assessing the zone or span of direction of a user or obstructing object, an is silent on any adjustment mechanisms of the antenna pattern as detailed in the present invention-- he merely mentions dual band operation is possible in the 5 GHz and 60 GHz WiFi bands, but lacks specific teaching pertinent to the present invention.

Kezys is similar to Werling in that it is aimed at providing a plurality of antennas, determining which of the antennas are optimal for operation of the mobile device, and selecting the optimal antennas (see paragraphs [0016] and [0019]). However, there is no teaching Kezys akin to changing an antenna pattern to avoid particular zones or directions, particularly when considering the orientation of the user. Unlike the claimed invention, Kezys primary concern is reception, not transmission.

If the references were to be combined, the undersigned disputing such a combination would be practicable, the combined structure might have two antenna elements for receiving (e.g., Kezys), be able to have switchable dual band operation (Smulders), and be able to power up and power down differently on specific directional antenna elements (Werling). It would wholly lack the salient features presented in the independent claims, and no claims should be deemed obvious for at least this reason alone.

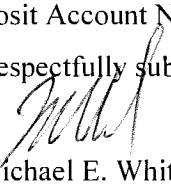
Furthermore, the Examiner should also note that dependent claims 16, 18, 20, and 22, for example, specify particular attributes, e.g., where one is transmitting in particular zones, but receiving from particular zones that were avoided using the steerable antenna. None of the references show such features.

Based on the amendments, claims 1, 3-12, 14-16, 18-20, and 22-35 should be in immediate condition for allowance. Reconsideration and allowance is requested.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

A provisional petition is hereby made for any extension of time necessary for the continued pendency during the life of this application. Please charge any fees for such provisional petition and any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,



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Cellular frequencies in the US

From Wikipedia, the free encyclopedia

Contents

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- 3 Interference and limitations
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United States Carrier Frequency Use

Carrier	2G Frequency in MHz Band name			3G Frequency in MHz Band name			4G LTE Frequency in MHz Band number								
	800	850	1900	850	1700 2100	1900	L700	L700	U700	800	850	1700 2100	1900	2300	2500
	SMR	CLR	PCS	CLR	AWS	PCS	12,17	29	13	26	5	4,66	2,25	30	41
AT&T	No	No	No	UMTS	No	UMTS	Yes	No	No	No	No	Yes	Yes	Yes	No
T-Mobile	No	No	GSM	No	UMTS	UMTS	Yes	No	No	No	No	Yes	Yes	No	No
Sprint	CdmaOne	No	CdmaOne	No	No	CDMA2000	No	No	No	Yes	No	No	Yes	No	Yes
Verizon	No	CdmaOne	CdmaOne	CDMA2000	No	CDMA2000	No	No	Yes	No	No	Yes	Yes	No	No
U.S. Cellular	No	CdmaOne	CdmaOne	CDMA2000	No	CDMA2000	Yes	No	No	No	Yes	Yes	Yes	No	No

Distribution and regulation

The usage of frequencies within the United States is regulated by the Federal Communications Commission (FCC). The US is then divided geographically into a number of Trading Areas. A mobile operator (or other interested parties) must bid on each trading area individually. A bidder can use the frequency spectrum for whatever purpose they want.

The Cellular band occupies 824–849 MHz and 869–894 MHz ranges. To issue cellular licenses, the FCC divided the U.S. into 734 geographic markets called Cellular Market Areas (CMAs) and divided the 40 MHz of spectrum into two, 20 MHz amounts referred to as channel blocks; channel block A and channel block B. A single license for the A block and the B block were made available in each market. The B block of spectrum was awarded to a local wireline carrier that provided landline telephone service in the CMA. The A block was awarded to non-wireline carriers. In 1986, the FCC allocated an additional 5 MHz of spectrum for each channel block, raising the total amount of spectrum per block to the current total of 25 MHz.[1]

The 1850–1990 MHz PCS band is divided into six frequency blocks (A through F). Each block is between 10 MHz and 30 MHz in bandwidth. License (A or B) is granted for Major Trading Areas (MTAs). License (C to F) is granted for Basic Trading Areas (BTAs). License (G), where issued, is granted for Economic Areas (EAs). There are 51 MTAs, 493 BTAs and 175 EAs in the United States.

- A: 1850–1865 MHz and 1930–1945 MHz (30 MHz)
- B: 1870–1885 MHz and 1950–1965 MHz (30 MHz)
- C: 1895–1910 MHz and 1975–1990 MHz (30 MHz, 15 MHz or 10 MHz)
- D: 1865–1870 MHz and 1945–1950 MHz (10 MHz)
- E: 1885–1890 MHz and 1965–1970 MHz
- F: 1890–1895 MHz and 1970–1975 MHz
- G: 1910–1915 MHz and 1990–1995 MHz[2]

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The Advanced Wireless Services (AWS) bands, auctioned in the summer of 2006, were for 1,710–1,755 MHz, and 2,110–2,155 MHz. The spectrum was divided into blocks: A blocks were for Cellular Market Areas, based on existing cellular (1G) licenses, and were 2 × 10 MHz. B and C blocks (2 × 10 MHz and 2 × 5 MHz respectively) were for Basic Economic Areas, larger than CMAs, usually comprising large portions of single states. D, E, and F blocks covered huge areas of the country, typically several states at a time, and covered 2 × 5 MHz for D and E blocks, 2 × 10 MHz for F.[3]

The 700 MHz band was auctioned in early 2008 using spectrum previously used by television stations' analog broadcasts, with Verizon Wireless and AT&T Mobility winning the majority of available spectrum. Qualcomm and Echostar were winners of a significant amount of broadcast-oriented spectrum. Verizon Wireless will use the upper band of the 700 MHz spectrum to deploy their LTE network starting on Dec 5, 2010.

Initially the SMR band could only be used for narrowband wireless technologies such as iDEN technology. In 2004 the FCC developed a new band plan where narrowband operations are provided in 806–816 and 851–861 MHz ranges while wideband operations are allowed in 817–824 MHz and 862–816 MHz separated from narrowband services by a 1 MHz wide guard band.[4] The wideband services part of the SMR band was called ESMR (Enhanced SMR). The new band plan allowed Sprint Corporation to deploy CDMA and LTE technologies on this band. The transition to the new band plan is still ongoing as of August 2016 although it's reaching its final stages.[5]

Interference and limitations

- Professional wireless microphones used the 700 MHz band until 2010 when they were made illegal, but equipment still exists in use that may interfere with 3G and 4G technologies.[6]
- Due to immediate adjacency to channel 51 lower 700 MHz A block license holders were prohibited to use it within channel 51 station service areas. Initially almost one third of US population was in the channel 51 exclusion zones. As of August 2016 T-Mobile US has cleared almost all exclusion zones by either subsidizing relocation of channel 51 stations or by obtaining a permission to use 700 A block while the stations still operate on channel 51.[7]

See also

Detailed lists:

- Bands by technology:
  - GSM frequency bands
  - UMTS frequency bands
  - LTE frequency bands

Other articles:

- Comparison of mobile phone standards
- 3GPP
- Roaming
- Dual-band
- Tri-band
- Quad-band
- 700 MHz wireless spectrum auction
- Microwave
- 4G
- 3GPP Long Term Evolution (LTE)
- Title 47 of the Code of Federal Regulations
- List of United States wireless communications service providers

References

1. "Cellular Service". FCC. Retrieved 2016-08-17.
2. http://www.fcc.gov/encyclopedia/broadband-personal-communications-service-pcs
3. AWS References (https://slashdot.org/~squiggleslash/journal/145577)
4. "Improving Public Safety Communications in the 800 MHz Band" (PDF). FCC. 2004-06-06. Retrieved 2016-08-14.
5. "Sprint's Status Report on 800 MHz Band Reconfiguration" (PDF). FCC. 2016-08-01. Retrieved 2016-08-17.
6. https://www.fcc.gov/encyclopedia/wireless-microphones

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7. "Map of T-Mobile's 700 MHz spectrum". Retrieved 2016-08-07.

External links

- Wireless Advisor (http://www.wirelessadvisor.com/)
- FCC (http://www.fcc.gov/)
- New bands considered by FCC (http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-305A1.pdf)
- Spectrum Frequency Chart (http://www.qrctech.com/assets/Frequency-Chart/19Nov201024x36FreqChart.pdf) - most common forward link (base station to mobile) frequencies and channelization
- Frequencies by Provider (https://www.wilsonamplifiers.com/frequencies-by-provider)

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Categories: Radio resource management

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NEXT STORY
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by Kellex on Feb 5, 2015 @droid_life

Cheat Sheet: US Wireless Carrier Band:

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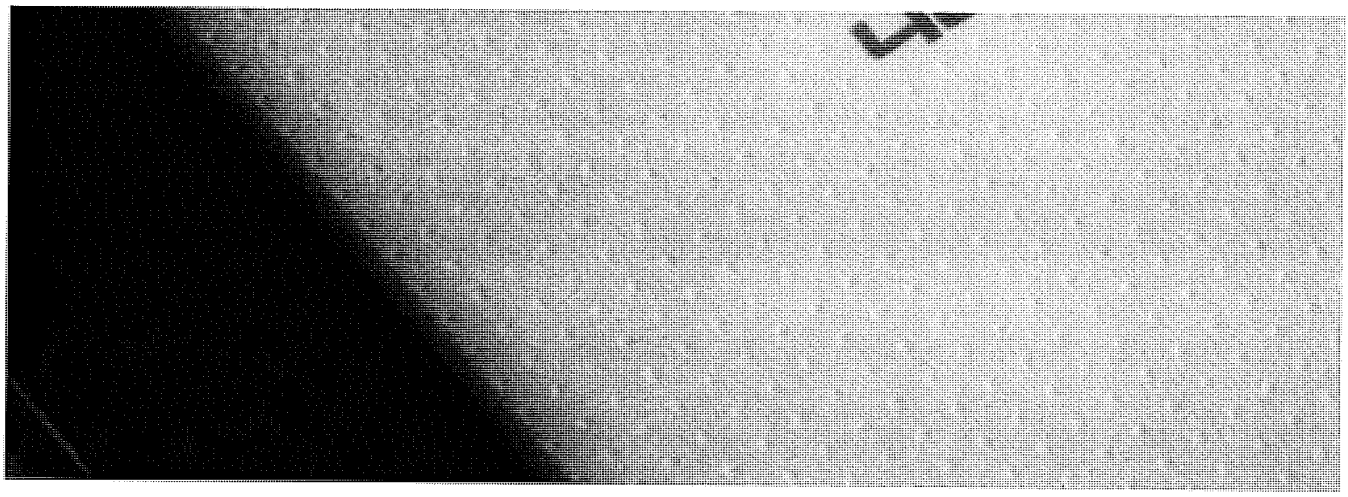

"Does this unlocked phone work with my carrier?" "What are the US wireless carrier bands?"

How many times have you asked that over the last couple of years? I know we ask it often. Ir prepaid services are very attractive, and more and more phones are available as **unlocked** m on a variety of **LTE and GSM/CDMA bands**, this a question you should be able to easily find a since there doesn't seem to be a quick reference guide for figuring out if a particular unlocke on a specific carrier's network (trust me, I've looked), we decided to throw one together.

Below, we have given you a quick chart that shows each of the five major US carriers (**Verizo T-Mobile, Sprint, and US Cellular**), along with 3G and 4G LTE bands and frequencies. By no m most in-depth wireless carrier band and frequency chart, but it should help when you go to b unlocked phone.

If for some reason you can't see the full table below, you can download an image of it here.

CARRIER	NETWORK	3G BANDS	3G FREQUENCIES
AT&T	GSM/UMTS/HSPA+	2, 5	1900, 850
VERIZON	CDMA	0, 1	850, 1900
T-MOBILE	GSM/UMTS/HSPA+	2, 4	1900, 1700/2100
SPRINT	CDMA	10, 1	800, 1900
US CELLULAR	CDMA	0, 1	850, 1900

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Pete B • 2 years ago

http://www.willmyphonework.... is a pretty good site to figure out if your specific phone is c even specific model number, then which network you want to check its compatibility on. S

29 ^ v • Share ›

AngryBadger → Pete B • 2 years ago

Damn, that is good site. thanks for the share.

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Picaso86 → AngryBadger • 2 years ago

G2 for Verizon works with almost every carrier except US Cellular, Boost M

3 ^ v • Share ›

Cole → Picaso86 • 2 years ago

Does the LTE work? Cuz more of Verizon's phone are unlocked glol

1 ^ v • Share ›

Rob Paek → Cole • 2 years ago

It will not work by just putting your SIM Card in. Your statement sou

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Picaso86 → Cole • 2 years ago

Yes! you have to install the Cricket rom from XDA.

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Dimitre Guenov • 2 years ago

As a side note: you cannot generalize Verizon as having Band 4 (1700 f). They use MOR with AT&T. In my area, T-Mobile holds A+B+C, while Verizon holds D+E+F. That is exactly support specific blocks. It covers AWS-1 (A-F). Doesn't matter what the carrier uses.

Also, Verizon holds 700 Upper C, while AT&T holds Lower C. That 700 ABC thing will con to Band 12 now as well, eliminating Band 17 from their device portfolio.

6 ^ v • Share ›

Trevor • 2 years ago

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About Droid Life

We consider ourselves to have the greatest Android community in the world, here at Droid Life. We talk general news, feature apps, review phones, and even teach you how to hack a little. But most importantly, there is no place on the internet that has the reader participation that we do and consider ourselves to be completely community driven. If you were looking for the best place to learn about Android and talk with like-minded folks about all things tech, then Droid Life is for you.

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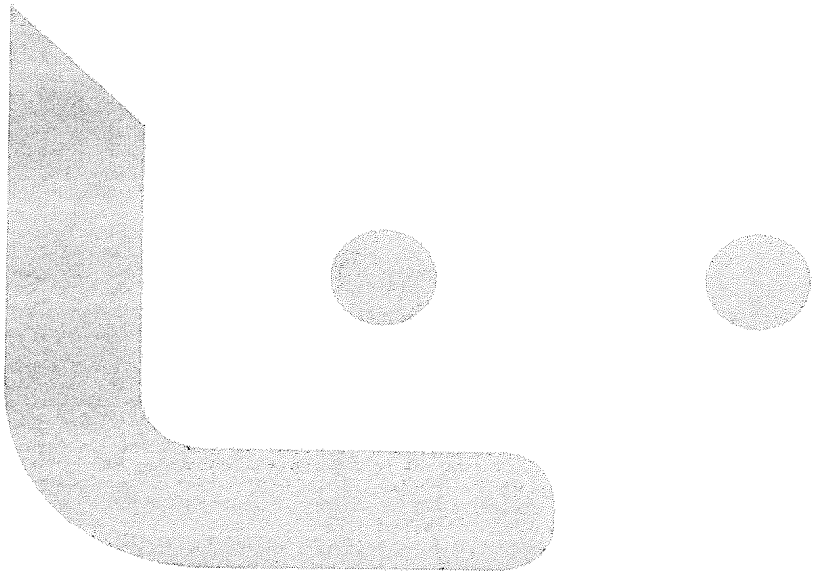

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UMTS (telecommunication)

From Wikipedia, the free encyclopedia

The **Universal Mobile Telecommunications System** (**UMTS**) is a third generation mobile cellular system for networks based on the GSM standard. Developed and maintained by the 3GPP (3rd Generation Partnership Project), UMTS is a component of the International Telecommunications Union IMT-2000 standard set and compares with the CDMA2000 standard set for networks based on the competing cdmaOne technology. UMTS uses wideband code division multiple access (W-CDMA) radio access technology to offer greater spectral efficiency and bandwidth to mobile network operators.

UMTS specifies a complete network system, which includes the radio access network (UMTS Terrestrial Radio Access Network, or UTRAN), the core network (Mobile Application Part, or MAP) and the authentication of users via SIM (subscriber identity module) cards.

The technology described in UMTS is sometimes also referred to as Freedom of Mobile Multimedia Access (FOMA)[1] or 3GSM.

Unlike EDGE (IMT Single-Carrier, based on GSM) and CDMA2000 (IMT Multi-Carrier), UMTS requires new base stations and new frequency allocations.

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Features

UMTS supports maximum theoretical data transfer rates of 42 Mbit/s when Evolved HSPA (HSPA+) is implemented in the network.[2] Users in deployed networks can expect a transfer rate of up to 384 kbit/s for Release '99 (R99) handsets (the original UMTS release), and 7.2 Mbit/s for High-Speed Downlink Packet Access (HSDPA) handsets in the downlink connection. These speeds are significantly faster than the 9.6 kbit/s of a single GSM error-corrected circuit switched data channel, multiple 9.6 kbit/s channels in High-Speed Circuit-Switched Data (HSCSD) and 14.4 kbit/s for CDMAOne channels.

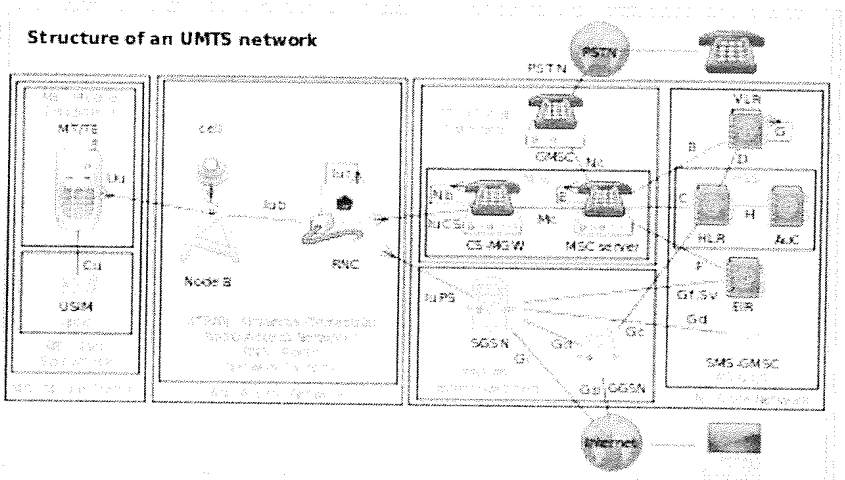
Since 2006, UMTS networks in many countries have been or are in the process of being upgraded with High-Speed Downlink Packet Access (HSDPA), sometimes known as 3.5G. Currently, HSDPA enables downlink transfer speeds of up to 21 Mbit/s. Work is also progressing on improving the uplink transfer speed with the High-Speed Uplink Packet Access (HSUPA). Longer term, the 3GPP Long Term Evolution (LTE) project plans to move UMTS to 4G speeds of 100 Mbit/s down and 50 Mbit/s up, using a next generation air interface technology based upon orthogonal frequency-division multiplexing.

The first national consumer UMTS networks launched in 2002 with a heavy emphasis on telco-provided mobile applications such as mobile TV and video calling. The high data speeds of UMTS are now most often utilised for Internet access: experience in Japan and elsewhere has shown that user demand for video calls is not high, and telco-provided audio/video content has declined in popularity in favour of high-speed access to the World Wide Web—either directly on a handset or connected to a computer via Wi-Fi, Bluetooth or USB.

Air interfaces

UMTS combines three different terrestrial air interfaces, GSM's Mobile Application Part (MAP) core, and the GSM family of speech codecs.

The air interfaces are called **UMTS Terrestrial Radio Access (UTRA)**.[3] All air interface options are part of ITU's IMT-2000. In the currently most popular variant for cellular mobile telephones, W-CDMA (IMT Direct Spread) is used.

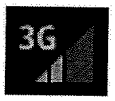


UMTS network architecture

Please note that the terms W-CDMA, TD-CDMA and TD-SCDMA are misleading. While they suggest covering just a channel access method (namely a variant of CDMA), they are actually the common names for the whole air interface standards.[4]

W-CDMA (UTRA-FDD)

W-CDMA or **WCDMA** (**Wideband Code Division Multiple Access**), along with **UMTS-FDD**, **UTRA-FDD**, or **IMT-2000 CDMA Direct Spread** is an air interface standard found in 3G mobile telecommunications networks. It supports conventional cellular voice, text and MMS services, but can also carry data at high speeds, allowing mobile operators to deliver higher bandwidth applications including streaming and broadband Internet access.[5]



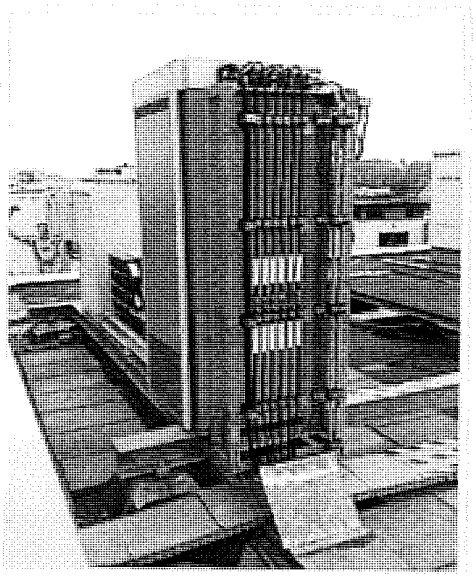
3G sign shown in notification bar on an Android powered smartphone.

W-CDMA uses the DS-CDMA channel access method with a pair of 5 MHz wide channels. In contrast, the competing CDMA2000 system uses one or more available 1.25 MHz channels for each direction of communication. W-CDMA systems are widely criticized for their large spectrum usage, which delayed deployment in countries that acted relatively slowly in allocating new frequencies specifically for 3G services (such as the United States).

The specific frequency bands originally defined by the UMTS standard are 1885–2025 MHz for the mobile-to-base (uplink) and 2110–2200 MHz for the base-to-mobile (downlink). In the US, 1710–1755 MHz and 2110–2155 MHz are used instead, as the 1900 MHz band was already used.[6] While UMTS2100 is the most widely deployed UMTS band, some countries' UMTS operators use the 850 MHz and/or 1900 MHz bands (independently, meaning uplink and downlink are within the same band), notably in the US by AT&T Mobility, New Zealand by Telecom New Zealand on the XT Mobile Network and in Australia by Telstra on the Next G network. Some carriers such as T-Mobile use band numbers to identify the UMTS frequencies. For example, Band I (2100 MHz), Band IV (1700/2100 MHz), and Band V (850 MHz).

UMTS-FDD is an acronym for Universal Mobile Telecommunications System (UMTS) - frequency-division duplexing (FDD) and a 3GPP standardized version of UMTS networks that makes use of frequency-division duplexing for duplexing over an UMTS Terrestrial Radio Access (UTRA) air

interface.[7]



UMTS base station on the roof of a building

W-CDMA is the basis of Japan's NTT DoCoMo's FOMA service and the most-commonly used member of the Universal Mobile Telecommunications System (UMTS) family and sometimes used as a synonym for UMTS.[8] It uses the DS-CDMA channel access method and the FDD duplexing method to achieve higher speeds and support more users compared to most previously used time division multiple access (TDMA) and time division duplex (TDD) schemes.

While not an evolutionary upgrade on the airside, it uses the same core network as the 2G GSM networks deployed worldwide, allowing dual mode mobile operation along with GSM/EDGE; a feature it shares with other members of the UMTS family.

Development

In the late 1990s, W-CDMA was developed by NTT DoCoMo as the air interface for their 3G network FOMA. Later NTT DoCoMo submitted the specification to the International Telecommunication Union (ITU) as a candidate for the international 3G standard known as IMT-2000. The ITU eventually accepted W-CDMA as part of the IMT-2000 family of 3G standards, as an alternative to CDMA2000, EDGE, and the short range DECT system. Later, W-CDMA was selected as an air interface for UMTS.

As NTT DoCoMo did not wait for the finalisation of the 3G Release 99 specification, their network was initially incompatible with UMTS.[9] However, this has been resolved by NTT DoCoMo updating their network.

Code Division Multiple Access communication networks have been developed by a number of companies over the years, but development of cell-phone networks based on CDMA (prior to W-CDMA) was dominated by Qualcomm, the first company to succeed in developing a practical and cost-effective CDMA implementation for consumer cell phones and its early IS-95 air interface standard has evolved into the current CDMA2000 (IS-856/IS-2000) standard. Qualcomm created an experimental wideband CDMA system called CDMA2000 **3x** which unified the W-CDMA (3GPP) and CDMA2000 (3GPP2) network technologies into a single design for a worldwide standard air interface. Compatibility with CDMA2000 would have beneficially enabled roaming on existing networks beyond Japan, since Qualcomm CDMA2000 networks are widely deployed, especially in the Americas, with coverage in 58 countries as of 2006. However, divergent requirements resulted in the W-CDMA standard being retained and deployed globally. W-CDMA has then become the dominant technology with 457 commercial networks in 178 countries as of April 2012.[10] Several CDMA2000 operators have even converted their networks to W-CDMA for international roaming compatibility and smooth upgrade path to LTE.

Despite incompatibility with existing air-interface standards, late introduction and the high upgrade cost of deploying an all-new transmitter technology, W-CDMA has become the dominant standard.

Rationale for W-CDMA

W-CDMA transmits on a pair of 5 MHz-wide radio channels, while CDMA2000 transmits on one or several pairs of 1.25 MHz radio channels. Though W-CDMA does use a direct sequence CDMA transmission technique like CDMA2000, W-CDMA is not simply a wideband version of CDMA2000. The W-CDMA system is a new design by NTT DoCoMo, and it differs in many aspects from CDMA2000. From an engineering point of view, W-CDMA provides a different balance of trade-offs between cost, capacity, performance, and density; it also promises to achieve a benefit of reduced cost for video phone handsets. W-CDMA may also be better suited for deployment in the very dense cities of Europe and Asia. However, hurdles remain, and cross-licensing of patents between Qualcomm and W-CDMA vendors has not eliminated possible patent issues due to the features of W-CDMA which remain covered by Qualcomm patents.[11]

W-CDMA has been developed into a complete set of specifications, a detailed protocol that defines how a mobile phone communicates with the tower, how signals are modulated, how datagrams are structured, and system interfaces are specified allowing free competition on technology elements.

Deployment

The world's first commercial W-CDMA service, FOMA, was launched by NTT DoCoMo in Japan in 2001.

Elsewhere, W-CDMA deployments are usually marketed under the UMTS brand.

W-CDMA has also been adapted for use in satellite communications on the U.S. Mobile User Objective System using geosynchronous satellites in place of cell towers.

J-Phone Japan (once Vodafone and now SoftBank Mobile) soon followed by launching their own W-CDMA based service, originally branded "Vodafone Global Standard" and claiming UMTS compatibility. The name of the service was changed to "Vodafone 3G" (now "SoftBank 3G") in December 2004.

Beginning in 2003, Hutchison Whampoa gradually launched their upstart UMTS networks.

Most countries have, since the ITU approved of the 3G mobile service, either "auctioned" the radio frequencies to the company willing to pay the most, or conducted a "beauty contest"—asking the various companies to present what they intend to commit to if awarded the licences. This strategy has been criticised for aiming to drain the cash of operators to the brink of bankruptcy in order to honour their bids or proposals. Most of them have a time constraint for the rollout of the service—where a certain "coverage" must be achieved within a given date or the licence will be revoked.

Vodafone launched several UMTS networks in Europe in February 2004. MobileOne of Singapore commercially launched its 3G (W-CDMA) services in February 2005. New Zealand in August 2005 and Australia in October 2005.

AT&T Wireless (now a part of Cingular Wireless) has deployed UMTS in several cities. Though advancements in its network deployment have been delayed due to the merger with Cingular, Cingular began offering HSDPA service in December 2005.

Rogers in Canada March 2007 has launched HSDPA in the Toronto Golden Horseshoe district on W-CDMA at 850/1900 MHz and plan the launch the service commercial in the top 25 cities October,

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2007.

TeliaSonera opened W-CDMA service in Finland October 13, 2004 with speeds up to 384 kbit/s. Availability only in main cities. Pricing is approx. €2/MB.

SK Telecom and KTF, two largest mobile phone service providers in South Korea, have each started offering W-CDMA service in December 2003. Due to poor coverage and lack of choice in handhelds, the W-CDMA service has barely made a dent in the Korean market which was dominated by CDMA2000. By October 2006 both companies are covering more than 90 cities while SK Telecom has announced that it will provide nationwide coverage for its WCDMA network in order for it to offer SBSM (Single Band Single Mode) handsets by the first half of 2007. KT Freecel will thus cut funding to its CDMA2000 network development to the minimum.

In Norway, Telenor introduced W-CDMA in major cities by the end of 2004, while their competitor, NetCom, followed suit a few months later. Both operators have 98% national coverage on EDGE, but Telenor has parallel WLAN roaming networks on GSM, where the UMTS service is competing with this. For this reason Telenor is dropping support of their WLAN service in Austria (2006).

Maxis Communications and Celcom, two mobile phone service providers in Malaysia, started offering W-CDMA services in 2005.

In Sweden, Telia introduced W-CDMA March 2004.

UTRA-TDD

UMTS-TDD, an acronym for **Universal Mobile Telecommunications System (UMTS) - time-division duplexing (TDD)**, is a 3GPP standardized version of UMTS networks that use UTRA-TDD.[7] UTRA-TDD is a UTRA that uses time-division duplexing for duplexing.[7] While a full implementation of UMTS, it is mainly used to provide Internet access in circumstances similar to those where WiMAX might be used. UMTS-TDD is not directly compatible with UMTS-FDD: a device designed to use one standard cannot, unless specifically designed to, work on the other, because of the difference in air interface technologies and frequencies used. It is more formally as IMT-2000 CDMA-TDD or IMT 2000 Time-Division (IMT-TD).[12][13]

The two UMTS air interfaces (UTRAs) for UMTS-TDD are TD-CDMA and TD-SCDMA. Both air interfaces use a combination of two channel access methods, code division multiple access (CDMA) and time division multiple access (TDMA): the frequency band is divided into time slots (TDMA), which are further divided into channels using CDMA spreading codes. These air interfaces are classified as TDD, because time slots can be allocated to either uplink or downlink traffic.

TD-CDMA (UTRA-TDD 3.84 Mcps High Chip Rate (HCR))

TD-CDMA, an acronym for **Time-division-Code division multiple access**, is a channel access method based on using spread spectrum multiple access (CDMA) across multiple time slots (TDMA). TD-CDMA is the channel access method for **UTRA-TDD HCR**, which is an acronym for **UMTS Terrestrial Radio Access-Time Division Duplex High Chip Rate**.[12]

UMTS-TDD's air interfaces that use the TD-CDMA channel access technique are standardized as

UTRA-TDD HCR, which uses increments of 5 MHz of spectrum, each slice divided into 10 ms frames containing fifteen time slots (1500 per second).[12] The time slots (TS) are allocated in fixed percentage for downlink and uplink. TD-CDMA is used to multiplex streams from or to multiple transceivers. Unlike W-CDMA, it does not need separate frequency bands for up- and downstream, allowing deployment in tight frequency bands.[14]

TD-CDMA is a part of IMT-2000, defined as IMT-TD Time-Division (**IMT CDMA TDD**), and is one of the three UMTS air interfaces (UTRAs), as standardized by the 3GPP in UTRA-TDD HCR. UTRA-TDD HCR is closely related to W-CDMA, and provides the same types of channels where possible. UMTS's HSDPA/HSUPA enhancements are also implemented under TD-CDMA.[15]

TD-SCDMA (UTRA-TDD 1.28 Mcps Low Chip Rate (LCR))

Time Division Synchronous Code Division Multiple Access (**TD-SCDMA**) or **UTRA TDD 1.28 mcps low chip rate (UTRA-TDD LCR)**[13][16] is an air interface[13] found in UMTS mobile telecommunications networks in China as an alternative to W-CDMA.

TD-SCDMA uses the TDMA channel access method combined with an adaptive synchronous CDMA component[13] on 1.6 MHz slices of spectrum, allowing deployment in even tighter frequency bands than TD-CDMA. It is standardized by the 3GPP and also referred to as "UTRA-TDD LCR" However, the main incentive for development of this Chinese-developed standard was avoiding or reducing the license fees that have to be paid to non-Chinese patent owners. Unlike the other air interfaces, TD-SCDMA was not part of UMTS from the beginning but has been added in Release 4 of the specification.

Like TD-CDMA, TD-SCDMA is known as **IMT CDMA TDD** within IMT-2000.

The term "TD-SCDMA" is misleading. While it suggests covering only a channel access method, it is actually the common name for the whole air interface specification.[16]

TD-SCDMA / UMTS-TDD (LCR) networks are incompatible with W-CDMA / UMTS-FDD and TD-CDMA / UMTS-TDD (HCR) networks.

Objectives

TD-SCDMA was developed in the People's Republic of China by the Chinese Academy of Telecommunications Technology (CATT), Datang Telecom, and Siemens AG in an attempt to avoid dependence on Western technology. This is likely primarily for practical reasons, since other 3G formats require the payment of patent fees to a large number of Western patent holders.

TD-SCDMA proponents also claim it is better suited for densely populated areas.[13] Further, it is supposed to cover all usage scenarios, whereas W-CDMA is optimised for symmetric traffic and macro cells, while TD-CDMA is best used in low mobility scenarios within micro or pico cells.[13]

TD-SCDMA is based on spread spectrum technology which makes it unlikely that it will be able to completely escape the payment of license fees to western patent holders. The launch of a national TD-SCDMA network was initially projected by 2005[17] but only reached large scale commercial trials with 60,000 users across eight cities in 2008.[18]

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On January 7, 2009, China granted a TD-SCDMA 3G licence to China Mobile.[19]

On September 21, 2009, China Mobile officially announced that it had 1,327,000 TD-SCDMA subscribers as of the end of August, 2009.

While TD is primarily a China-only system, it may well be exported to developing countries. It is likely to be replaced with a newer TD-LTE system over the next 5 years.

Technical highlights

TD-SCDMA uses TDD, in contrast to the FDD scheme used by W-CDMA. By dynamically adjusting the number of timeslots used for downlink and uplink, the system can more easily accommodate asymmetric traffic with different data rate requirements on downlink and uplink than FDD schemes. Since it does not require paired spectrum for downlink and uplink, spectrum allocation flexibility is also increased. Using the same carrier frequency for uplink and downlink also means that the channel condition is the same on both directions, and the base station can deduce the downlink channel information from uplink channel estimates, which is helpful to the application of beamforming techniques.

TD-SCDMA also uses TDMA in addition to the CDMA used in WCDMA. This reduces the number of users in each timeslot, which reduces the implementation complexity of multiuser detection and beamforming schemes, but the non-continuous transmission also reduces coverage (because of the higher peak power needed), mobility (because of lower power control frequency) and complicates radio resource management algorithms.

The "S" in TD-SCDMA stands for "synchronous", which means that uplink signals are synchronized at the base station receiver, achieved by continuous timing adjustments. This reduces the interference between users of the same timeslot using different codes by improving the orthogonality between the codes, therefore increasing system capacity, at the cost of some hardware complexity in achieving uplink synchronization.

History

On January 20, 2006, Ministry of Information Industry of the People's Republic of China formally announced that TD-SCDMA is the country's standard of 3G mobile telecommunication. On February 15, 2006, a timeline for deployment of the network in China was announced, stating pre-commercial trials would take place starting after completion of a number of test networks in select cities. These trials ran from March to October, 2006, but the results were apparently unsatisfactory. In early 2007, the Chinese government instructed the dominant cellular carrier, China Mobile, to build commercial trial networks in eight cities, and the two fixed-line carriers, China Telecom and China Netcom, to build one each in two other cities. Construction of these trial networks was scheduled to finish during the fourth quarter of 2007, but delays meant that construction was not complete until early 2008.

The standard has been adopted by 3GPP since Rel-4, known as "UTRA TDD 1.28Mbps Option".[13]

On March 28, 2008, China Mobile Group announced TD-SCDMA "commercial trials" for 60,000 test users in eight cities from April 1, 2008. Networks using other 3G standards (WCDMA and CDMA2000 EV/DO) had still not been launched in China, as these were delayed until TD-SCDMA was ready for commercial launch.

In January 2009 the Ministry of Industry and Information Technology (MIIT) in China took the unusual step of assigning licences for 3 different third-generation mobile phone standards to three carriers in a long-awaited step that is expected to prompt $41 billion in spending on new equipment. The Chinese-developed standard, TD-SCDMA, was assigned to China Mobile, the world's biggest phone carrier by subscribers. That appeared to be an effort to make sure the new system has the financial and technical backing to succeed. Licences for two existing 3G standards, W-CDMA and CDMA2000 1xEV-DO, were assigned to China Unicom and China Telecom, respectively. Third-generation, or 3G, technology supports Web surfing, wireless video and other services and the start of service is expected to spur new revenue growth.

Frequency bands & Deployments

The following is a list of mobile telecommunications networks using third-generation **TD-SCDMA / UMTS-TDD (LCR)** technology.

Operator	Country	Frequency (MHz)	Band	Launch date	Notes
China Mobile	China	2100	A+ (Band 34)	Jan 2009	[20][21][22] (↓↑) 2010 – 2025 MHz **Network being phased out in favour of LTE.**
China Mobile	China	1900	A- (Band 33)	Jan 2009	[20][21][22] (↓↑) 1900 – 1920 MHz *(Subset of Band 39)* Previously used by Xiaolingtong (PHS). **Network being phased out in favour of LTE.**
none	China	1900	F (Band 39)	*N/A*	(↓↑) 1880 – 1920 MHz *No deployments, later used for TD-LTE instead.*
none	China	2300	E (Band 40)	*N/A*	(↓↑) 2300 – 2400 MHz *No deployments, later used for TD-LTE instead.*
Xinwei (CooTel)	Nicaragua	1800	*N/A*	Apr 2016	[23][24][25] (↓↑) 1785 – 1805 MHz

Unlicensed UMTS-TDD

In Europe, CEPT allocated the 2010-2020 MHz range for a variant of UMTS-TDD designed for unlicensed, self-provided use.[26] Some telecom groups and jurisdictions have proposed withdrawing this service in favour of licensed UMTS-TDD,[27] due to lack of demand, and lack of development of a UMTS TDD air interface technology suitable for deployment in this band.

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Comparison with UMTS-FDD

Ordinary UMTS uses UTRA-FDD as an air interface and is known as UMTS-FDD. UMTS-FDD uses W-CDMA for multiple access and frequency division for duplexing, meaning that the up-link and down-link transmit on different frequencies. UMTS is usually transmitted on frequencies assigned for 1G, 2G, or 3G mobile telephone service in the countries of operation.

UMTS-TDD uses time division duplexing, allowing the up-link and down-link to share the same spectrum. This allows the operator to more flexibly divide the usage of available spectrum according to traffic patterns. For ordinary phone service, you would expect the up-link and down-link to carry approximately equal amounts of data (because every phone call needs a voice transmission in either direction), but Internet-oriented traffic is more frequently one-way. For example, when browsing a website, the user will send commands, which are short, to the server, but the server will send whole files, that are generally larger than those commands, in response.

UMTS-TDD tends to be allocated frequency intended for mobile/wireless Internet services rather than used on existing cellular frequencies. This is, in part, because TDD duplexing is not normally allowed on cellular, PCS/PCN, and 3G frequencies. TDD technologies open up the usage of left-over unpaired spectrum.

Europe-wide, several bands are provided either specifically for UMTS-TDD or for similar technologies. These are 1900 MHz and 1920 MHz and between 2010 MHz and 2025 MHz. In several countries the 2500-2690 MHz band (also known as MMDS in the USA) have been used for UMTS-TDD deployments. Additionally, spectrum around the 3.5 GHz range has been allocated in some countries, notably Britain, in a technology-neutral environment. In the Czech Republic UTMS-TDD is also used in a frequency range around 872 MHz.[28]

Deployment

UMTS-TDD has been deployed for public and/or private networks in at least nineteen countries around the world, with live systems in, amongst other countries, Australia, Czech Republic, France, Germany, Japan, New Zealand, South Africa, the UK, and the USA.

Deployments in the US thus far have been limited. It has been selected for a public safety support network used by emergency responders in New York,[29] but outside of some experimental systems, notably one from Nextel, thus far the WiMAX standard appears to have gained greater traction as a general mobile Internet access system.

Competing Standards

A variety of Internet-access systems exist which provide broadband speed access to the net. These include WiMAX and HIPERMAN. UMTS-TDD has the advantages of being able to use an operator's existing UMTS/GSM infrastructure, should it have one, and that it includes UMTS modes optimized for circuit switching should, for example, the operator want to offer telephone service. UMTS-TDD's performance is also more consistent. However, UMTS-TDD deployers often have regulatory problems with taking advantage of some of the services UMTS compatibility provides. For example, UMTS-TDD spectrum in the UK cannot be used to provide telephone service, though the regulator OFCOM is discussing the possibility of allowing it at some point in the future. Few operators considering UMTS-TDD have

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existing UMTS/GSM infrastructure.

Additionally, the WiMAX and HIPERMAN systems provide significantly larger bandwidths when the mobile station is in close proximity to the tower.

Like most mobile Internet access systems, many users who might otherwise choose UMTS-TDD will find their needs covered by the ad hoc collection of unconnected Wifi access points at many restaurants and transportation hubs, and/or by Internet access already provided by their mobile phone operator. By comparison, UMTS-TDD (and systems like WiMAX) offers mobile, and more consistent, access than the former, and generally faster access than the latter.

Radio access network

UMTS also specifies the **Universal Terrestrial Radio Access Network** (**UTRAN**), which is composed of multiple base stations, possibly using different terrestrial air interface standards and frequency bands.

UMTS and GSM/EDGE can share a Core Network (CN), making UTRAN an alternative radio access network to GERAN (GSM/EDGE RAN), and allowing (mostly) transparent switching between the RANs according to available coverage and service needs. Because of that, UMTS's and GSM/EDGE's radio access networks are sometimes collectively referred to as **UTRAN/GERAN**.

UMTS networks are often combined with GSM/EDGE, the latter of which is also a part of IMT-2000.

The UE (User Equipment) interface of the RAN (Radio Access Network) primarily consists of RRC (Radio Resource Control), PDCP (Packet Data Convergence Protocol), RLC (Radio Link Control) and MAC (Media Access Control) protocols. RRC protocol handles connection establishment, measurements, radio bearer services, security and handover decisions. RLC protocol primarily divides into three Modes—Transparent Mode (TM), Unacknowledge Mode (UM), Acknowledge Mode (AM). The functionality of AM entity resembles TCP operation whereas UM operation resembles UDP operation. In TM mode, data will be sent to lower layers without adding any header to SDU of higher layers. MAC handles the scheduling of data on air interface depending on higher layer (RRC) configured parameters.

The set of properties related to data transmission is called Radio Bearer (RB). This set of properties decides the maximum allowed data in a TTI (Transmission Time Interval). RB includes RLC information and RB mapping. RB mapping decides the mapping between RB<->logical channel<->transport channel. Signaling messages are sent on Signaling Radio Bearers (SRBs) and data packets (either CS or PS) are sent on data RBs. RRC and NAS messages go on SRBs.

Security includes two procedures: integrity and ciphering. Integrity validates the resource of messages and also makes sure that no one (third/unknown party) on the radio interface has modified the messages. Ciphering ensures that no one listens to your data on the air interface. Both integrity and ciphering are applied for SRBs whereas only ciphering is applied for data RBs.

Core network

With **Mobile Application Part**, UMTS uses the same core network standard as GSM/EDGE. This allows a simple migration for existing GSM operators. However, the migration path to UMTS is still costly: while much of the core infrastructure is shared with GSM, the cost of obtaining new spectrum licenses

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and overlaying UMTS at existing towers is high.

The CN can be connected to various backbone networks, such as the Internet or an Integrated Services Digital Network (ISDN) telephone network. UMTS (and GERAN) include the three lowest layers of OSI model. The network layer (OSI 3) includes the Radio Resource Management protocol (RRM) that manages the bearer channels between the mobile terminals and the fixed network, including the handovers.

Frequency bands and channel bandwidths

UARFCN

A **UARFCN** (abbreviation for UTRA Absolute Radio Frequency Channel Number, where UTRA stands for UMTS Terrestrial Radio Access) is used to identify a frequency in the UMTS frequency bands.

Typically channel number is derived from the frequency in MHz through the formula Channel Number = Frequency * 5. However, this is only able to represent channels that are centered on a multiple of 200 kHz, which do not align with licensing in North America. 3GPP added several special values for the common North American channels.

Spectrum allocation

Over 130 licenses have already been awarded to operators worldwide (as of December 2004), specifying W-CDMA radio access technology that builds on GSM. In Europe, the license process occurred at the tail end of the technology bubble, and the auction mechanisms for allocation set up in some countries resulted in some extremely high prices being paid for the original 2100 MHz licenses, notably in the UK and Germany. In Germany, bidders paid a total €50.8 billion for six licenses, two of which were subsequently abandoned and written off by their purchasers (Mobilcom and the Sonera/Telefonica consortium). It has been suggested that these huge license fees have the character of a very large tax paid on future income expected many years down the road. In any event, the high prices paid put some European telecom operators close to bankruptcy (most notably KPN). Over the last few years some operators have written off some or all of the license costs. Between 2007 and 2009, all three Finnish carriers began to use 900 MHz UMTS in a shared arrangement with its surrounding 2G GSM base stations for rural area coverage, a trend that is expected to expand over Europe in the next 1–3 years.

The 2100 MHz band (downlink around 2100 MHz and uplink around 1900 MHz) allocated for UMTS in Europe and most of Asia is already used in North America. The 1900 MHz range is used for 2G (PCS) services, and 2100 MHz range is used for satellite communications. Regulators have, however, freed up some of the 2100 MHz range for 3G services, together with a different range around 1700 MHz for the uplink.

AT&T Wireless launched UMTS services in the United States by the end of 2004 strictly using the existing 1900 MHz spectrum allocated for 2G PCS services. Cingular acquired AT&T Wireless in 2004 and has since then launched UMTS in select US cities. Cingular renamed itself AT&T Mobility and is rolling out some cities with a UMTS network at 850 MHz to enhance its existing UMTS network at 1900 MHz and now offers subscribers a number of dual-band UMTS 850/1900 phones.

T-Mobile's rollout of UMTS in the US was originally focused on the 1700 MHz band. However, T-Mobile

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has been moving users from 1700 MHz to 1900 MHz (PCS) in order to reallocate the spectrum to 4G LTE services.[30]

In Canada, UMTS coverage is being provided on the 850 MHz and 1900 MHz bands on the Rogers and Bell-Telus networks. Bell and Telus share the network. Recently, new providers Wind Mobile, Mobilicity and Videotron have begun operations in the 1700 MHz band.

In 2008, Australian telco Telstra replaced its existing CDMA network with a national UMTS-based 3G network, branded as NextG, operating in the 850 MHz band. Telstra currently provides UMTS service on this network, and also on the 2100 MHz UMTS network, through a co-ownership of the owning and administrating company 3GIS. This company is also co-owned by Hutchison 3G Australia, and this is the primary network used by their customers. Optus is currently rolling out a 3G network operating on the 2100 MHz band in cities and most large towns, and the 900 MHz band in regional areas. Vodafone is also building a 3G network using the 900 MHz band.

In India, BSNL has started its 3G services since October 2009, beginning with the larger cities and then expanding over to smaller cities. The 850 MHz and 900 MHz bands provide greater coverage compared to equivalent 1700/1900/2100 MHz networks, and are best suited to regional areas where greater distances separate base station and subscriber.

Carriers in South America are now also rolling out 850 MHz networks.

Interoperability and global roaming

UMTS phones (and data cards) are highly portable—they have been designed to roam easily onto other UMTS networks (if the providers have roaming agreements in place). In addition, almost all UMTS phones are UMTS/GSM dual-mode devices, so if a UMTS phone travels outside of UMTS coverage during a call the call may be transparently handed off to available GSM coverage. Roaming charges are usually significantly higher than regular usage charges.

Most UMTS licensees consider ubiquitous, transparent global roaming an important issue. To enable a high degree of interoperability, UMTS phones usually support several different frequencies in addition to their GSM fallback. Different countries support different UMTS frequency bands – Europe initially used 2100 MHz while the most carriers in the USA use 850 MHz and 1900 MHz. T-Mobile has launched a network in the US operating at 1700 MHz (uplink) /2100 MHz (downlink), and these bands also have been adopted elsewhere in the US and in Canada and Latin America. A UMTS phone and network must support a common frequency to work together. Because of the frequencies used, early models of UMTS phones designated for the United States will likely not be operable elsewhere and vice versa. There are now 11 different frequency combinations used around the world—including frequencies formerly used solely for 2G services.

UMTS phones can use a Universal Subscriber Identity Module, USIM (based on GSM's SIM) and also work (including UMTS services) with GSM SIM cards. This is a global standard of identification, and enables a network to identify and authenticate the (U)SIM in the phone. Roaming agreements between networks allow for calls to a customer to be redirected to them while roaming and determine the services (and prices) available to the user. In addition to user subscriber information and authentication information, the (U)SIM provides storage space for phone book contact. Handsets can store their data on their own memory or on the (U)SIM card (which is usually more limited in its phone book contact

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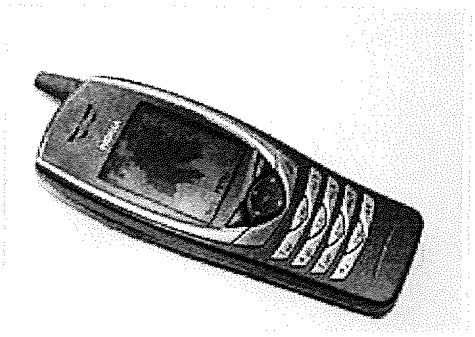
information). A (U)SIM can be moved to another UMTS or GSM phone, and the phone will take on the user details of the (U)SIM, meaning it is the (U)SIM (not the phone) which determines the phone number of the phone and the billing for calls made from the phone.

Japan was the first country to adopt 3G technologies, and since they had not used GSM previously they had no need to build GSM compatibility into their handsets and their 3G handsets were smaller than those available elsewhere. In 2002, NTT DoCoMo's FOMA 3G network was the first commercial UMTS network—using a pre-release specification,[31] it was initially incompatible with the UMTS standard at the radio level but used standard USIM cards, meaning USIM card based roaming was possible (transferring the USIM card into a UMTS or GSM phone when travelling). Both NTT DoCoMo and SoftBank Mobile (which launched 3G in December 2002) now use standard UMTS.

Handsets and modems

All of the major 2G phone manufacturers (that are still in business) are now manufacturers of 3G phones. The early 3G handsets and modems were specific to the frequencies required in their country, which meant they could only roam to other countries on the same 3G frequency (though they can fall back to the older GSM standard). Canada and USA have a common share of frequencies, as do most European countries. The article UMTS frequency bands is an overview of UMTS network frequencies around the world.



The Nokia 6650, an early (2003) UMTS handset

Using a cellular router, PCMCIA or USB card, customers are able to access 3G broadband services, regardless of their choice of computer (such as a tablet PC or a PDA). Some software installs itself from the modem, so that in some cases absolutely no knowledge of technology is required to get online in moments. Using a phone that supports 3G and Bluetooth 2.0, multiple Bluetooth-capable laptops can be connected to the Internet. Some smartphones can also act as a mobile WLAN access point.

There are very few 3G phones or modems available supporting all 3G frequencies (UMTS850/900 /1700/1900/2100 MHz). Nokia has recently released a range of phones that have Pentaband 3G coverage, including the N8 and E7. Many other phones are offering more than one band which still enables extensive roaming. For example, Apple's iPhone 4 contains a quadband chipset operating on 850/900 /1900/2100 MHz, allowing usage in the majority of countries where UMTS-FDD is deployed.

Other competing standards

The main competitor to UMTS is CDMA2000 (IMT-MC), which is developed by the 3GPP2. Unlike UMTS, CDMA2000 is an evolutionary upgrade to an existing 2G standard, cdmaOne, and is able to operate within the same frequency allocations. This and CDMA2000's narrower bandwidth requirements make it easier to deploy in existing spectra. In some, but not all, cases, existing GSM operators only have enough spectrum to implement either UMTS or GSM, not both. For example, in the US D, E, and F PCS spectrum blocks (http://wireless.fcc.gov/auctions/data/bandplans/pcsband.pdf), the amount of spectrum available is 5 MHz in each direction. A standard UMTS system would saturate that spectrum. Where

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CDMA2000 is deployed, it usually co-exists with UMTS. In many markets however, the co-existence issue is of little relevance, as legislative hurdles exist to co-deploying two standards in the same licensed slice of spectrum.

Another competitor to UMTS is EDGE (IMT-SC), which is an evolutionary upgrade to the 2G GSM system, leveraging existing GSM spectrums. It is also much easier, quicker, and considerably cheaper for wireless carriers to "bolt-on" EDGE functionality by upgrading their existing GSM transmission hardware to support EDGE rather than having to install almost all brand-new equipment to deliver UMTS. However, being developed by 3GPP just as UMTS, EDGE is not a true competitor. Instead, it is used as a temporary solution preceding UMTS roll-out or as a complement for rural areas. This is facilitated by the fact that GSM/EDGE and UMTS specification are jointly developed and rely on the same core network, allowing dual-mode operation including vertical handovers.

China's TD-SCDMA standard is often seen as a competitor, too. TD-SCDMA has been added to UMTS' Release 4 as UTRA-TDD 1.28 Mcps Low Chip Rate (UTRA-TDD LCR). Unlike TD-CDMA (UTRA-TDD 3.84 Mcps High Chip Rate, UTRA-TDD HCR) which complements W-CDMA (UTRA-FDD), it is suitable for both micro and macro cells. However, the lack of vendors' support is preventing it from being a real competitor.

While DECT is technically capable of competing with UMTS and other cellular networks in densely populated, urban areas, it has only been deployed for domestic cordless phones and private in-house networks.

All of these competitors have been accepted by ITU as part of the IMT-2000 family of 3G standards, along with UMTS-FDD.

On the Internet access side, competing systems include WiMAX and Flash-OFDM.

Migrating from GSM/GPRS to UMTS

From a GSM/GPRS network, the following network elements can be reused:

- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Equipment Identity Register (EIR)
- Mobile Switching Center (MSC) (vendor dependent)
- Authentication Center (AUC)
- Serving GPRS Support Node (SGSN) (vendor dependent)
- Gateway GPRS Support Node (GGSN)

From a GSM/GPRS communication radio network, the following elements cannot be reused:

- **Base station controller (BSC)**
- Base transceiver station (BTS)

They can remain in the network and be used in dual network operation where 2G and 3G networks co-exist while network migration and new 3G terminals become available for use in the network.

The UMTS network introduces new network elements that function as specified by 3GPP:

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- Node B (base transceiver station)
- Radio Network Controller (RNC)
- Media Gateway (MGW)

The functionality of MSC and SGSN changes when going to UMTS. In a GSM system the MSC handles all the circuit switched operations like connecting A- and B-subscriber through the network. SGSN handles all the packet switched operations and transfers all the data in the network. In UMTS the Media gateway (MGW) take care of all data transfer in both circuit and packet switched networks. MSC and SGSN control MGW operations. The nodes are renamed to MSC-server and GSN-server.

Problems and issues

Some countries, including the United States, have allocated spectrum differently from the ITU recommendations, so that the standard bands most commonly used for UMTS (UMTS-2100) have not been available. In those countries, alternative bands are used, preventing the interoperability of existing UMTS-2100 equipment, and requiring the design and manufacture of different equipment for the use in these markets. As is the case with GSM900 today, standard UMTS 2100 MHz equipment will not work in those markets. However, it appears as though UMTS is not suffering as much from handset band compatibility issues as GSM did, as many UMTS handsets are multi-band in both UMTS and GSM modes. Penta-band (850, 900, 1700 / 2100, and 1900 MHz bands), quad-band GSM (850, 900, 1800, and 1900 MHz bands) and tri-band UMTS (850, 1900, and 2100 MHz bands) handsets are becoming more commonplace.

In its early days, UMTS had problems in many countries: Overweight handsets with poor battery life were first to arrive on a market highly sensitive to weight and form factor. The Motorola A830, a debut handset on Hutchison's 3 network, weighed more than 200 grams and even featured a detachable camera to reduce handset weight. Another significant issue involved call reliability, related to problems with handover from UMTS to GSM. Customers found their connections being dropped as handovers were possible only in one direction (UMTS → GSM), with the handset only changing back to UMTS after hanging up. In most networks around the world this is no longer an issue.

Compared to GSM, UMTS networks initially required a higher base station density. For fully-fledged UMTS incorporating video on demand features, one base station needed to be set up every 1–1.5 km (0.62–0.93 mi). This was the case when only the 2100 MHz band was being used, however with the growing use of lower-frequency bands (such as 850 and 900 MHz) this is no longer so. This has led to increasing rollout of the lower-band networks by operators since 2006.

Even with current technologies and low-band UMTS, telephony and data over UMTS requires more power than on comparable GSM networks. Apple Inc. cited[32] UMTS power consumption as the reason that the first generation iPhone only supported EDGE. Their release of the iPhone 3G quotes talk time on UMTS as half that available when the handset is set to use GSM. Other manufacturers indicate different battery lifetime for UMTS mode compared to GSM mode as well. As battery and network technology improve, this issue is diminishing.

Security issues

As early as 2008 it was known that carrier networks can be used to surreptitiously gather user location

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information.[33] In August 2014, the Washington Post reported on widespread marketing of surveillance systems using Signalling System No. 7 (SS7) protocols to locate callers anywhere in the world.[33]

In December 2014, news broke that SS7's very own functions can be repurposed for surveillance, because of its lax security, in order to listen to calls in real time or to record encrypted calls and texts for later decryption, or to defraud users and cellular carriers.[34]

The German Telekom and Vodafone declared the same day that they had fixed gaps in their networks, but that the problem is global and can only be fixed with a telecommunication system-wide solution.[35]

Releases

The evolution of UMTS progresses according to planned releases. Each release is designed to introduce new features and improve upon existing ones.

Release '99

- Bearer services
- 64 kbit/s circuit switch
- 384 kbit/s packet switched
- Location services
- Call service: compatible with Global System for Mobile Communications (GSM), based on Universal Subscriber Identity Module (USIM)
- Voice quality features – Tandem Free Operation

Release 4

- Edge radio
- Multimedia messaging
- MExE (Mobile Execution Environment)
- Improved location services
- IP Multimedia Services (IMS)
- TD-SCDMA (UTRA-TDD 1.28 Mcps low chip rate)

Release 5

- IP Multimedia Subsystem (IMS)
- IPv6, IP transport in UTRAN
- Improvements in GERAN, MExE, etc.
- HSDPA

Release 6

- WLAN integration
- Multimedia broadcast and multicast
- Improvements in IMS

- HSUPA
- Fractional DPCH

Release 7

- Enhanced L2
- 64 QAM, MIMO
- Voice over HSPA
- CPC – continuous packet connectivity
- FRLC – Flexible RLC

Release 8

- Dual-Cell HSDPA

Release 9

- Dual-Cell HSUPA

See also

- List of Deployed UMTS networks
- 3GPP: the body that manages the UMTS standard.
- 3GPP Long Term Evolution, the 3GPP project to evolve UMTS towards 4G capabilities.
- GAN/UMA: A standard for running GSM and UMTS over wireless LANs.
- Opportunity Driven Multiple Access, ODMA: a UMTS TDD mode communications relaying protocol
- HSDPA, HSUPA: updates to the W-CDMA air interface.
- PDCP
- Subscriber Identity Module
- UMTS-TDD: a variant of UMTS largely used to provide wireless Internet service.
- UMTS frequency bands
- UMTS channels
- W-CDMA: the primary air interface standard used by UMTS.
- W-CDMA 2100
- TD-SCDMA

Other, non-UMTS, 3G and 4G standards

- CDMA2000: evolved from cdmaOne (also known as IS-95 or "CDMA"), managed by the 3GPP2
- FOMA
- WiMAX
- GSM
- GPRS
- EDGE
- ETSI

Other information

- 3G, 4G, IMT-2000
- Cellular frequencies
- CDMA
- Comparison of wireless data standards
- DECT
- Dynamic TDMA
- Evolution-Data Optimized/CDMA2000
- FOMA
- GSM/EDGE
- HSPA
- PN sequences
- Spectral efficiency comparison table
- UMTS frequency bands

- WiMAX
- Telecommunications industry in China
- Communications in China
- Standardization in China
- Mobile modem
- Spectral efficiency comparison table
- Code Division Multiple Access (CDMA)
- Common pilot channel or CPICH, a simple synchronisation channel in WCDMA.
- Multiple-input multiple-output (MIMO) is the major issue of multiple antenna research.
- Wi-Fi: a local area wireless technology that is complementary to UMTS.
- List of device bandwidths
- Operations and Maintenance Centre
- Radio Network Controller
- UMTS security
- Huawei SingleRAN: a RAN technology allowing migration from GSM to UMTS or simultaneous use of both

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- TS 25.201 Physical Layer - General Description (http://www.3gpp.org/ftp/specs/archive/25_series /25.201/) - Describes basic differences between FDD and TDD.
- TS 25.211 Physical channels and mapping of transport channels onto physical channels (FDD)

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- TS 25.221 Physical channels and mapping of transport channels onto physical channels (TDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.221/)
- TS 25.212 Multiplexing and channel coding (FDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.212/)
- TS 25.222 Multiplexing and channel coding (TDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.222/)
- TS 25.213 Spreading and modulation (FDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.213/)
- TS 25.223 Spreading and modulation (TDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.223/)
- TS 25.214 Physical layer procedures (FDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.214/)
- TS 25.224 Physical layer procedures (TDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.224/)
- TS 25.215 Physical layer - Measurements (FDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.215/)
- TS 25.225 Physical layer - Measurements (TDD) (http://www.3gpp.org/ftp/Specs/archive/25_series/25.225/)

External links

- 3gpp.org (http://www.3gpp.org/ftp/Specs/html-info/25104.htm) - 3rd Generation Partnership Project Standard
- 3GPP Specifications Numbering Schemes (http://www.3gpp.org/specs/numbering.htm)
- Vocabulary for 3GPP Specifications, up to Release 8 (http://www.3gpp.org/ftp/Specs/html-info/21905.htm)
- UMTS LTE Link Budget Comparison (http://sites.google.com/site/lteencyclopedia/lte-radio-link-budgeting-and-rf-planning/lte-link-budget-comparison)
- UMTS FAQ (http://www.umtsworld.com/umts/faq.htm) on UMTS World
- Worldwide W-CDMA frequency allocations (http://www.umtsworld.com/technology/frequencies.htm) on UMTS World
- UMTS TDD Alliance (http://www.umtstdd.org) The Global UMTS TDD Alliance
- 3GSM World Congress (http://www.3gsmworldcongress.com/)
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- TD-SCDMA Forum (http://www.tdscdma-forum.org/EN/index.asp)
- TD-SCDMA Industry Alliance (http://www.tdscdma-alliance.org/english/)

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Categories: Channel access methods | 2002 introductions | 3GPP standards | Bandplans | Metropolitan area networks | Mobile telecommunications | Mobile telecommunications standards | Network access | UMTS (telecommunication) | Videotelephony | Wireless networking

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Electronic Patent Application Fee Transmittal

Application Number:	13966853
Filing Date:	14-Aug-2013
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham
Attorney Docket Number:	08610010PA

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	2251	1	100	100
Miscellaneous:				
RCE- 1st Request	2801	1	600	600
		Total in USD ($)		**700**

Electronic Acknowledgement Receipt

EFS ID:	28707741
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	22-MAR-2017
Filing Date:	14-AUG-2013
Time Stamp:	15:56:37
Application Type:	Utility under 35 USC 111(a)

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	Amendment Submitted/Entered with Filing of CPA/RCE		2	2	
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	Amendment/Req. Reconsideration-After Non-Final Reject		13	21	
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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/966,853	Filing Date 08/14/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **03/22/2017**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 31	Minus	** 31	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***6	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** 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 number found in the appropriate box in column 1.

LIE
JUDY SWAYNE

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 11/23/2016

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ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
11/23/2016	PAPER

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.

Office Action Summary	Application No. 13/966,853	Applicant(s) RAPPAPORT, THEODORE S.	
	Examiner HELENA SERAYDARYAN	Art Unit 3648	AIA (First Inventor to File) Status No

-- 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 *08/02/2016*.

☐ 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 and 3-32* 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, 3-32* 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 *08/14/2013* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *08/02/2016*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Response to Arguments

2. Applicant's arguments, see Remarks, filed 08/02/2016, with respect to newly amended claims 1, 4-5 and 8-9, and newly added claims 12-32 have been fully considered.

3. Applicant's arguments regarding the rejection of amended claims 1, 3-11 and newly added claims 12-32 under 35 USC § 102(b) are persuasive. Upon further consideration, a new ground(s) of rejection is made in view of Werling (US 6456856) and Rappaport (US 20100060531) necessitated by Applicant's amendment of claims 1, 4-5, 8-9 and newly added claims 12-32.

Drawings

4. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the method steps must

be shown in a flow-chart diagram or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as “amended.” If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either “Replacement Sheet” or “New Sheet” pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

5. Figure 1 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled “Replacement Sheet” in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the

applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

6. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

> (a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

7. Claims 1-32 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

8. There is no enough disclosure in the specification for the claimed use of a multiple band steerable antenna at 10 GHz or above. The disclosed and shown (Figs. 2-4) multiband antenna is for GSM, cellular, Bluetooth and UWB systems, wherein only

UWB going up to 10.6 GHz meets the claim limitation. Thus, the multiband steerable antenna operating at 10 GHz and above is either misdescriptive or not clearly enabled by the specification. There is no explanation in the specification of the device being limited to 10 GHz or above. It is not clear what are the multiple bands considered by the applicant that are 10 GHz or above; and whether the device is limited so as to not be directed to the conventional cellular, Wi-Fi, Bluetooth, etc. frequency bands, as it is shown in the drawings.

9. 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.

10. Claims 1-32 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

11. As per Claims 1, 4, 8, 24, 27 and 30, the claim limitation “a receiver for receiving signals on said at least one steerable antenna or another antenna” is unclear, as it is not defined what the “another antenna” comprises and what is its relationship to the device or the system.

Claim Rejections - 35 USC § 103

12. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

14. **Claims 1, 3-13, 15-17, 19-21, 23-25, 27-28, and 30-31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rappaport (US 20100060531).**

15. **As per Claim 1**, Werling teaches a method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna (Col. 1, Line 65 –

Col. 2, Line 6; Fig. 2; Fig. 1, array 12-15; Col. 2, Lines 54-62; Col. 3, Lines 51-55), comprising the steps of:

detecting, using one or more sensors (Fig. 1, Item 18), one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at 3least one steerable antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32),

wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41- 61; Fig. 4; the user proximity is determined several times in a loop; the number of times of performing the method steps depends on the number of programmed iterations); and

receiving signals on said at least one steerable antenna or another antenna (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above and operates on multiple bands.

However Rappaport teaches a method of communication with a wireless device (Par. 0003, 0017), wherein the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027) and operates on multiple bands (Par. 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Rappaport method to greatly simplify the antenna structures in a portable wireless device, and greatly reduce the mechanical design complexity, the cost of bill of materials, and the variance in manufacturing of different devices of a particular model (Rappaport: Par. 0017).

16. **As per Claim 3**, Werling teaches the method set forth above, wherein said detecting step comprises:

detecting heat from a human user with at least one heat sensor (Col. 4, Lines 53-57; ambient temperature).

17. **As per Claim 4**, Werling teaches a wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect one or more parameters of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device (Fig. 1, Item 18; Col. 3, Lines 1 -14; Col. 4, Lines 53-57; ambient temperature);

one or more processors communicatively coupled to said one or more sensors (Col. 3, Lines 1-14; Fig. 1, control element 17);

at least one steerable antenna communicatively coupled to said one or more processors (Fig. 1, Items 12-15; Col. 2, Lines 56-59; Col. 3, Lines 45-55); and

a non-transitory computer readable medium comprising executable instructions (Col. 2, Lines 59- 65; Fig. 1, control element 17) that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said one or more parameters (Fig. 1, Item 18; Col. 3, Lines 1 -14; Col. 4, Lines 53-57; ambient temperature);

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32),

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions (Col. 4, Lines 4-10, 41-61; Fig. 4);

wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41- 61; Fig. 4; the user proximity is determined several times in a loop; the number of times of performing the method steps depends on the number of programmed iterations); and

a receiver for receiving over-the-air signals on said at least one steerable antenna or another antenna (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above and operates on multiple bands.

However Rappaport teaches a wireless (Par. 0003, 0017), wherein the at least one steerable antenna radiates at 10 gigahertz (GHz) or above and operates on multiple bands (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Rappaport's device to greatly simplify the antenna structures in a portable wireless device, and greatly reduce the mechanical design complexity, the cost of bill of materials, and the variance in manufacturing of different devices of a particular model (Rappaport: Par. 0017).

18. **As per Claim 5**, Werling teaches the wireless device set forth above, wherein said steerable antenna comprises a plurality of steerable antennas, said plurality of antennas forming an antenna array (Fig. 1, array 12-15; Col. 2, Lines 54-62; Claim 3; Col. 3, Lines 41-44, 51-54, "phased-array type").

19. **As per Claim 6**, Werling teaches the wireless device set forth above, wherein said one or more sensors includes one or more heat sensors (Fig. 1, Item 18; Col. 3, Lines 1-8).

20. **As per Claim 7**, Werling teaches the wireless device set forth above, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound (Col. 2, Lines 17-25; Col. 3, Lines 1-8; ambient temperature).

21. **As per Claim 8**, Werling teaches a steerable antenna system for avoiding radiation of a user or structure by a wireless device (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2), comprising:

one or more sensors (Fig. 1, Item 18) configured to detect at least one parameter of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions (Col. 3, Lines 1-14; Fig. 1, control element 17);

at least one steerable antenna (Fig. 1, array 12-15; Col. 2, Lines 54-62; claim 3; Col. 3, Lines 41-44, 51-54, "phased-array type") communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams

in one or more directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32).

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna (Col. 3, Lines 8-14) wherein said at least one steerable antenna operates on multiple bands; and

a receiver for receiving signals on said at least one steerable antenna or another antenna (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

But Werling does not teach that the at least one steerable antenna operates on multiple bands.

However Rappaport teaches a system of communication by a wireless device (Par. 0003, 0017), wherein the at least one steerable antenna operates on multiple bands (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Rappaport's system to greatly simplify the antenna structures in a portable wireless device, and greatly reduce the mechanical design complexity, the cost of bill of materials, and the variance in manufacturing of different devices of a particular model (Rappaport: Par. 0017).

22. **As per Claim 9**, Werling teaches the steerable antenna system set forth above, wherein said at least one steerable antenna comprises a plurality of steerable antennas

(Fig. 1, arrays 12-15; Col. 2, Lines 54-62; claim 3; Col. 3, Lines 41-44, 51-54, “phased-array type”).

23. **As per Claim 10**, Werling teaches the steerable antenna device set forth above, wherein said one or more sensors includes one or more heat sensors (Fig. 1, Item 18; Col. 3, Lines 1-8).

24. **As per Claim 11**, Werling teaches the steerable antenna device set forth above, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound (Col. 2, Lines 17-25; Col. 3, Lines 1-8; ambient temperature).

25. **As per Claim 12**, Werling teaches the method set forth above, wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Col. 3, Lines 19-21, 37-41).

26. **As per Claim 13**, Werling teaches the method set forth above, but does not teach that said signals received in said receiving step are 10 GHz or above.

However Rappaport teaches that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Rappaport’s method as

wireless devices evolve to millimeter wave (mmWave) carrier frequencies (Rappaport: Par. 0039).

27. **As per Claim 15**, Werling teaches the method set forth above wherein said at least one steerable antenna or said another antenna uses phasing (Col. 3, Lines 41-44, 51-54, “phased-array type”).

28. **As per Claim 16**, Werling teaches the wireless device set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna or said another antenna used by said receiver to receive said over-the-air signals (Col. 3, Lines 19-21, 37-41).

29. **As per Claim 17**, Werling teaches the wireless device set forth above, but does not teach that said receiver receives said over-the-air signals of 10 GHz or above.

However Rappaport teaches that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Rappaport’s device as wireless devices evolve to millimeter wave (mmWave) carrier frequencies (Rappaport: Par. 0039).

30. **As per Claim 19**, Werling teaches the wireless device set forth above wherein said at least one steerable antenna or said another antenna uses phasing (Col. 3, Lines 41-44, 51-54, “phased-array type”).

31. **As per Claim 20**, Werling teaches the steerable antenna system set forth above wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna or said another antenna used by said receiver to receive said signals (Col. 3, Lines 19-21, 37-41).

32. **As per Claim 21**, Werling teaches the steerable antenna system set forth above, but does not teach that said receiver receives signals of 10 GHz or above.

However Rappaport teaches that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Rappaport’s system as wireless devices evolve to millimeter wave (mmWave) carrier frequencies (Rappaport: Par. 0039).

33. **As per Claim 23**, Werling teaches the steerable antenna system set forth above wherein said at least one steerable antenna or said another antenna uses phasing (Col. 3, Lines 41-44, 51-54, “phased-array type”).

34. **As per Claim 24**, Werling teaches a method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2; Fig. 1, array 12-15; Col. 2, Lines 54-62; Col. 3, Lines 51-55), comprising the steps of:

detecting, using one or more sensors (Fig. 1, Item 18), one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32), and wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41- 61; Fig. 4; the user proximity is determined several times in a loop; the number of times of performing the method steps depends on the number of programmed iterations);

receiving signals on said at least one steerable antenna or another antenna, wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above.

However Rappaport teaches a method of communication with a wireless device (Par. 0003, 0017), wherein the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Rappaport's method as wireless devices evolve to millimeter wave (mmWave) carrier frequencies (Rappaport: Par. 0039).

35. **As per Claim 27**, Werling teaches a wireless device for avoiding radiation of a user or structure (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2; Fig. 1, array 12-15; Col. 2, Lines 54-62; Col. 3, Lines 51-55), comprising:

one or more sensors (Fig. 1, Item 18) configured to detect one or more parameters of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

one or more processors communicatively coupled to said one or more sensors (Col. 3, Lines 1-14; Fig. 1, control element 17);

at least one steerable antenna communicatively coupled to said one or more processor (Fig. 1, Items 12-15; Col. 2, Lines 56-59; Col. 3, Lines 45-55);

and a non-transitory computer readable medium comprising executable instructions (Col. 2, Lines 59- 65; Fig. 1, control element 17) that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said one or more parameters (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions, wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions (Col. 3, Lines 15-22, 27-32), wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63; Col. 4, Lines 41- 61; Fig. 4; the user proximity is determined several times in a loop; the number of times of performing the method steps depends on the number of programmed iterations); and

a receiver for receiving over-the-air signals on said at least one steerable antenna or another antenna, wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said another antenna used by said receiver to receive said over-the-air signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

While Werling teaches that the equipment operates with frequencies in the gigahertz domain (Col 3, Lines 41-44), Werling does not teach that the at least one steerable antenna radiates at 10 gigahertz (GHz) or above.

However Rappaport teaches a wireless device (Par. 0003, 0017), wherein the at least one steerable antenna radiates at 10 gigahertz (GHz) or above (Par. 0027, 0039).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Rappaport's device as wireless devices evolve to millimeter wave (mmWave) carrier frequencies (Rappaport: Par. 0039).

36. **As per Claim 30**, Werling teaches a steerable antenna system for avoiding radiation of a user or structure by a wireless device (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2; Fig. 1, array 12-15; Col. 2, Lines 54-62; Col. 3, Lines 51-55), comprising:

one or more sensors (Fig. 1, Item 18) configured to detect at least one parameter of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

a computation module communicatively coupled to said one or more sensors (Col. 3, Lines 1-14; Fig. 1, control element 17) configured to determine zones or spans of directions (Col. 3, Lines 8-14);

at least one steerable antenna communicatively coupled to said computation module (Fig. 1, Items 12-15; Col. 2, Lines 56-59; Col. 3, Lines 45-55), said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions, wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna (Col. 3, Lines 15-22, 27-32); and

a receiver for receiving signals on said at least one steerable antenna or another antenna, wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said another antenna used by said receiver to receive said signals (Col. 3, Lines 19-21, 37-41, 57-60; Rx).

37. **Claims 25, 28 and 31 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rappaport (US 20100060531) and Smulders ("Exploiting the 60 GHz Band for Local Wireless Multimedia Access: Prospects and Future Directions", IEEE Communications Magazine; January 2002).**

38. **As per Claim 25**, Werling teaches the method set forth above, but does not teach it further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna.

However, Smulders teaches a method of wireless communication (Page 140, Introduction), the method further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna (Page 145; “Dual-Band Operation”, column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Smulders method for cost reduction, processing efficiency and power efficiency (Smulders: Page 145; “Dual-Band Operation”, column 2, last paragraph).

39. **As per Claim 28**, Werling teaches the wireless device set forth above, but does not teach that said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said another antenna.

However, Smulders teaches a device for wireless communication (Page 140, Introduction), wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable

antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said another antenna (Page 145; “Dual-Band Operation”, column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Smulders device for cost reduction, processing efficiency and power efficiency (Smulders: Page 145; “Dual-Band Operation”, column 2, last paragraph).

40. **As per Claim 31**, Werling teaches the steerable antenna system set forth above, but does not teach that the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna.

However, Smulders teaches a system for wireless communication (Page 140, Introduction), wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna (Page 145; “Dual-Band Operation”, column 2, last paragraph).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Smulders system for cost

reduction, processing efficiency and power efficiency (Smulders: Page 145; “Dual-Band Operation”, column 2, last paragraph).

41. **Claims 14, 18, 22, 26, 29 and 32 are rejected under pre-AIA 35 U.S.C. 103 as being unpatentable over Werling (US 6456856) and further in view of Rappaport (US 20100060531) and Kezys (US 20060084395)**

42. **As per Claim 14**, Werling teaches the method set forth above, but does not teach that said step of receiving signals with said at least one steerable antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a method for avoiding radiation of a user or structure by a wireless device (Par. 0002, 0016), wherein said step of receiving signals with said at least one steerable antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Smulders method to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

43. **As per Claim 18**, Werling teaches the wireless device set forth above, but does not teach that said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a wireless device for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Smulders device to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

44. **As per Claim 22**, Werling teaches the steerable antenna system set forth above but does not teach that said receiver using said at least one steerable antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a system for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver using said at least one steerable antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Smulders system to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

45. **As per Claim 26**, Werling teaches the method set forth above, but does not teach that said step of receiving signals with said at least one steerable antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a method for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said step of receiving signals with said at least one steerable antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the method of Werling with the property of Smulders method to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

46. **As per Claim 29**, Werling teaches the wireless device set forth above, but does not teach that said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a wireless device for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the device of Werling with the property of Smulders device to provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

47. **As per Claim 32**, Werling teaches the steerable antenna system set forth above, but does not teach that said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

However, Kezys teaches a system for avoiding radiation of a user or structure (Par. 0002, 0016), wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure (Par. 0017, 0019, 0038, 0040-0041, 0051).

At the time of the invention, it would have been obvious for one of ordinary skill in the art to have modified the system of Werling with the property of Smulders system to

provide overall high antenna system efficiency for the common user holding position and provide optimized signal reception in reaction to the device's immediate environment (Kezys: Par. 0016, 0051).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, THIS ACTION IS MADE FINAL. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HELENA SERAYDARYAN whose telephone number is (571)270-0706. The examiner can normally be reached on M-Th, 7:30-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tashiana Adams can be reached on (571)270-5228. 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 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.

/HELENA SERAYDARYAN/

Examiner, Art Unit 3648

/TASHIANA ADAMS/
Supervisory Patent Examiner, Art Unit 3648

Notice of References Cited	Application/Control No. 13/966,853	Applicant(s)/Patent Under Reexamination RAPPAPORT, THEODORE S.	
	Examiner HELENA SERAYDARYAN	Art Unit 3648	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-2006/0084395 A1	04-2006	Kezys; Vytautas Robertas	H01Q1/243	455/101
*	B	US-2010/0060531 A1	03-2010	Rappaport; Theodore S.	H01Q1/243	343/702
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
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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	P. Smulders, "Exploiting the 60 GHz Band for Local Wireless Multimedia Access: Prospects and Future Directions", IEEE Communications Magazine; January 2002.
	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.

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13966853
Filing Date	2013-08-14
First Named Inventor	T. Rappaport
Art Unit	3648
Examiner Name	SERAYDARYAN
Attorney Docket Number	08610010PA

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	1	20160103199	A1	2016-04-14	T. Rappaport	

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /H.H.S/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Filing Date	2013-08-14
First Named Inventor	T. Rappaport
Art Unit	3648
Examiner Name	SERAYDARYAN
Attorney Docket Number	08610010PA

	1	T. RAPPAPORT ET AL., Millimeter Wave Wireless Communications, Chapter 1, 2015 Prentice Hall.
	2	T. RAPPAPORT ET AL., "Wideband Millimeter-Wave Propagation Measurements and Channel Models for Future Wireless Communication System Design," IEEE TRANSACTIONS ON COMMUNICATIONS, September 2015, pages 3029-3056, vol. 63, no. 9.
	3	T. RAPPAPORT ET AL., "Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!", IEEE ACCESS, May 2013, pages 335-349, vol. 1.

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EXAMINER SIGNATURE

Examiner Signature	/HELENA H SERAYDARYAN/	Date Considered	10/31/2016

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

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

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Filing Date	2013-08-14
First Named Inventor	T. Rappaport
Art Unit	3648
Examiner Name	SERAYDARYAN
Attorney Docket Number	08610010PA

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael E. Whitham/	Date (YYYY-MM-DD)	2016-08-02
Name/Print	Michael E. Whitham	Registration Number	32635

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

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

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

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13966853	RAPPAPORT, THEODORE S.
	Examiner	Art Unit
	HELENA SERAYDARYAN	3648

CPC- SEARCHED		
Symbol	Date	Examiner
H01Q1/245	4/11/2016	H.S.
H01Q1/245 (updated)	11/2/2016	H.S.

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
342	368	4/1/2016	H.S.
342	368 (updated)	11/2/2016	H.S.

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search in PALM	4/1/2016	H.S.
Inventor Name Search in EAST	4/1/2016	H.S.
Text Search in EAST	4/11/2016	H.S.
Consulted with Primary G. Issing	4/1/2016	H.S.
Consulted with G. Issing	11/2/2016	H.S.

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

/HELENA SERAYDARYAN/ Examiner.Art Unit 3648	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	40	342/368.ccls. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:57
L3	91	H01Q1/245.cpc. and @pd>"20160506"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/11/02 16:59
S1	104	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2016/04/01 13:02
S2	218	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:02
S3	1	S2 and ((steerable adj antenna) with sensors)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S4	1748	342/368.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S5	3044	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S6	2704	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S7	4870	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S8	6373	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S10	23279	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S11	196	steer$4 with sensor with phone	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:47
S14	36859	S5 or S6 or S7 or S8 or S10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49

S16	775	steer$4 with sensor with (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S17	11	S16 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S18	6	S14 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S19	3	"52780741".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/11 16:51
S20	1533	S14 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S21	452	S20 and (cellphone or phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S22	77	S20 and (cellphone or phone)S21 and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S23	1	S22 and (steer$4 or redirect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:55
S24	73	S22 and (steer$4 or redirect$4 or direct$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:56
S25	1	2014-T60821.NRAN.	DERWENT	AND	ON	2016/04/11 16:57
S26	19336	((steer$4 or redirect$4 or direct or direction or directionality) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S27	41	S14 and S26	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S28	25566	((steer$4 or redirect$4 or direct or direction or directionality or pattern) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:33
S29	79	S14 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:34
S30	27	H01Q1/245.cpc. and steer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:35
S31	277	H01Q1/245.cpc. and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:49

S32	1058	steer$4 with antenna with mobile	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/12 09:08
S33	5	"9529117".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/12 09:34
S34	2	(US-20080242349-$).did. or (US-6456856-$).did.	US-PGPUB; USPAT	AND	ON	2016/04/12 10:53

11/2/2016 5:30:01 PM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13966853	RAPPAPORT, THEODORE S.
	Examiner	**Art Unit**
	HELENA SERAYDARYAN	3648

✓	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	04/12/2016	11/02/2016							
	1	✓	✓							
	2	✓	-							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
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	29		✓							
	30		✓							
	31		✓							
	32		✓							

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13966853
Filing Date	2013-08-14
First Named Inventor	T. Rappaport
Art Unit	3648
Examiner Name	SERAYDARYAN
Attorney Docket Number	08610010PA

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20160103199	A1	2016-04-14	T. Rappaport	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13966853
	Filing Date	2013-08-14
	First Named Inventor	T. Rappaport
	Art Unit	3648
	Examiner Name	SERAYDARYAN
	Attorney Docket Number	08610010PA

	1	T. RAPPAPORT ET AL., Millimeter Wave Wireless Communications, Chapter 1, 2015 Prentice Hall.
	2	T. RAPPAPORT ET AL., "Wideband Millimeter-Wave Propagation Measurements and Channel Models for Future Wireless Communication System Design," IEEE TRANSACTIONS ON COMMUNICATIONS, September 2015, pages 3029-3056, vol. 63, no. 9.
	3	T. RAPPAPORT ET AL., "Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!", IEEE ACCESS, May 2013, pages 335-349, vol. 1.

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13966853
	Filing Date	2013-08-14
	First Named Inventor	T. Rappaport
	Art Unit	3648
	Examiner Name	SERAYDARYAN
	Attorney Docket Number	08610010PA

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael E. Whitham/	Date (YYYY-MM-DD)	2016-08-02
Name/Print	Michael E. Whitham	Registration Number	32635

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

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

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

Electronic Patent Application Fee Transmittal

Application Number:	13966853
Filing Date:	14-Aug-2013
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham/Walter Richardson
Attorney Docket Number:	08610010PA

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	2806	1	90	90
		Total in USD ($)		**90**

Electronic Acknowledgement Receipt

EFS ID:	26516725
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham/Walter Richardson
Filer Authorized By:	Michael E. Whitham
Attorney Docket Number:	08610010PA
Receipt Date:	02-AUG-2016
Filing Date:	14-AUG-2013
Time Stamp:	10:15:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$90
RAM confirmation Number	080216INTEFSW00008037502041
Deposit Account	502041
Authorized User	Walter Richardson

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	08610010PA_IDS3.pdf	612702 aa2197d1eef90cfa73e0b1b5aafda8e219f4fd0f	no	4
Warnings:					
Information:					
2	Non Patent Literature	08610010pa_IDS3_npl1.pdf	1160866 234a0bfa86e0e5cb47095c9229414a9c7674d1c8	no	4
Warnings:					
Information:					
3	Non Patent Literature	08610010pa_IDS3_npl2.pdf	2513054 710ef9b0d40bc4c49f4db32f6c3d2dd12d7a87a7	no	28
Warnings:					
Information:					
4	Non Patent Literature	08610010pa_IDS3_npl3.pdf	1277279 49e5f3a3a57cb7dfa04df22d28274349d8f417f9	no	15
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	30272 93103e1d862222d5c38daf7bc24a627fa87481e4	no	2
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		Total Files Size (in bytes):	5594173		

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Rappaport

Serial No. 13/966,853

Filed August 14, 2013

For STEERABLE ANTENNA DEVICE

Confirmation No. 2489

Group Art Unit 3648

Examiner Seraydaryan

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

AMENDMENT UNDER 37 C.F.R. 1.111

Sir:

The undersigned thanks the Examiner for the interview which took place on July 27, 2016. This amendment makes the substance of the interview of record in the application.

In response to the office action mailed May 6, 2016, please amend the above-identified patent application as follows:

Amendments to the Specification begin on page 2

Amendment to the Abstract begin on page 3

Amendments to the Claims: begin on page 4

Remarks: begin on page 13

Amendments to the Specification

On page 19, please amend the first full paragraph as follows:

Note that beamforming operations may also be used to simultaneously find the best or sufficient beam pointing directions to ensure a link between the transmitter and receiver, while still avoiding radiation of energy toward a human user. It should be noted that for receiving signals, the same beam arrays used for transmitting might be used to point in a different direction (for example, on receive, the beam array may wish to point at a human user to pick up reflections off of the human body). In future mmWave wireless systems, time division duplexing may be likely, since the transmitter-receiver distances will likely shrink to a few hundred meters, allowing antenna arrays to be used partially for transmit and partially for receive, in a time division duplexed fashion, thereby allowing a device to provide different beam patterns on transmit than on receive. It is understood that as future mmWave wireless standard evolve, the beamforming computations need to be made within a time frame between successive time division transmissions. Thus a portable wireless device would need to be able to use sensory information to determine spatial zones of avoidance of the beamforming process, so that the computations and recomputations (as the device is moved) in a periodic or non periodic fashion between transmission slots (as indicated by the wireless standards created for mmWave wireless systems, <u>are</u> ~~or~~ at least at a rate much <u>greater</u> ~~less~~ than the movement of humans, so as to ensure that the primary beam directions would avoid the zones where the human would be estimated to be by the wireless portable device.

Amendments to the Abstract

Please amend the Abstract as follows:

Wireless devices, and particularly mobile devices such as cellphones, PDAs, computers, navigation devices, etc., as well as other devices which transmit or receive data or other signals at multiple frequency bands utilize at least one steerable antenna, and may be configured to transmit and receive using ~~and a~~ plurality of different bands (e.g., GSM cellular communication band; Bluetooth short range communication band; ultrawideband (UWB) communications, etc.). These wireless devices can determine zones or spans of directions in which to avoid radiating beams at 10 GHz or above, and can receive signals on either the steerable antenna or another antenna. In addition, the wireless devices can be configured for radiating in a pattern that is different from the receiving pattern. ~~simultaneously transmit or receive at a plurality of different bands, or simultaneously transmit and receive at different bands. The wireless devices have the ability to use a single physical structure (e.g., an antenna) for transmission and reception of many different bands. The antenna can be either actively tuned or passively tuned using one or more elements. The antenna may comprise a plurality of antenna elements or antennas, and at least one antenna may be a steerable antenna.~~

Listing of the Claims:

The following is a complete listing of all the claims in the application, with an indication of the status of each:

1. (currently amended) A method for avoiding radiation of a user or structure by a wireless device having at least one ~~a~~ steerable antenna which radiates at 10 gigahertz (GHz) or above, comprising the steps of:

detecting, using one or more sensors, one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device;

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna which radiates at 10 GHz or above to radiate in one or more directions which are not in said zones or spans of directions,

wherein said at least one steerable antenna operates on multiple bands, and

wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time; and

receiving signals on said at least one steerable antenna or another antenna.

2. (canceled)

3. (original) The method of claim 1, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to one or more of the proximity of a user or orientation of user with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer;

detecting heat from a human user with at least one heat sensor; and

detecting touch or proximity of a user's skin or clothing with at least one capacitive sensor.

4. (currently amended) A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect one or more parameters ~~at least one parameter~~ of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;

one or more processors communicatively coupled to said one or more sensors;

at least one ~~a~~ steerable antenna communicatively coupled to said one or more processors,

wherein said at least one steerable antenna radiates at 10 GHz or above; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said one or more parameters ~~at least one parameter~~;

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions,

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions,

wherein said at least one steerable antenna operates on multiple bands, and

wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time; and

a receiver for receiving over-the-air signals on said at least one steerable antenna or another antenna.

5. (currently amended) The wireless device of claim 4, wherein said at least one steerable antenna comprises a plurality of steerable antennas~~, said plurality of antennas forming an antenna array~~.

6. (original) The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, heat sensors, gyroscopes, light or motion detectors, capacitive detectors, microphones, and ultrasound sensors or transducers.

7. (original) The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

8. (currently amended) A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect at least one parameter of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions; ~~and~~

at least one ~~a~~ steerable antenna communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna,

wherein said at least one steerable antenna operates on multiple bands; and

a receiver for receiving signals on said at least one steerable antenna or another antenna.

9. (currently amended) The steerable antenna system of claim 8, wherein said at least one steerable antenna comprises a plurality of steerable antennas~~, said plurality of antennas forming an antenna array~~.

10. (original) The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, heat sensors, gyroscopes, light or motion detectors, capacitive detectors, microphones, and ultrasound transducers.

11. (original) The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

12. (New) The method of claim 1 wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

13. (New) The method of claim 1 wherein said signals received in said receiving step are 10 GHz or above.

14. (New) The method of claim 1 wherein said step of receiving signals with said at least one steerable antenna or another antenna receives said signals arriving from one or more directions that are within said zones or spans of directions of said user or structure.

15. (New) The method of claim 1 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

16. (New) The wireless device of claim 4 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna or said another antenna used by said receiver to receive said over-the-air signals.

17. (New) The wireless device of claim 4 wherein said receiver receives said over-the-air signals of 10 GHz or above.

18. (New) The wireless device of claim 4 wherein said receiver receives said over-the-air signals in one or more directions that are within said zones or spans of directions of said user or structure.

19. (New) The wireless device of claim 4 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

20. (New) The steerable antenna system of claim 8 wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern of said at least one steerable antenna or said another antenna used by said receiver to receive said signals.

21. (New) The steerable antenna system of claim 8 wherein said receiver receives signals of 10 GHz or above.

22. (New) The steerable antenna system of claim 8 wherein said receiver using said at least one steerable antenna or another antenna receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

23. (New) The steerable antenna system of claim 8 wherein said at least one steerable antenna or said another antenna uses one or more of: beamforming, beamsteering, beam or antenna element selection, adaptive beamforming, multibeam combining, MIMO, phasing, beam switchable array, active combining, passive combining, and hybrid antenna structure.

24. (New) A method for avoiding radiation of a user or structure by a wireless device having at least one steerable antenna which radiates at 10 gigahertz (GHz) or above, comprising the steps of:

detecting, using one or more sensors, one or more parameters of either said wireless device or pertaining to said user's or said structure's physical relationship to said wireless device;

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna which radiates at 10 GHz or above to radiate in one or more directions which are not in said zones or spans of directions, and

wherein said steps of detecting, determining, and adjusting are performed multiple times as said one or more parameters change over time;

receiving signals on said at least one steerable antenna or another antenna,

wherein a directional radiating pattern of said one or more beams is different from a receiving pattern used in said step of receiving said signals.

25. (New) The method of claim 24 further comprising using time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna.

26. (New) The method of claim 24 wherein said step of receiving signals with said at least one steerable antenna or another antenna receives said signals arriving

from one or more directions that are within said zones or spans of directions of said user or structure.

27. (New) A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect one or more parameters of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;

one or more processors communicatively coupled to said one or more sensors;

at least one steerable antenna communicatively coupled to said one or more processors,

wherein said at least one steerable antenna radiates at 10 GHz or above; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said one or more parameters;

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions,

wherein said at least one steerable antenna radiates said one or more beams based on signals from said one or more processors determined on execution of said executable instructions,

wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time; and

a receiver for receiving over-the-air signals on said at least one steerable antenna or another antenna,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said another antenna used by said receiver to receive said over-the-air signals.

28. (New) The wireless device of claim 27 wherein said wireless device is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and using over-the-air signals received by at least one of said at least one steerable antenna or said another antenna.

29. (New) The wireless device of claim 27 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

30. (New) A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect at least one parameter of either said wireless device or pertaining to a user's or structure's physical relationship to said wireless device;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions;

at least one steerable antenna communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna; and

a receiver for receiving signals on said at least one steerable antenna or another antenna,

wherein a directional radiating pattern of said one or more beams radiated from said at least one steerable antenna is different from a receiving pattern used by said at least one steerable antenna or said another antenna used by said receiver to receive said signals.

31. (New) The steerable antenna system of claim 30 wherein the steerable antenna system is configured for time division duplexing for communication, using said one or more beams radiated by said at least one steerable antenna and signals received by at least one of said at least one steerable antenna or said another antenna.

32. (New) The steerable antenna system of claim 30 wherein said receiver receives signals in one or more directions that are within said zones or spans of directions of said user or structure.

REMARKS

The specification is amended to correct two obvious typographical errors and put the passage in agreement with the remainder of the paragraph on page 19 and the last five lines on page 16.

The Abstract is amended to better reflect the claimed subject matter.

Claim 2 is canceled. Claims 1, 4, 5, 8, and 9 are amended. Claims 12-32 are added. The application now includes claims 1 and 3-32. The Commissioner is authorized to charge attorney's deposit account 50-2041 (Whitham, Curtis & Cook) for three additional independent claims and eleven excess total claims, and for any other charges required to gain entry and consideration of this amendment. Support for the amendments can be found throughout the patent application particularly at Figure 7 and 8 and pages 15-21.

Claims 1-11 were rejected for being anticipated by U.S. Patent 6,456,856 to Werling. This rejection is traversed in view of the amendments above and remarks below.

As discussed during the interview, and to accelerate the application to grant (the applicant reserving the right to pursue the original claims and/or additional claims in one or more continuing applications) independent claims 1, 4, and 8 each require that the steerable antenna is configured to be able to radiate on multiple bands. This is discussed throughout the application (e.g., page 10, line 1 teaches transmission on multiple bands; page 13, three lines from the bottom and the first full paragraph on page 14 teach transmitter and antenna tuning on multiple bands; page 20, second full paragraph and the last few lines on page 21 teach that the steerable antenna may be implemented in multiple bands, as well as in other passages). For example, the paragraph bridging pages 7 and 8 of the application teaches:

"One potential application of the invention is in the IEEE 802.11ad standard, where very high throughput wireless devices (e.g., 60 GHz carrier transmissions) may use one or more transmitters, receivers or transceivers to simultaneously provide capabilities in the existing 802.11a and 802.11b bands of 2.4 GHz and 5.8 GHz, as well as the 60 GHz spectrum. Instead of requiring

different antennas for the different RF bands, the present invention allows for the use of a single antenna 28 for multiple bands (or multiple antennas, at least one of which can be used for multiple bands, and at least one of which may be a steerable antenna, where a steerable antenna may steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and may be used on one or more bands."

As another example, page 14 states:

"As wireless devices begin to evolve to millimeter wave (mmWave) carrier frequencies above 10 GHz, say at 28 or 38 GHz, and even to frequencies in the 70 to 500 GHz range, and even to Terahertz frequencies, the need to integrate the tuning and interconnection of a single antenna to RF circuitry will become even greater."

As discussed during the interview, U.S. Patent 6,456,856 to Werling does not have any discussion about such a feature, and therefore does not anticipate or make obvious this feature.

Moreover, claims 1, 4, and 8 are amended to be focused on ensuring both radiation in one or more directions that are not zones or spans that correspond to a user or structure relative to the antenna and also being able to receive signals with the steerable antenna or another antenna, and where adjustments are made over time as the parameters change over time. For example, considering the specific case of a mobile phone, as a person walks through an urban setting, the way he or she holds the device can vary, as can the surroundings that affect radio propagation, and this invention adjusts for those variations to continually cause the transmitted energy to avoid the person. This is discussed throughout the specification and particularly on page 19 of the application. U.S. Patent 6,456,856 to Werling does not have any discussion about such features, and because Werling is not working with mm Wave frequencies, Werling would not be as concerned with the importance of directionality imposed by mm Wave frequencies, and thus there would be no reason to make adjustments as contemplated herein. While Werling mentions the possibility of operation in "the gigahertz domain" at column 3, line 44, Werling at no point discussed frequencies of 10 GHz or above, where

directionality of the propagation channel would be much more of a factor in maintaining communications.

The claims are further amended to include the fact that the sensor inputs and computations are required to occur multiple times such that the steering of the transmitter antenna can be updated during movement of the user, the device, or the channel to ensure the transmitter is able to continually avoid the zones where the user or structure are located over time. For example, Claim 4 has been amended to include a step such that "wherein said executable instructions cause said steps of receiving, using, and adjusting to be performed multiple times as said one or more parameters change over time." Support for this step, which requires sufficiently fast update rates to assure on-going communication transmissions while also ensuring that energy is not radiated in the direction of the avoidance zones is given, for example, on page 19:

"Thus a portable wireless device would need to be able to use sensory information to determine spatial zones of avoidance of the beamforming process, so that the computations and recomputations (as the device is moved) in a periodic or non periodic fashion between transmission slots (as indicated by the wireless standards created for mmWave wireless systems), are at least at a rate much greater than the movement of humans, so as to ensure that the primary beam directions would avoid the zones where the human would be estimated to be by the wireless portable device."

Claim 1 has also been amended to include this step, which assures avoidance of the user or structure during movement by the human, the device, the structure, or due to changes in the radio channel that require the radiating pattern to change. This teaching is not found in Werling.

In addition, as discussed during the interview, Werling provides no teaching or suggestion that the radiation pattern of a transmitted beam would be different from the receive pattern, as is required in dependent claims 12, 15, and 18, and independent claims 24, 27, and 30. Werling also provides no teaching or suggestion of being able to intentionally exploit reflections from the user or structure by allowing the receiver antenna pattern to receive energy reflected or scattered from the user or other structure (see., e.g., page 19, lines 3-6) while also

configuring the transmitted beams to intentionally radiate away from the user or structure (see., e.g., claims 14, 18, 22, 26, 29, and 32).

Simply put, Werling's design does not consider multi-band operation, and does not consider the use of the same or alternate antennas for receiving. Furthermore, Werling does not consider that the receiving antenna(s) (which may be the same or different from the transmitting antenna) could implement different beam patterns or directions than that used for transmitting. Furthermore, Werling, fails to teach details needed to create a viable solution for higher frequency bands that recently have been found usable for mobile wireless communication above 10 GHz as provided by the claimed invention, since Werling uses a much more simplistic antenna and control architecture than the claimed invention. Note that at the time of Werling, commercial cellular phone systems around the globe did not operate at frequencies greater than 2 or 3 GHz, and the technologies and spectrum bands for the claimed invention either did not exist, were not practically known or used, or were in their infancy or undiscovered.

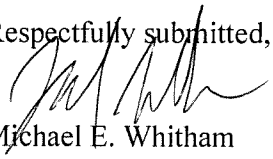
Also, it is important to note that Werling does not teach the need to make multiple computations over time to ensure that the transmitting antenna pattern is able to continually avoid a user or structure over time, while simultaneously adapting to maintain communications in the face of changing device orientations or channel conditions.

In view of the foregoing, it is respectfully requested that the application be reconsidered, that claims 1, 3-32 be allowed, and that the application be passed to issue.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

A provisional petition is hereby made for any extension of time necessary for the continued pendency during the life of this application. Please charge any fees for such provisional petition and any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,



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Electronic Patent Application Fee Transmittal

Application Number:	13966853
Filing Date:	14-Aug-2013
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham
Attorney Docket Number:	08610010PA

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Claims in excess of 20	2202	11	40	440
Independent Claims in Excess of 3	2201	3	210	630
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1070**

Electronic Acknowledgement Receipt

EFS ID:	26520492
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham
Filer Authorized By:	
Attorney Docket Number:	08610010PA
Receipt Date:	02-AUG-2016
Filing Date:	14-AUG-2013
Time Stamp:	13:43:56
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	yes
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Payment was successfully received in RAM	$1070
RAM confirmation Number	080216INTEFSW00010784502041
Deposit Account	502041
Authorized User	Michael Whitham

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1		08610010pa_res_8_2_16.pdf	556270 f2bbec2e2df593c8fb7d0edbe88e0c5f72eb867e	yes	17

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Abstract	2	2
	Specification	3	3
	Claims	4	12
	Applicant Arguments/Remarks Made in an Amendment	13	17

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	31799 847c85ac89331413c49e24fcaf49ba483c7f5f10	no	2
Warnings:					
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			Total Files Size (in bytes):	588069	

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/966,853	Filing Date 08/14/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT	08/02/2016	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 31	Minus	** 20	= 11	X $40 =	440
	Independent (37 CFR 1.16(h))	* 6	Minus	***3	= 3	X $210 =	630
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	1070

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** 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 number found in the appropriate box in column 1.

LIE
CHRISTINE V. MOORE

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Rappaport | Confirmation No. 2489

Serial No. 13/966,853 | Group Art Unit 3648

Filed August 14, 2013 | Examiner Seraydaryan

For STEERABLE ANTENNA DEVICE

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

TOPICS FOR DISCUSSION AT INTERVIEW JULY 27, 2016

PROPOSED AMENDMENTS TO INDEPENDENT CLAIMS AND NEW CLAIMS

1. (currently amended) A method for avoiding radiation of a user or structure by a wireless device having at least one a steerable antenna which radiates and or receives at 10 gigahertz (GHz) or above, comprising the steps of:

detecting, using one or more sensors, one or more parameters of said wireless device or pertaining to said user's physical relationship to said wireless device;

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna which radiates ~~to radiate~~ and or receives at 10 GHz or above in one or more directions which are not in said zones or spans of directions and to ensure a wireless link,

wherein said one or more beams are adjusted as said one or more parameters change over time.

4. (currently amended) A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect one or more parameters ~~at least one parameter~~ of said wireless device or pertaining to a user's physical relationship to said wireless device;

one or more processors communicatively coupled to said one or more sensors;

at least one ~~a~~-steerable antenna communicatively coupled to said one or more processors wherein said at least one steerable antenna radiates and/or receives at 10 GHz or above; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said one or more parameters~~at least one parameter~~;

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna; and

adjusting one or more beams of said at least one steerable antenna to radiate in one or more directions which are not in said zones or spans of directions and to ensure a wireless link,

wherein said at least one steerable antenna radiates in said one or more directions at 10 GHz or above based on signals from said one or more processors determined on execution of said executable instructions,

wherein said one or more beams are adjusted as said one or more parameters change over time.

8. (currently amended) A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect at least one parameter of said wireless device or pertaining to a user's physical relationship to said wireless device;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions; and

at least one a-steerable antenna communicatively coupled to said computation module, said at least one steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions and to ensure a wireless link,

wherein said at least one steerable antenna radiates and/or receives at 10 GHz or above,

wherein said one or more beams are adjusted as said one or more parameters change over time,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said at least one steerable antenna.

12. (New) The method of claim 1 wherein said one or more beams simultaneously radiate on multiple bands.

13. (New) The wireless device of claim 4 wherein the one more beams simultaneously radiate on multiple bands.

14. (New) The steerable antenna system of claim 8 wherein the one or more beams simultaneously radiate on multiple bands.

SUPPORT IN THE SPECIFICATION

Claims 12-14 pertain to configurations for simultaneous transmission in multiple bands using the same steerable antenna to better enable simultaneous multipurpose use. This is discussed throughout the application (see for example page 6, lines 1-4, and page 14, lines 13 and 14). U.S. Patent 6,456,856 to Werling does not have any discussion about such a feature, and therefore does not anticipate or make obvious this feature.

Claims 1, 4, and 8 are amended to be focused on mmWave frequencies. The use of mmWave frequencies at or above 10 GHz are discussed on page 20 second full paragraph (and at other locations such as page 14 second paragraph, etc.). Claims 1, 4, and 8 are amended to be focused on ensuring both radiation (i.e.,

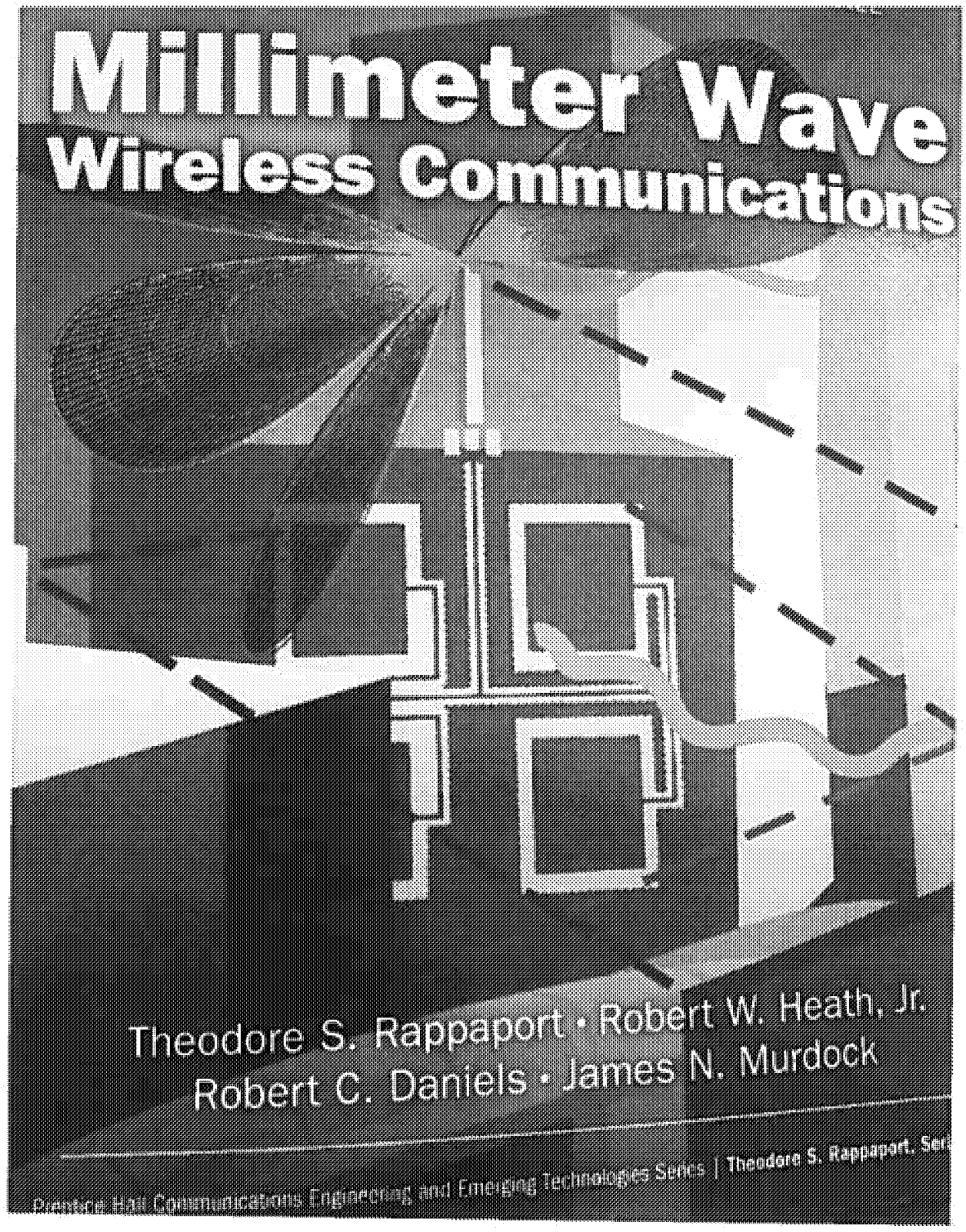
transmission) in one or more directions that are not zones or spans that correspond to a user or structure relative to the antenna and to ensure a wireless link (i.e., people and or objects that interfere with transmission are avoided and a wireless communications link is maintained) and adjustments are made over time as the parameters change over time (e.g., as a person walks through an urban setting the way he or she holds the device can vary and the surroundings can vary, and this invention adjusts for that). This is discussed throughout the specification and particularly at the first full paragraph on page 19 of the application. U.S. Patent 6,456,856 to Werling does not have any discussion about such features, and therefore does not anticipate or make obvious this feature.

RELATED EVIDENCE

Directionality of the radio propagation channel is an important distinguishing feature with mmWaves. The claimed invention teaches how mmWave devices can be used by people in the real world which is not taught, discussed or alluded to by U.S. Patent 6,456,856 to Werling.

See the following

1) Rappaport, Millimeter Wave Wireless Communications
2) 6 Ways Federal Investments Helped Usher in Our Wireless World, *Huffington Post* 7 22 2016 (recognition of Dr. Rappaports contribution in mmWaves)
3) *Spectrum Frontiers: The New World of Millimeter Wave Mobile Communication* March 10, 2016 (discussion of directionality)
4) *Spectrum Frontiers Workshop*
5) Rappaport, *IEEE Transactions on Communications* 63(9):3029-3055 Figs 17 and 18 that show how when there is an obstruction, the channel becomes highly directional
6) Rappaport, *IEEE Access* May 29, 2013(see figure 9)



Samsung Ex. 1002, Page 516 of 679

MEW

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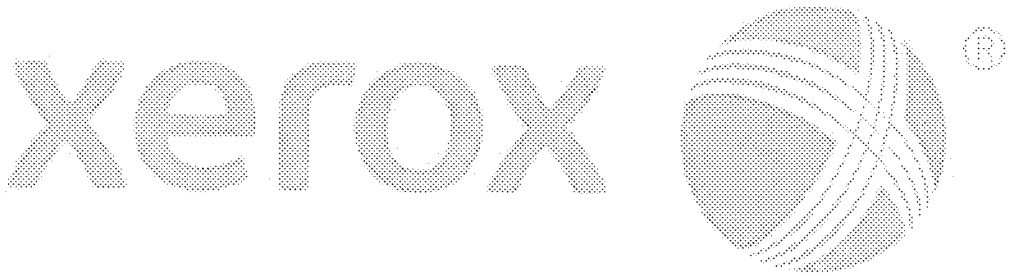

MmWave wireless communication [illegible] concepts. As of the writing of this book, mmWave based on the 60 GHz unlicensed band is seeing the most active commercial deployment in consumer devices through IEEE 802.11ad [IEE12]. The cellular industry is just beginning to realize the potential for much greater bandwidths for mobile users in the mmWave bands [Gro13][RSM+13]. Many of the design examples in this book draw from the experience in 60 GHz systems and the authors' early works on mmWave cellular and peer-to-peer studies for the 28 GHz, 38 GHz, 60 GHz, and 72 GHz bands. But 60 GHz WLAN, WPAN, backhaul, and mmWave cellular are only the beginning these are early versions of the next generation of mmWave and terahertz systems that will support even higher bandwidths and further advances in connectivity.

New 60 GHz wireless products are exciting, not only because of their ability to satisfy consumer demand for high-speed wireless access, but also because 60 GHz products may be deployed worldwide, thanks to harmonious global spectrum regulations. Global spectrum allocations allow manufacturers to develop worldwide markets, as demonstrated through the widespread adoption and commercial success of IEEE 802.11b WLANs in 1999, and more recent improvements such as IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, and IEEE 802.11ac WLANs that all operate in the same globally allocated spectrum. WLAN succeeded because there was universal international agreement for the use of the 2.4 GHz ISM and 5 GHz Unlicensed National Information Infrastructure bands, which allowed major manufacturers to devote significant resources to create products that could be sold and used globally. Without international spectral agreements, technology can fizzle. This was demonstrated by early Ultra-wide band (UWB) at the turn of the century, whose initial hype dramatically waned in the face of nonuniform worldwide spectral interference regulations. Fortunately, the governments of the USA, Europe, Korea, Japan, and Australia have largely followed the recommendations of the ITU, which designated frequencies between 57 and 66 GHz for unlicensed communications applications [Intb]. In the USA, the FCC has designated bands from 57 to 64 GHz for unlicensed use [Fed06]. In Europe, the European CEPT has allocated bands from 59 to 66 GHz for some form of mobile application [Tan06]. Korea and Japan have designated bands from 57 to 66 GHz and 59 to 66 GHz, respectively [DMRH10]. Australia has dedicated a smaller band from 59.3 to 62.9 GHz. Consequently, there is roughly 7 GHz of spectrum available worldwide for 60 GHz devices.

At the time of this writing, the cellular industry is just beginning to explore similar spectrum harmonization for the use of mobile cellular networks in frequency bands that are in the mmWave spectrum.[1] Dubbed "Beyond 4G" or "5G" by the industry, new cellular network concepts that use orders of magnitude more channel bandwidth, for simultaneous mobility coverage as well as wireless backhaul, are just now being introduced to governments and the ITU to create new global spectrum bands at carrier frequencies that are at least an order of magnitude greater than today's fourth-generation (4G) Long

1. Although the mmWave band is formally defined as the spectrum between 30 and 300 GHz, the industry has loosely considered the term *mmWave* to denote all frequencies between 10 and 100 GHz. The term "sub-terahertz" has been used loosely to define frequencies above 100 GHz but lower than 300 GHz.

new technologies and fundamental knowledge for future mmWave wireless devices and networks [NY13]. The Wireless Networking and Communications Group (WNCG) at The University of Texas at Austin has a vibrant research program on 5G cellular technologies including mmWave [rW13]. The University of Southern California, the University of California at Santa Barbara, the University of California at Berkeley, the California Institute of Technology, the University of Bristol, and the Korea Advanced Institute of Science and Technology (KAIST) are just some of the many universities that have substantial research efforts on mmWave for future wireless networks.

WPANs, WLANs, and cellular communication mark the beginning of mass consumer applications of mmWave, where we evolve to a world where data is transported to and from the cloud and to each other in quantities we cannot fathom today. We believe that mmWave is the "tip of the iceberg" for dramatic new products and changes in our way of life, and will usher in a new generation of engineers and technologists with new capabilities and expertise. This exciting future will bring about revolutionary changes in the way content is distributed among us, and will completely change the form factor of many electronic devices, motivating the use of larger bandwidths found in the mmWave spectrum for many other types of networks, far beyond 60 GHz [RMG11] [Rap12a]. For this to happen, however, many challenges must be overcome. Although we predict that future inexpensive UWB wireless cellular and personal area networks will be enabled through a move to mmWave frequencies and continued advancements in highly integrated digital circuitry, we do not predict that all future advancements will be carried on the shoulders of solid-state process engineers, alone. Future wireless engineers will need to understand not only communications engineering and wireless system design principles, but also circuit design, antenna and propagation models, and mmWave electromagnetic theory to successfully codevelop their designs of future wireless solutions.

1.2 A Preview of MmWave Implementation Challenges

Implementation challenges for mmWave communication involve many layers of the communications stack. At the hardware level of the PHY, antennas are a major challenge. To minimize costs, mmWave chipset vendors may prefer to exploit the short carrier wavelength by incorporating antennas or antenna arrays directly on-chip or in-package. For the simplest and lowest-cost solutions, high-gain single solutions are attractive [RGAA09]. Single-antenna solutions, however, must overcome the challenges of low on-chip efficiencies whereas in-package antennas must overcome lossy package interconnects. MmWave systems may also employ many closely spaced antennas in packages smaller than a centimeter when using high-dielectric materials. Adaptive or switched-beam antenna arrays can provide transmit and receive antenna gain, but require protocol modifications at the signal processing level of the PHY and the data link layer to direct the beams.

A cornerstone of low-cost mmWave circuits is the use of CMOS or SiGe technology. Silicon on Insulator (SOI) CMOS processes are also attractive for high-end applications as they provide impressive quality (Q) factors due to reduced values for parasitic capacitances and inductances. SOI processes, however, suffer from increased costs compared with standard CMOS with a joined device channel and substrate. Because CMOS processes have now reached transit frequencies of hundreds of gigahertz, single-chip mmWave

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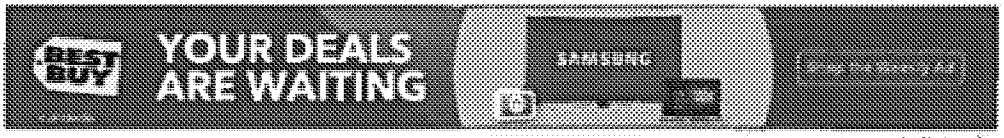
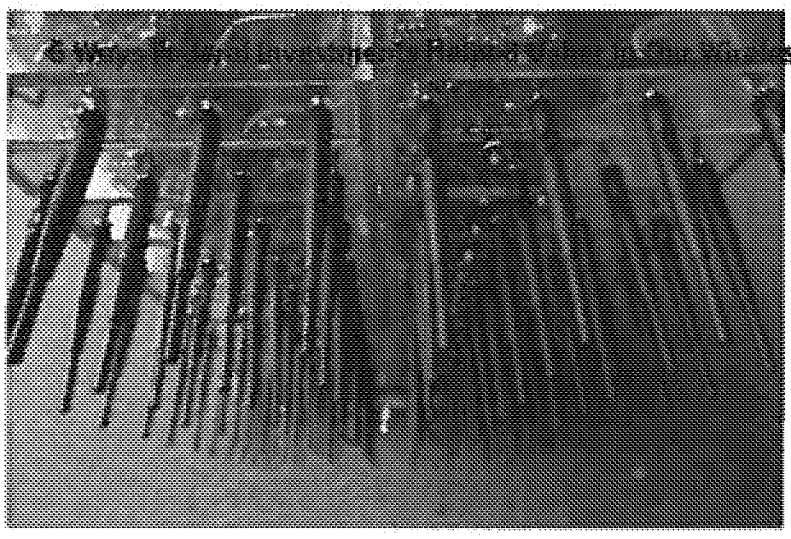


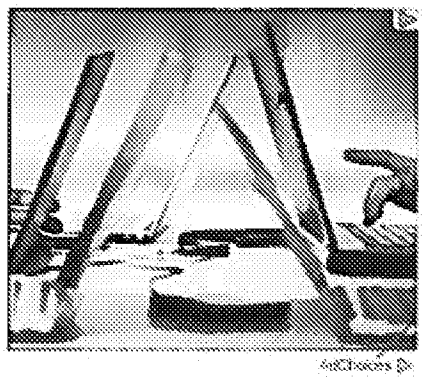
THE BLOG

6 Ways Federal Investments Helped Usher In Our Wireless World

Alexis Dubrow
Media officer for the National Science Foundation covering advances in computing, IT, cyberinfrastructure and engineering



Rice University's Argos Network uses base stations with more than 100 antennas to share spectrum



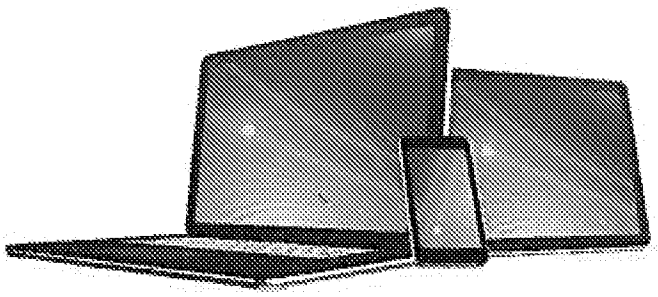
This is far from NSF's first foray into wireless research. From fundamental mathematics to engineered devices to leading telecommunications companies, NSF support for fundamental wireless communication research led to the advances that enabled 3G, 4G, LTE and Wi-Fi and helped make the wireless world what it is today.

Here are six pivotal advances in wireless communications enabled by NSF.

Nurturing an industry leader

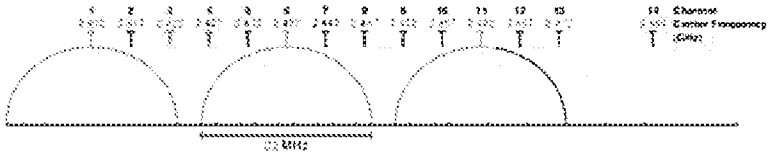
In 1987, Andrew Viterbi, the co-founder of Qualcomm, Inc., received the first of two NSF Small Business Innovation Research (SBIR) awards to advance Code Division Multiple Access (CDMA), a technology used in wireless communication throughout the world.

CDMA allows multiple users to communicate with cell phones, satellites and radios on the same physical channel through the sharing of bandwidth.



Wireless communications have transformed how we live and work.

only the portion of the data that contains no apparent errors. The technology is vital in high-speed wireless networking, cable modems and digital television.



Graphical representation of Wi-Fi channels in the 2.4 GHz band

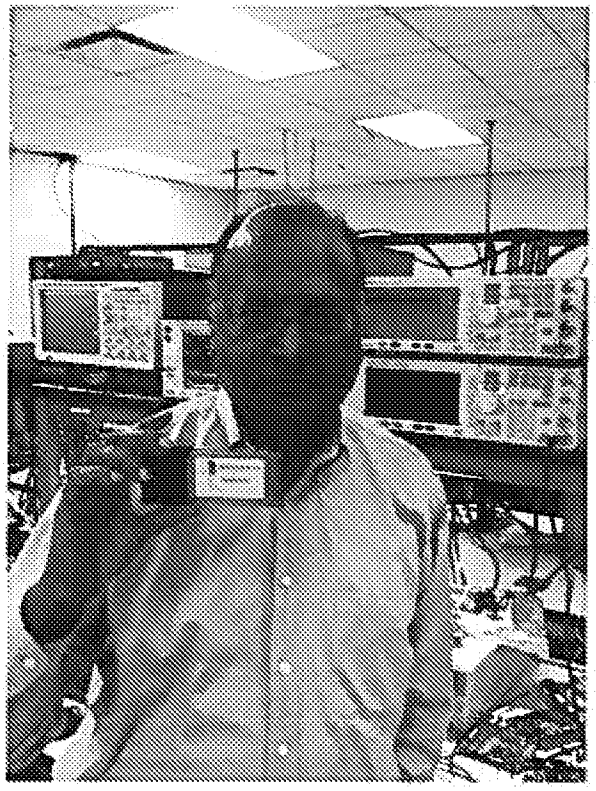
In 1997, Heegard founded Alantro, a Santa Rosa-based startup that ultimately developed the underlying technology for Wi-Fi, an all-pervasive mode of high-speed wireless networking that is used by millions of people worldwide. Alantro was acquired by Texas Instruments in 2000 for $300 million in stock, helping to make wireless Internet access widely available.

Boosting wireless capacity

Arogyaswami Paulraj of Stanford University was supported by NSF to perform the fundamental research that developed the electronics and smart antenna technology essential to Multiple Input Multiple Output (MIMO).

MIMO is a method for multiplying the capacity of a radio link by using multiple transmit and receive antennas to allow radio signals to reach a receiving antenna by two or more paths.

MIMO increases wireless capacity by a factor of eight in current systems, but is expected to increase capacity by more than 100 in coming years.



frequency domain, resulting in a signal with a wider bandwidth. This results in improvements in security, as resistance to natural interference, noise and jamming is increased and detection prevention improved.

New spectrum frontiers

Millimeter-length waves (mmWave) operate in the band of radio frequencies in the electromagnetic spectrum from 30 to 300 gigahertz (GHz). In the past, they have commonly been used in space communications, radio astronomy and remote sensing — but not in telecommunications because they are prone to deterioration in crowded settings.

To speed the development of 5G, NYU WIRELESS researchers are making key software free and open to all.

Recent NSF-supported research by Theodore (Ted) S. Rappaport, founding director of NYU WIRELESS, showed that mmWave can be made to travel long distances and can also transmit effectively in cities and other crowded locations.

Rappaport and his colleagues have made all of their mmWave data measurement and channel simulator software open source, accelerating developments in this promising area of wireless research.

[Images courtesy of NYU-Poly/Marian Goldman, WINLAB Rutgers University, Jeff Fitlow/Rice University, Richard Scholtz, Arogyaswami Paulraj, and Wikimedia Commons]

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More: What's Next On The Move Communication 5g

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CONVERSATIONS

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FURIOUS PACE IF THI
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PAYMENT IN 6 MONTI

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20% Youll be shocked wher
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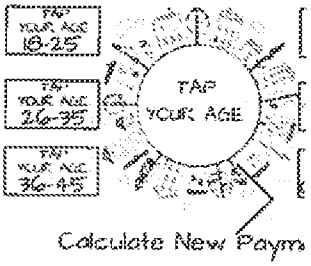

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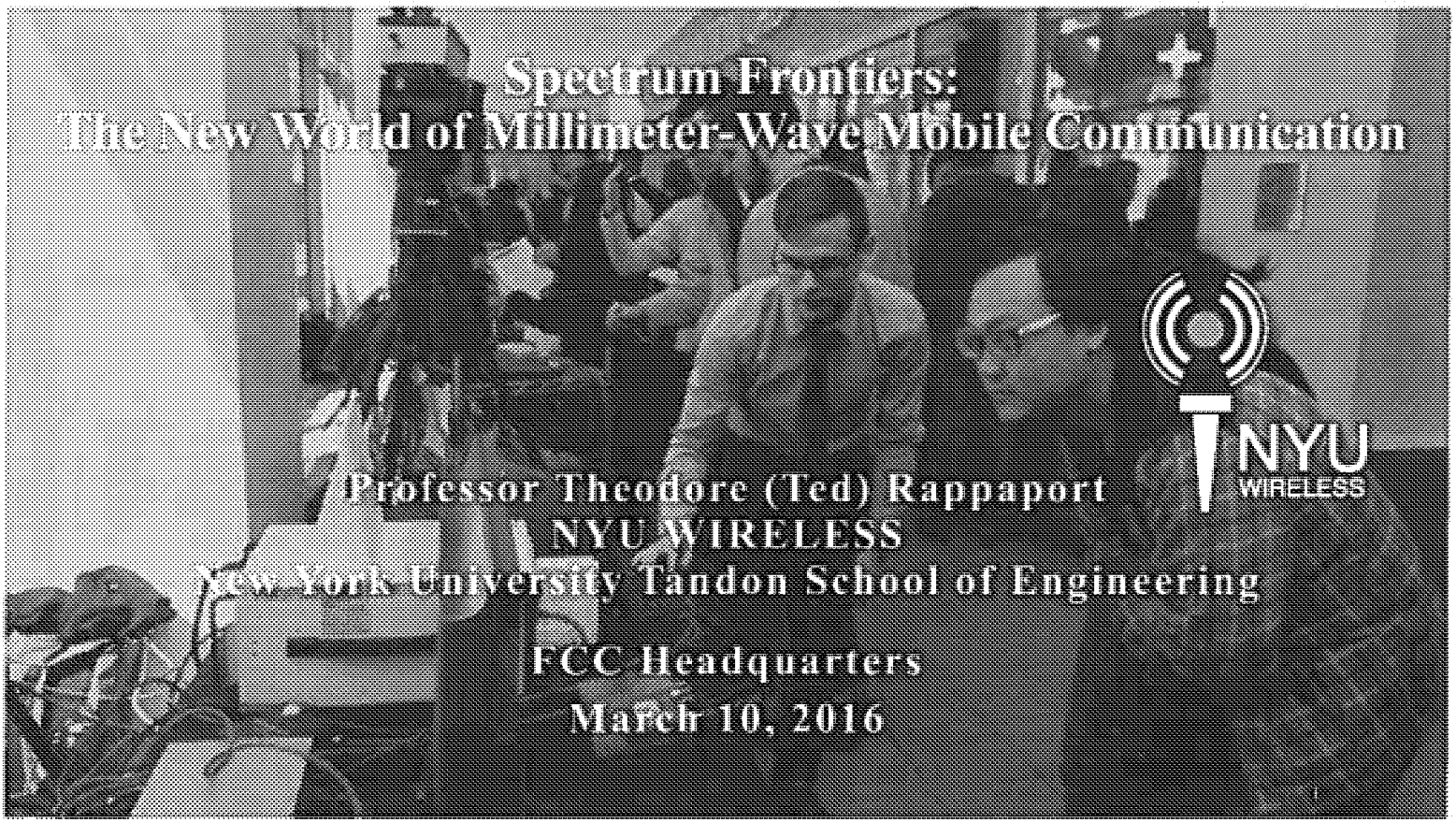

Spectrum Frontiers:
The New World of Millimeter-Wave Mobile Communication

Professor Theodore (Ted) Rappaport
NYU WIRELESS
New York University Tandon School of Engineering

FCC Headquarters
March 10, 2016

What Comes After Exabyte?

Cisco VNI forecasts annual global internet bandwidth consumption will reach 1.0 ***zettabytes*** in 2016 and 2.0 zettabytes by 2019. A zettabyte is equal to 1024 exabytes, which is ***one sextillion*** bytes. By 2020, global *mobile* IP traffic will reach an annual run rate of 367 exabytes, up from 44 exabytes in 2015.

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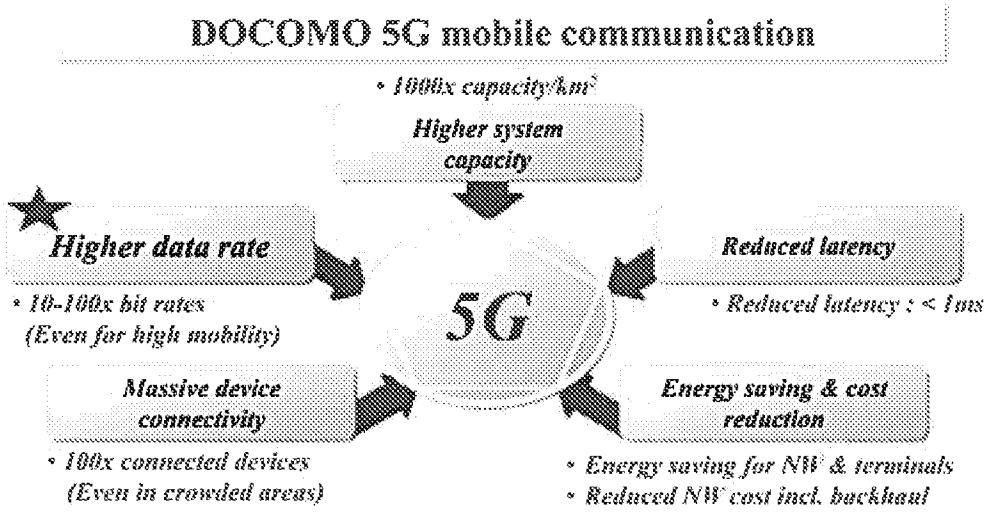
Wireless Carrier Frequencies Have Not Kept Pace

Moore's Law in the Past 40 Years

	1976	2016	Increase
Personal Computer Clock Speed	1 MHz	5 GHz	5,000x
Personal Computer Memory Size	256 KB	500 GB	4,000,000x
Cellular Phone Carrier Frequency	850 MHz	2.5 GHz	3x

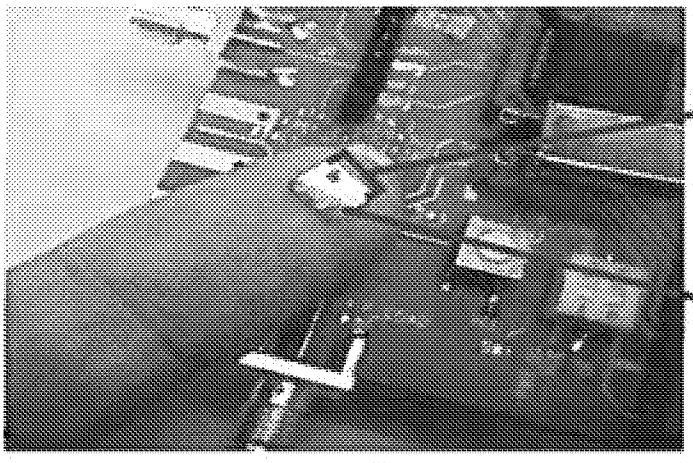
5G Requirements and Targets

docomo



Source: TU3F-2 NTT DOCOMO, INC., Copyright 2014, All rights reserved. IMS2014, Tampa, 1-6 June, 2014

mmWave Wavelength Visualization – 60 GHz



Source: F. Gutierrez, S. Agarwal, K. Parrish, and T.S. Rappaport, "On-Chip Integrated Antenna Structures in CMOS for 60 GHz WPAN Systems," IEEE Journal on Selected Areas in Communications, vol. 27, no. 8, October 2009, pp. 1367 - 1377

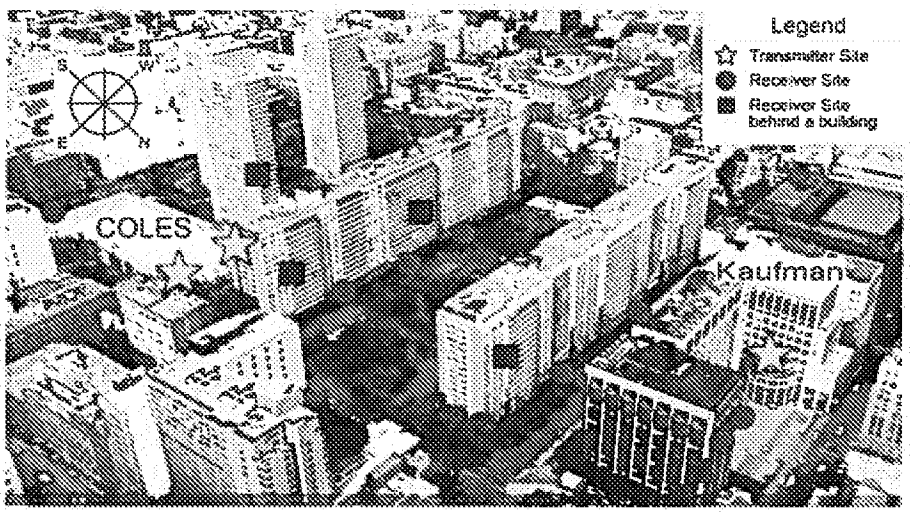
28 GHz Measurements in 2012
Dense, Urban NYC

- 4 TX sites
- 33 RX sites (35 w/ LOS)

- Pedestrian and vehicular traffic
- High-rise buildings, trees, shrubs

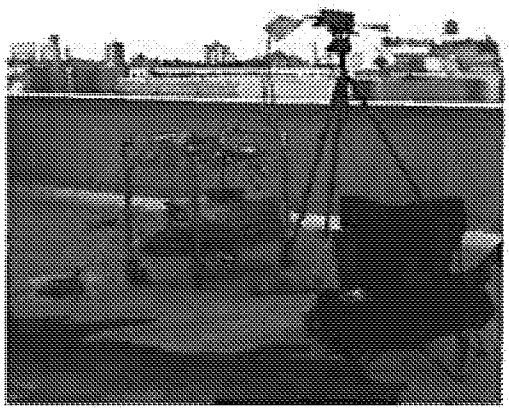
- TX sites:
  - TX-COL1 – 7 m
  - TX-COL2 – 7 m
  - TX-KAU – 17 m
  - TX-ROG – 40 m

- RX sites:
  - Randomly selected near AC outlets
  - Located outdoors in walkways

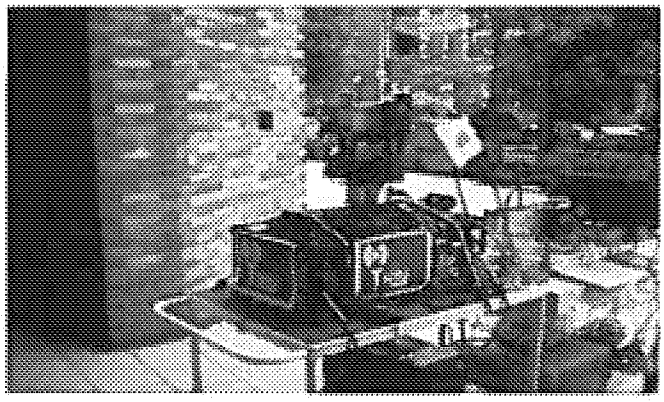


Rappaport, T. S., Shu Sun, Mayzus, R., Hang Zhao, Azar, Y., Wang, K., Wong, G. N., Schulz, J. K., Samimi, M., Gutierrez, F., "Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!," IEEE Access, vol. 1, pp. 335-349, May 2013.

28 GHz Channel Sounder



TX Hardware



RX Hardware

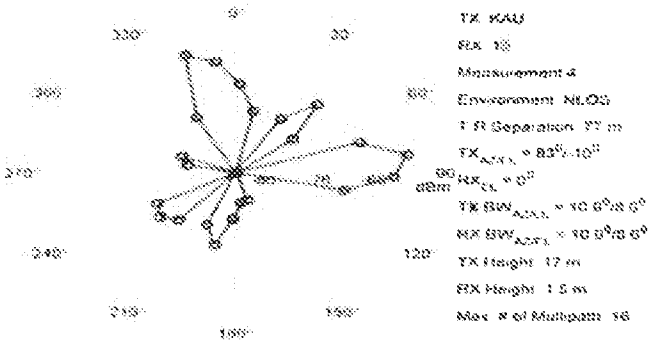
Y. Azar, G. N. Wong, K. Wang, R. Mayzus, J. K. Schulz, H. Zhao, F. Gutierrez, D. Hwang, T. S. Rappaport, "28 GHz Propagation Measurements for Outdoor Cellular Communications Using Steerable Beam Antennas in New York City," *2013 IEEE International Conference on Communications (ICC)*, June 9-13, 2013

T. S. Rappaport et. al., "Wideband Millimeter-Wave Propagation Measurements and Channel Models for Future Wireless Communication System Design," IEEE Trans. Comm., Vol. 63, No. 9, Sept. 2015

G. MacCartney, et. al., "Indoor Office Wideband Millimeter-Wave Propagation Measurements and Channel Models at 28 and 73 GHz for ultra-dense 5G Wireless networks," IEEE Access, Vol. 3, November 2015

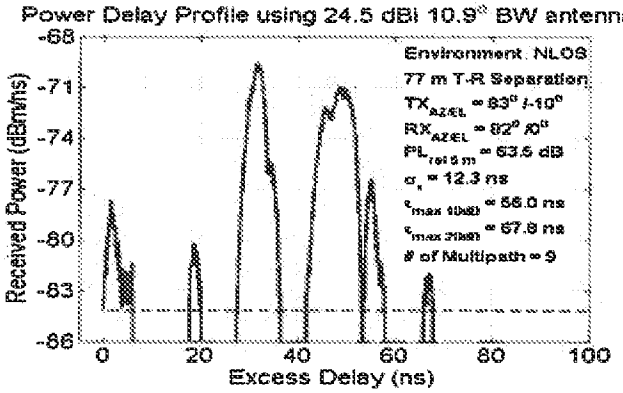
Measurements show Millimeter Wave is Revolutionary!

28 GHz Received Power over 360° Azimuth Plane



Signals arrive within 2 to 5 "lobes" in NYC over many azimuth angles in Non Line of Sight (NLOS)

Power Delay Profile using 24.5 dBi 10.9° BW antennas

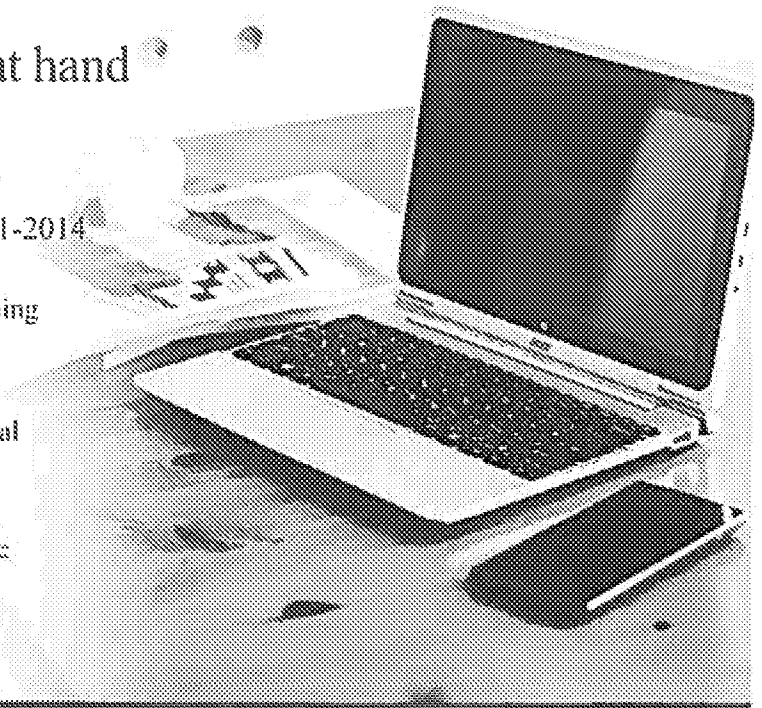


Rappaport, T.S.; Shu Sun; Mayzus, R.; Hang Zhao; Azar, Y.; Wang, K.; Wong, G.N.; Schulz, J.K.; Samimi, M.; Gutierrez, F., "Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!," *Access, IEEE*, vol. 1, no., pp.335,349, 2013

Samsung Ex. 1002, Page 532 of 679

The Renaissance of Wireless is at hand

- mmW mobile offers 1000x capacity over 4G/LTE
- Experimental confirmation in NYC, Texas in 2011-2014
  - 200 m cell radius very feasible using only 1 Watt
  - Much greater range (>450 m) through beam combining
  - Simulations show multi-Gbps mobile data is viable
  - See prototypes on exhibit at the FCC today
  - NYU WIRELESS announces Open-Source Statistical Spatial Channel Model software suite for 5G
  - Complete simulator, extensive resources, field data
  - http://nyuwireless.com/5g-millimeter-wave-channel-modeling-software/
  - http://bit.ly/1WNPpDX



Samsung Ex. 1002, Page 533 of 679

Conclusion

•In the *massively broadband®* era, wireless networks will obviate print, magnetic media, content, and wired connections in revolutionary ways!

•In 40 years, cellular carrier frequencies have only increased by a *factor of three* (850 MHz to 2.5 GHz). FCC's *Spectrum Frontiers* begins to address the capacity demand, bringing Moore's Law to carrier frequencies.

•By 2018 we will have commercial products above 70 GHz and 20 Gbps speeds in 5G cellular networks.

•Millimeter Wave wireless communications will revolutionize the mobile industry – ushering in a new frontier with unthinkable advances.

massively broadband ® is the property of T.S. Rappaport

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Acknowledgement to our NYU WIRELESS Industrial Affiliates and NSF

Federal Communications Commission

Spectrum Frontiers Workshop

MAR (MARCH) 10 2016

Spectrum Frontiers Workshop (/news-events/events/2016/03/spectrum-frontiers-workshop)

9:00 am EST

Commission Meeting Room at FCC Headquarters in Washington, DC

The FCC 's Office of Engineering and Technology, Wireless Telecommunications Bureau, and the International Bureau hosted this workshop exploring the concepts raised in the Commission's Spectrum Frontiers NPRM and the state of technological developments in the millimeter wave (mmW) bands . In parallel to the workshop, OET, WTB, and IB hosted equipment demonstrations

Qualcomm (https://www.fcc.gov/oet/5G/Workshop/panel2/FCC 5G Workshop Panel 2-Qualcomm.pdf)
Motorola (https://www.fcc.gov/oet/5G/Workshop/panel2/FCC 5G Workshop Panel 2-Motorola.pdf)
NSF (https://www.fcc.gov/oet/5G/Workshop/panel2/FCC 5G Workshop Panel 2-NSF.pdf)
Samsung (https://www.fcc.gov/oet/5G/Workshop/panel2/FCC 5G Workshop Panel 2-Samsung.pdf)

Presenter Biographies and Workshop Agenda
(https://www.fcc.gov/oet/5G/Workshop/ProgramAgendaBios.pdf)

Agenda

9:00 a.m.

Opening Remarks, Remarks

Presenters:

- Tom Wheeler, Chairman, Federal Communications Commission
- Michael O'Rielly, Commissioner, Federal Communications Commission

9:00 a.m.
9:40 a.m.

Keynote

Presenters:

- Ted Rappaport, David Lee/Ernst Weber Professor of Electrical Engineering at NYU, and founding Director of NYU Wireless

9:40 a.m.
10:50 a.m.

Panel 1: Envisioned Services, Applications, and Deployment of Next Generation Wireless Technologies

Presenters:

- Joan Marsh, Vice President of Federal Regulatory, AT&T
- Davidi Jonas, CEO and President, Straight Path
- Michael Daum, Technology Policy Strategist , Microsoft

3:00 p.m.
4:00 p.m.

Panel 4: Fireside Chat Furthering Spectrum Policy and Promoting Wireless Technology

Presenters:

- Julius Knapp, Chief, Office of Engineering and Technology
- Jon Wilkins, Chief, Wireless Telecommunications Bureau
- Paige Atkins, Associate Administrator, NTIA
- Nada Golmie, Chief, Wireless Networks Division, NIST
- Fred Moorefield, Director, Spectrum Policy and International Engagements, DOD CIO
- Renee Gregory, Senior Advisor, White House Office of Science and Technology Policy

4:00 p.m.
5:00 p.m.

Wrap Up Exhibit/Demo closes at 5:00 p.m.

Presenters:

- Exhibitors

Wideband Millimeter-Wave Propagation Measurements and Channel Models for Future Wireless Communication System Design

Theodore S. Rappaport, *Fellow, IEEE*, George R. MacCartney, Jr., *Student Member, IEEE*, Mathew K. Samimi, *Student Member, IEEE*, and Shu Sun, *Student Member, IEEE*

(Invited Paper)

***Abstract*—The relatively unused millimeter-wave (mmWave) spectrum offers excellent opportunities to increase mobile capacity due to the enormous amount of available raw bandwidth. This paper presents experimental measurements and empirically-based propagation channel models for the 28, 38, 60, and 73 GHz mmWave bands, using a wideband sliding correlator channel sounder with steerable directional horn antennas at both the transmitter and receiver from 2011 to 2013. More than 15,000 power delay profiles were measured across the mmWave bands to yield directional and omnidirectional path loss models, temporal and spatial channel models, and outage probabilities. Models presented here offer side-by-side comparisons of propagation characteristics over a wide range of mmWave bands, and the results and models are useful for the research and standardization process of future mmWave systems. Directional and omnidirectional path loss models with respect to a 1 m close-in free space reference distance over a wide range of mmWave frequencies and scenarios using directional antennas in real-world environments are provided herein, and are shown to simplify mmWave path loss models, while allowing researchers to globally compare and standardize path loss parameters for emerging mmWave wireless networks. A new channel impulse response modeling framework, shown to agree with extensive mmWave measurements over several bands, is presented for use in link-layer simulations, using the observed fact that spatial lobes contain multipath energy that arrives at many different propagation time intervals. The results presented here may assist researchers in analyzing and simulating the performance of next-generation mmWave wireless networks that will rely on adaptive antennas and multiple-input and multiple-output (MIMO) antenna systems.**

***Index Terms*—Millimeter-wave, path loss, multipath, RMS delay spread, small cell, channel sounder, statistical spatial channel models, 28 GHz, 38 GHz, 60 GHz, 73 GHz, propagation measurements, MIMO, 5G, SSCM.**

Manuscript received October 7, 2014; revised March 10, 2015; accepted May 6, 2015. Date of publication May 18, 2015; date of current version September 3, 2015. This material is based upon work supported by the NYU WIRELESS Industrial Affiliates: AT&T, Cable Labs, Ericsson, Huawei, Intel Corporation, InterDigital Inc., Keysight Technologies, L3 Communications, Nokia, National Instruments, Qualcomm Technologies, Samsung Corporation, SiBeam, and Straight Path Communications. This work is also supported by the GAANN Fellowship Program and three National Science Foundation Grants (NSF Accelerating Innovative Research, NetS Medium, and NetS Small). Initial results in this work have been published in [1], [3]–[6], [13], [14], [34]–[36], [38], [39], [44], [62], and [64]. The associate editor coordinating the review of this paper and approving it for publication was M. Junti.

The authors are with the NYU WIRELESS Research Center, NYU Polytechnic School of Engineering, Brooklyn, NY 11201 USA (e-mail: tsr@nyu.edu; gmac@nyu.edu; mks@nyu.edu; ss7152@nyu.edu).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TCOMM.2015.2434384

I. Introduction

THE development and growth of wireless technologies in the past decade has led to the rapid adoption of smartphones and tablets, and emerging wearable devices for health and fitness. Consumers are expecting every device they have to be connected to the network to record, transfer, view, or monitor data. With these new technologies comes the demand for more data, video, and content access. While the growth in wireless devices and technologies has sky-rocketed, the spectrum available for these devices has not kept pace. Carriers and other fixed or mobile service providers are reaching the upper bounds of channel capacity, and the reality of a spectrum shortfall is now becoming increasingly clear. The wireless spectrum below 6 GHz will not be enough to meet future needs, as the current global allocation of cellular and unlicensed wireless local area network (WLAN) spectrum is quite small when compared to the vast spectrum available between 6 and 300 GHz [1]–[4]. In the past 40 years since the advent of the modern mobile communications industry, clock speeds and memory sizes of communications and computer devices have increased by 4 to 6 orders of magnitude (or more), while the carrier frequencies of all WLAN and cellular networks have increased by less than an order of magnitude, from 450 MHz first generation cellphones, to today's 2 GHz 4G/LTE systems [2], [3], [5]–[7].

The demand for content will continue growing at extreme rates, such that annual mobile traffic will exceed 291.8 Exabytes (EBs) by 2019 [7], [8]. CISCO has forecasted that mobile data traffic will increase from 2.5 EBs per month in 2014 to 24.3 EBs per month in 2019 [7]–[9]. Existing allocated spectrum will not provide enough bandwidth for carriers to increase capacity for meeting the growing demand, even with smaller cells, heterogeneous networks, complex modulation schemes and MIMO systems. By the year 2020, Nokia and Samsung predict a 10,000x increase in traffic on wireless networks with virtually no latency for content access [6], [10]. With the massive impending traffic growth and a global spectrum shortfall below 6 GHz, there are only a few potential avenues that will satisfy the pending capacity explosion.

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Utilizing unused raw mmWave spectrum is one key enabling solution for meeting the extreme data demand growth.* While mmWave spectrum offers a great opportunity to increase capacity, little is known about the channel propagation characteristics for mobile access networks in dense urban environments at these carrier frequencies. In the past, mmWave spectrum was primarily used for satellite communications, long-range point-to-point communications, military applications, and Local Multipoint Distribution Service (LMDS) [11], [12]. MmWave frequencies have much smaller wavelengths, ranging from 1 mm to 10 mm, about the size of a human fingernail, whereas 4G frequencies have wavelengths that are tens of centimeters. Smaller wavelengths at mmWave frequencies have often been thought to result in higher attenuation (due to oxygen absorption and precipitation) through air, than that observed at today's cellular bands. It is true that mmWave frequencies undergo greater free space attenuation in the first meter of propagation once leaving an antenna, than today's Ultra High Frequency (UHF) cellular frequencies; however, atmospheric attenuation across most of the mmWave spectrum only induces a fraction of a dB to just a few dB of additional loss at a 1 km distance, compared to UHF bands [1], [4]. Only at certain frequency bands, such as 60, 180, or 380 GHz, do molecular resonances create high atmospheric attenuation causing signals to attenuate much more rapidly with distance than today's UHF/microwave bands. These specific high attenuation mmWave bands will be better suited for local or personal area communications, or "whisper radios" with coverage distances of a few meters (m) [1]–[3]. Rain attenuation only contributes a few dB of additional propagation path loss at mmWaves compared to free space when considering inter-site base station distances of no more than a few hundred meters, implying that the impact of rain will be mollified through the use of high gain, steerable antennas [3], [13], [14].

In late 2014, the Federal Communications Commission (FCC) put forth a notice of inquiry (NOI) in FCC 14-154 and FCC 14-177, to gain a better understanding of the spectrum bands above 24 GHz for mobile radio services [15], [16]. The NOI asked more than 170 questions regarding technology specifications, bandwidth allocations, health effects, and more, in order to gain insight into the viability of mmWave bands for future mobile wireless communications. Numerous corporations and academic institutions, including the NYU WIRELESS research center and many of its industrial affiliate sponsors, responded to these questions to educate the FCC about industrial and academic studies already conducted at mmWave bands, to motivate them to open up this spectrum. In early 2015, UK's Ofcom sought similar public comments [17].

Aside from work conducted by authors at the University of Texas at Austin (UTA) and New York University (NYU), there have been relatively few published propagation studies at mmWave bands in dense urban environments for mobile access and backhaul communications. Many propagation studies performed at mmWave bands for these types of applications considered line-of-sight (LOS), point-to-point, or indoor test scenarios. Kyrö *et al.* at Aalto University performed channel measurements in the E-band from 81–86 GHz over 5 GHz of bandwidth for point-to-point communications in a long street canyon environment in Helsinki, Finland [18]. Measurements determined the channel's average root-mean-square (RMS) delay spread due to multipath scattering in the canyon environment, and compared the measurements with simulated RMS delay spreads. The results showed very little multipath delay spread, and yielded excellent agreement between measured and modeled (stochastic based geometrical single-bounce model [19]–[21]) delay spreads [18]. The difference between mean values was only 0.027 ns, where the maximum modeled RMS delay spread was only 0.25 ns [18]. Kyrö *et al.* also performed channel impulse response measurements by frequency sweeping across the 81–86 GHz band for both a street canyon and roof-to-street scenario [22]. Similar to [18], only a few LOS measurements were performed to prove that the LOS component was dominant in the channel when using highly directional antennas [22]. The study proved that multipath exists in the E-band channel, but extensive channel measurements for mobile or backhaul were not reported.

Many studies for the 28 GHz LMDS band were conducted to assess coverage, large-scale path loss, and fading and multipath effects. Measurements by Elrefaie *et al.* showed that better coverage was obtained for higher transmitter (TX) antenna heights than for lower heights [23], due to less obstructions. Violette *et al.* performed wideband non-line-of-sight (NLOS) studies in the 9.6, 28.8, and 57.6 GHz bands in downtown Denver, and measurements showed significant signal attenuation (as great as 100 dB) due to large building obstructions [24]. Penetration tests for glass with metalized layers showed that attenuation increased by 25 to 50 dB per layer [24], [92]. The results also revealed that delay spreads were no more than 10 ns relative to the LOS component when transmitting over 500 MHz of bandwidth while using narrowbeam, linearly polarized antennas. Foliage attenuation measurements at the 35 GHz band resulted in a mean attenuation of 24.8 dB through approximately 15 m of red pine trees, and revealed a considerable loss in excess of free space [25]. Propagation through a canopy of orchard trees was tested using CW signals at 9.6, 28.8, and 57.6 GHz which indicated that through the first 30 m of foliage depth, signal attenuation over distance is linear with approximately 1.3–2.0 dB/m of loss, and beyond this distance attenuation was only about 0.05 dB/m, revealing that scattering dominates propagation deep into foliage [26], [91].

The 60 GHz band has been one of the most studied mmWave bands as it is currently used for unlicensed WirelessHD and Wireless Gigabit Alliance (WiGig) WLAN devices [1], [27], that offer multiple gigabits per second data rates for short range indoor communications. A majority of measurements were conducted for indoor applications due to the earliest intended use cases (WLAN), and high oxygen absorption centered around 60 GHz [3]. However, with the 2013 FCC part 15 rule change that greatly expanded the effective radiated power of WLAN devices in the 60 GHz band from 40 to 82 dBm [1], 60 GHz outdoor communication for unlicensed backhaul applications has just recently garnered great interest. Outdoor studies at 59 GHz were conducted in Oslo city streets, and showed that a majority of delay spreads were less than 20 ns over 7 different street

*Frequencies from 30 GHz to 300 GHz are commonly known as mmWave frequencies, although industry often uses the term mmWave to define frequencies between 10 and 300 GHz [1].

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scenarios for LOS and obstructed environments [28]. Wideband measurements with 200 MHz of bandwidth revealed that city streets do not cause much multipath, as the RMS delay spread was observed to be lower than 20 ns [29]. Measurements and models showed that path loss in LOS environments behaves almost identical to free space, with a *path loss exponent* (PLE) of 2 (i.e., power decays as the square of the distance). In regards to path loss between 1.7 GHz and 60 GHz, Smulders *et al.* showed that the most significant difference in path loss between these frequency bands is the initial close-in free space path loss induced by the increase in carrier frequency due to Friis' free space equation [29], [30]. Other outdoor measurements in a city street environment at 55 GHz showed that power decreased much more rapidly with distance through narrower streets compared to a direct path or through wide city streets [31], and the coherence bandwidth range of 20–150 MHz closely matched the results by Violette *et al.* in [24]. Additionally, recent outdoor studies at 60 GHz in a street canyon environment indicated that the LOS path is most dominant but that the ground reflected path is significant at larger distances where the LOS path may be blocked, resulting in an overall PLE of 2.13, very close to theoretical free space (PLE $\approx$ 2) [32].

Samsung has been active in measuring mmWave channels for future mobile communications. Initial tests were performed at 28 GHz and 40 GHz to study penetration losses for common obstructions such as wood, water, hands, and leaves [33], [92]. Results showed that metal and water can attenuate the signal by 30 to 40 dB when very close to the receiver (RX); however, when moved further away, more reflected energy of the signal was able to reach the RX with relatively widebeam antennas. For LOS outdoor measurements at 28 GHz, a PLE of 1.98 (virtually identical to the theoretical free space value of 2) was measured for distances up to 100 m [33]. Increased signal strength was also reported at the RX in LOS environments when the RX elevation was uptilted and downtilted, attributed to captured reflected energy from both the ground and surrounding buildings. In NLOS environments in Austin, Texas, we observed from angle of arrival (AOA) measurements that wider beamwidth antennas captured more received power than higher gain, narrower beamwidth antennas, as reported in [34]–[36].

Samsung Electronics announced in May of 2013 that they were able to transmit data up to 1.056 Gbps at 28 GHz over distances up to 2 km using an adaptive array transceiver with multiple antenna elements [37]. While this early work did not include extensive measurements, Samsung is currently using a channel sounder that measures power delay profiles (PDPs) from multiple directions of arrival to create omnidirectional-like wideband channel measurements, while benefiting from high-gain antennas (based on approaches in [38]–[41]), to provide statistics necessary to build channel models similar to WINNER II and 3GPP for the 28 GHz wideband urban channel [42], [43]. Work at NYU WIRELESS described here has also focused on providing 3GPP-like channel models, including omnidirectional path loss models synthesized from directional channel measurements, and statistical 3-D channel impulse response models for directional and omnidirectional systems for use in emerging mmWave standard bodies [1], [3], [13], [38], [39], [41], [44]–[49].

The vast body of previous published work used for earlier versions of wireless technologies provides valuable insight into best practices for measuring and modeling directional mmWave wideband channels. Researchers have already studied directional UHF CDMA cellular radio systems [50]–[52]. Work in [52] showed that with correlated multipath, adaptive antenna arrays with just a few elements provided larger improvements in performance than a switched beam system. In addition to measurements, ray-tracing methods provided accurate predictions of wireless communication channel properties, such as path loss and RMS delay spreads, and may be used as a substitute for propagation measurements which are time-consuming and expensive. Further, ray-tracing is widely used to help with site-specific deployments [1]. 3-D ray-launching uses geodesic spheres and distributed wavefronts to simulate electromagnetic propagation, offering a simple and accurate propagation prediction method with low computational complexity [53].

Once accurate statistical models are developed for mmWave frequencies (often with the assistance of ray-tracing to fill in missing or sparse data), simulations for performance, capacity, and availability can be carried out to evaluate air-interface trade-offs. Previous work showed that with the use of real-time DSP techniques and adaptive antenna arrays, capacity and signal-to-noise ratio (SNR) improvements could be made for systems at UHF bands [54], [55]. Similar simulations are necessary for mmWave wireless systems; however, at these higher frequencies with new adaptive antenna architectures, there will be trade-offs on how and where processing will take place [1], [49], [56]. More reliance on analog processing at either or both the RF (Radio Frequency) or IF (Intermediate Frequency) may be possible as technological advancements are made [1], [3], [6], [43], [56]–[60].

Extensive mmWave channel propagation measurements with thousands of recorded PDPs over a wide range of urban microcell (abbreviated as UMi in the 3GPP standard) and urban macrocell (UMa) [50] environments have been conducted at UTA and NYU [3], [13], [14], [34]–[36], [39], [44], [57], [61]–[65]. These measurements and resulting channel models will aid researchers in the evaluation and design of future 5G mmWave systems. This paper serves as a detailed compilation of all mmWave measurements made by the authors from 2011 through 2013 with the benefit of more stringent data processing, experience, feedback, and requirements received from industry and academia over the past few years.

When writing this invited paper, we realized, in hindsight, that researchers in the channel modeling or propagation measurement fields often do not standardize or even define decisions made in their measurement or modeling approach, or their thresholding approach, yet such standardization yields much more meaningful and useful results between different researchers, allowing for easy comparisons and improvements. Thus, in this paper, we cast all of our previous work in a single, referenceable, standard approach for path loss (by referencing all received powers to a 1 m close-in free space reference distance), and elucidate practices that will allow the community to compare propagation and channel results in a more unified manner. For example, we provide a standard noise threshold for multipath PDP thresholding (using a 5 dB SNR threshold).

Section II describes the customized hardware used to perform the mmWave channel measurements and describes the measurement locations and operating scenarios in the UMi environment for each of the four bands of 28, 38, 60 and 73 GHz, in addition to UMa measurements (TX heights of 23 m and 36 m) at 38 GHz. Sections III and IV provide measured directional and omnidirectional path loss models, based on thousands of wideband PDPs measured in various scenarios (outdoor mobile access and outdoor backhaul). Section V shows the value of a simple $d_0 = 1$ m path loss model for comparing the distance extension available through beam combining [41]. Section VI presents measured mmWave outage studies, using randomly placed transmitters and receivers in UMi environments. Section VII presents the measured multipath and RMS delay spread characteristics of mmWave channels when using steerable antennas, for cases with arbitrary antenna steering, and also when directionally steering the antenna to the strongest arriving signal. Section VIII provides spatial statistics of mmWave channels, for the purpose of extending UHF/Microwave industry standard channel models to properly reflect the observed phenomena in mmWave channels, and we introduce a new channel modeling concept, the *spatial lobe*, that characterizes mmWave outdoor urban channels. Section IX presents characterizations of outdoor peer-to-peer (or device-to-device) channels and propagation into vehicles, and Section X introduces a wideband statistical spatial channel impulse response model based on NLOS measured data at 28 GHz and 73 GHz in New York City. Conclusions are drawn in Section XI.

II. Wideband mmWave Measurement Descriptions and Hardware Specifications

Wideband propagation studies at 28, 38, 60, and 73 GHz using first null-to-null RF channel sounding bandwidths of 800 MHz and 1.5 GHz were conducted in 2011 in Austin, and in 2012–2013 in New York City, to explore a wide range of mobile use cases over many transmitter-receiver (T-R) separation distances, in order to create 5G mmWave channel models. The four frequency bands were chosen for testing due to the likelihood of eventual use of this spectrum for ultrawideband mobile radio applications (indeed, [16] and [17] have recently suggested these bands will likely become available for mobile use) at these carrier frequencies. The 28 and 38 GHz bands were licensed for LMDS and backhaul communications, but the technology was not ready for market in the 1990's [11], [34]. The 60 GHz band experiences excessive attenuation due to oxygen absorption compared to other bands, but as explained in the Introduction, is a viable and attractive option for short-range (a few hundred meters) point-to-point (backhaul) applications as well as indoor Wi-Fi [27], [66]. 73 GHz is centered in 71–76 GHz E-band which is presently lightly-licensed globally, and relatively unexplored for mobile communications [10].

A. Hardware Descriptions and Specifications

Each measurement campaign used a common spread spectrum sliding correlator design with a double conversion superheterodyne RF architecture at the TX and RX, and common baseband/IF components. The common architecture consisted of the baseband signal upconverted to an IF between 5 and 7 GHz, and then mixed with a local oscillator up to the corresponding RF frequency for each campaign, where a pyramidal horn antenna was connected to the RF waveguide output. The received signal was then captured by a rotatable pyramidal horn antenna connected to a waveguide flange input at the RX where the signal was mixed with a local oscillator to obtain an IF between 5 and 7 GHz, and was then downconverted back to baseband. Pyramidal horn antennas that could be steered with relatively high gain (> 13 dBi) were used to collect channel data representative of future mmWave mobile devices that will employ beam steering antennas. Detailed specifications for the hardware used for each campaign is displayed in Table I.

B. Sliding Correlator Channel Sounder Theory and Design

A spread spectrum sliding correlator channel sounding method was used for each of the four measurement campaigns conducted in the mmWave spectrum (i.e. 28, 38, 60, and 73 GHz) [30], [67]–[69]. The fundamental concept of sliding correlation uses the correlation properties of two identical pseudorandom noise (PN) sequences at slightly different clock speeds generated at the TX and RX, resulting in a time dilated (bandwidth compressed) signal with processing gain that greatly improves SNR [70]. This technique allows for a narrowband detector while using a wideband PN sequence, while simultaneously providing additional link margin arising from the benefit of processing gain, so long as the channel remains pseudo-static during the averaging period where the two PN sequences slide past each other over a complete cycle [30], [67]–[70]. In mmWave communications, modulation symbols will have durations on the order of nanoseconds due to the much greater channel bandwidths, hence a wideband sliding correlator channel sounder offers an effective way to achieve excellent ns-scale temporal resolution and good dynamic range of the measured PDP [1], [59].

Our sliding correlator channel sounder produced a digital PN sequence using custom printed circuit boards that housed emitter-coupled-logic (ECL) shift registers to produce an 11-bit maximal length code with the shift registers tapped at the 9^{th} and 11^{th} flip-flop outputs [61]. Different frequency bands were measured by changing local oscillator frequencies, IF frequencies, and the RF front-ends; specifications and detailed block diagrams are given in [3], [13], [34], [61], [63], [65].

The transmitted pseudorandom binary sequence (PRBS) for the 28 GHz and 73 GHz campaigns had an 800 MHz RF spread spectrum first null bandwidth (we used a square-wave, non-shaped 400 Mcps baseband PN sequence). After propagating through the radio channel and upon reaching the RX antenna (rotatable horn antenna), the received wideband signal was downconverted to IF, where it was bandpass filtered, attenuated (for maintenance of proper linear range and maximum display range on the baseband digitizing oscilloscope detector) and amplified with a low-noise amplifier. After amplification, the IF signal was demodulated into its in-phase (I) and quadrature (Q) baseband signal components [61]. Both the I and Q signals were then correlated with a reference PN sequence that is identical to the transmitted sequence but clocked at a slightly slower rate, in order to create a time dilated cross-correlation. For example,

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TABLE I
HARDWARE SPECIFICATIONS OF THE 28, 38, 60, AND 73 GHz MEASUREMENTS

Campaign	28 GHz (2012)	38 GHz (2011)	60 GHz (2011)	73 GHz (2013)
Center Frequency	28 GHz	37.625 GHz	59.4 GHz	73.5 GHz
Antenna Sweeps	Yes	No	No	Yes
Broadcast Sequence	11^{th} order PN Code ($L = 2047$)			
TX and RX Antenna Type	Rotatable Pyramidal Horn Antenna			
TX Chip Rate	400 Mcps		250 Mcps	400 Mcps
RX Chip Rate	399.95 Mcps		749.9625 Mcps	399.95 Mcps
Slide Factor γ	8000		20000	8000
TX Ant. Gain	24.5 dBi, 15 dBi	25 dBi		27 dBi
TX AZ Ant. HPBW	10.9°, 28.8°	7.8°	7.3°	?
TX EL Ant. HPBW	8.6°, 30°	7.8°	7.3°	?
RX Ant. Gain	24.5 dBi, 15 dBi	25 dBi, 13.3 dBi	25 dBi	27 dBi
RX AZ Ant. HPBW	10.9°, 28.8°	7.8°, 49.4°	7.3°	?
RX EL Ant. HPBW	8.6°, 30°	7.8°, 89.4°	7.3°	?
Antenna Polarization (TX-to-RX)	V-V, V-H, H-V, H-H	V-V		
Max Transmit Power	30.8 dBm	21.2 dBm	5 dBm	14.6 dBm
Max EIRP	54.6 dBm	46.7 dBm	30 dBm	41.6 dBm
Max Measurable Path Loss	178 dB	150–160 dB	150 dB	181 dB

[a]160 dB was used for outage study signal detection, where a signal was detectable with the measurement equipment, but accurate PDPs could not be recorded as the signal was very close to the noise floor.

during the 73 GHz campaign, the TX code (PN code length 2047) was transmitted at 400 Mcps and the RX code was set to 399.95 Mcps, allowing for a time dilation factor, or slide factor γ, calculated to be 8 000 as follows:

$$\gamma = \frac{f_{TX}}{f_{TX} - f_{RX}} = \frac{400\ \text{MHz}}{400\ \text{MHz} - 399.95\ \text{MHz}} = 8{,}000 \quad (1)$$

The PN sequence duration (the period T) of the transmitted sequence is a function of the chip rate and length of the sequence: $T = \frac{1}{400\ \text{MHz}} \times 2047 = 5.11\ \mu\text{s}$ and the chip duration is $t_0 = \frac{1}{400\ \text{MHz}} = 2.5$ ns. Therefore, after a time-dilated cross-correlation with slide factor γ of 8,000, the period between successive cross-correlation peaks is: 2.5 ns × 8,000 × 2047 = 40.94 ms for the raw acquisition of one PDP. A National Instruments USB-5133 digitizer sampled the time-dilated I and Q cross-correlated voltages, and the corresponding received power was recovered using National Instruments LabVIEW software, programmed to square and add the two voltage components $I^2 + Q^2$, thereby recovering a raw PDP. Twenty successive raw PDPs were averaged for each PDP acquisition (40.94 ms × 20 = 818.8 ms for each recorded PDP) in order to increase the SNR and eliminate abrupt dynamic changes during the acquisition interval. The absolute axis of the time-dilated PDP was recovered by dividing the measured (dilated) PDP time scale by the slide factor γ. The slide factor is related to the RF bandwidth that can be measured compared to the baseband bandwidth needed for reception [30]. In our case, the baseband bandwidth for reception was 50 kHz (PN clock rate divided by the slide factor; in this case for a 400 Mcps sequence and a slide factor of 8 000). The use of highly-directional steerable horn antennas at the TX and RX provided the ability to capture directional azimuth and elevation plane measurements over the complete azimuth plane and many elevation angles, and provided a large link margin and system dynamic range as compared to what is achievable with low-gain omnidirectional antennas. From the PDPs measured at distinct azimuth and elevation angles, multipath channel parameters were extracted through post-processing techniques, and directional and omnidirectional channel models were formed [38], [41], [45], [65].

C. Channel Sounding Triggering and Thresholding

Typical channel sounding systems track the absolute or relative time of arrival of a propagating signal in order to determine precise temporal characteristics of a wireless channel. A popular channel sounding technique uses a Vector Network Analyzer (VNA) to measure the gain of the S21 parameter of the wireless channel, discretely across a wide range of frequencies (frequency swept sounding). In such a system, the TX and RX are physically connected to the VNA through a phasing cable, for knowledge of the precise phase at each discrete tone. Since the VNA measurement system consists of both the source and sink, accurate timing information is possible since the transmitted probing signal and acquisition recording are generally triggered via the same mechanism. Since the VNA is a one-box cable-connected system, it is not usually used to measure large T-R separation distances [30]. Also, the channel must be assumed static during the wideband frequency sweep (sometimes more than many seconds per measurement). For these reasons, VNAs are generally relegated to indoor channel sounding [30].

Time domain channel sounding systems, such as the sliding correlator, obtain timing information by either using exact timing at both the TX and RX from rubidium, cesium, or global positioning system (GPS) timing sources, or by using relative timing information, where the RX triggers on the first arriving multipath component (MPC) [1], [30]. Our channel sounder relied upon relative timing information via a triggering algorithm that logged free running data and time-aligned successive oscilloscope captures on the signal peak in a PDP window. The lack of an absolute timing reference required us to use ray-tracing

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to synthesize the exact propagation times of channel impulse responses received from different antenna pointing angles, so that the statistical channel models given in Section X would accurately account for temporal characteristics over space. In general, the LOS component is the strongest (first arriving) peak at the RX, and for reasonable SNR (greater than 5 dB), NLOS signals have stable first arriving signal levels, even if they are weaker than stronger, later-arriving MPCs. Temporal channel statistics such as relative excess delay and RMS delay spread do not require synchronized timing [30].

Once the raw PDPs were recorded they were thresholded based on a 5 dB SNR threshold relative to the mean thermal noise floor of the raw PDP, allowing us to keep a consistent noise floor threshold across all measurements, rather than other approaches reported in the literature [71] that use a threshold relative to the maximum multipath peak. The 5 dB SNR threshold was found for each measurement by computing the average noise power of the last several hundred ns of each PDP that had no detectable multipath, and we used the mean value of the noise in order to apply the 5 dB SNR threshold for detecting (and keeping) all MPCs in that PDP. Since all PDPs were measured using an RX gain that was manually adjusted to provide a large dynamic range on the received baseband PDP, an absolute SNR threshold does not artificially limit the sensitivity of the measured data and allows users to properly mimic actual wideband receiver functionality that will be implemented with automatic gain control (AGC) in future wideband mmWave mobile devices. This stringent 5 dB SNR thresholding was developed and applied to the measured data after initial measurements in [3] were published, thus RMS delay spreads and excess delays reported in [3] are larger than those presented here, since the earlier processed measurements included noise that has been subsequently removed (e.g., not considered to be multipath) using the more stringent 5 dB SNR thresholding technique. Thus, the noise thresholding of measured channel impulse responses is critical when interpreting PDP channel time dispersion results. For this reason, we advocate that all channel modeling activities specify a particular SNR thresholding as described above, since it is a practical thresholding level for wideband low-cost radios that are either non-coherent or that have typical noise figure or high phase noise [1], and allows repeatability by others without relying on particular measurement peaks that are widely variable for different pointing angles, locations, or measurement systems.

D. Measurement Descriptions and Methodologies

The measurement campaigns for each frequency band included numerous wideband multipath PDP large-scale path loss measurements for multiple AOA and Angle of Departure (AOD) orientations between the TX and RX, using various TX heights and deployment scenarios. Each propagation measurement campaign used mechanically steerable directional horn antennas, where the AOD for the transmitted signal was determined by the orientation of the TX antenna. Each individual wideband channel PDP measurement of every campaign was recorded for a specific TX and RX (TX-RX) location at specific directional antenna azimuth and elevation pointing angles between the TX and RX. This resulted in thousands of acquired PDPs, each one being a function of TX location i, TX height h_{TX} in meters, RX location j, RX height h_{RX} in meters, TX antenna gain G_{TX} in dBi, TX antenna azimuth and elevation angles θ_t and ϕ_t in degrees, respectively, RX antenna gain G_{RX} in dBi, RX antenna azimuth and elevation angles θ_r and ϕ_r in degrees, respectively, and 3-D T-R separation distance d in units of meters.

The 28 and 73 GHz campaigns consisted of *systematic antenna sweeps* that recorded PDPs at incremental angles across the entire azimuth plane for several TX and/or RX fixed elevation angles, whereas the 38 GHz and 60 GHz measurements randomly searched for signal at various angles in the azimuth and elevation planes, and only those PDPs with distinguishable energy were recorded. Sweeps in the azimuth plane at various fixed elevation planes allowed us to collect realistic channel impulse response measurements for future mmWave mobile devices that will take advantage of directional beam steering antennas and algorithms. Descriptions and specifications for each measurement campaign in each mmWave band are now presented.

1) 28 GHz Measurement Descriptions: 28 GHz propagation studies were conducted in 2012 in downtown Manhattan around NYU's main campus, along with a smaller study conducted in downtown Brooklyn around the NYU Polytechnic School of Engineering campus, with a maximum RF transmit power of 30.1 dBm over an 800 MHz first null-to-null RF bandwidth, yielding a maximum measurable dynamic range of 178 dB. In both studies, measurements were performed for a typical base station-to-mobile (access) scenario with the TX antenna on relatively low rooftops and the RX antenna located at a mobile height (1.5 m) around common city blocks typical of a dense urban environment. The majority of measurements were conducted using narrowbeam TX and RX antennas, each with 24.5 dBi gain and 10.9° half-power beamwidth (HPBW) in the azimuth (Az.) plane in both Manhattan and Brooklyn. As shown in Table I, elevation (El.) HPBW is comparable to azimuth (Az.) HPBW. A small subset of measurements in Manhattan were conducted with a wider 28.8° HPBW 15 dBi gain antenna at the RX for five locations, and an additional measurement from an outdoor TX to an indoor RX was recorded, but the dataset is too sparse to present here. Another small subset of measurements were conducted in Brooklyn with a wider 28.8° HPBW antenna at the TX, for four RX locations (using 10.9° HPBW antennas), in addition to a small number of cross-polarized antenna measurements [3], [62], [72]. Both sets of Brooklyn measurements included automated small-scale track measurements at two locations, in order to study small-scale spatial correlation of fading at mmWave frequencies [62]. The narrowbeam outdoor-to-outdoor measurements in Manhattan consisted of over 10,000 recorded PDPs using three TX locations and 27 RX locations that were visited repeatedly for each TX location, providing for a total of 74[‡] TX-RX location combinations. For each TX-RX location combination, the RX antenna was swept in 10° increments (approximately the antenna HPBW) in the azimuth plane for three different RX antenna elevation pointing angles and three different TX

[‡]Not all 27 RX locations were measured for each of the three TX locations due to time, student, and equipment availability.

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TABLE II
T-R SEPARATION DISTANCES FOR SPECIFIC TX LOCATIONS AT 28 GHz IN MANHATTAN AND BROOKLYN WHERE SIGNAL WAS RECORDED. LOS ENVIRONMENTS ARE WHEN THE TX AND RX LOCATIONS HAD A CLEAR OPTICAL PATH TO ONE ANOTHER. NLOS ENVIRONMENTS CONTAIN OBSTRUCTIONS BETWEEN THE TX AND RX

28 GHz Manhattan Measurements (RX: 1.5 m) (TX/RX Antenna Az. HPBW: 10.9°)		
TX Location (Abbr.) [height]	Environment	# of Locations with Signal
Coles Sports Center 1 (COL1) [7 m]	LOS	2 (31 m $\leq d \leq$ 102 m)
	NLOS	6 (81 m $\leq d \leq$ 162 m)
Coles Sports Center 2 (COL2) [7 m]	LOS	1 (d = 54 m)
	NLOS	7 (31 m $\leq d \leq$ 169 m)
Kaufman (KAU) [17 m]	LOS	3 (33 m $\leq d \leq$ 54 m)
	NLOS	7 (37 m $\leq d \leq$ 187 m)
28 GHz Brooklyn Measurements (RX: 1.5 m) (TX/RX Antenna Az. HPBW: 10.9°)		
Rogers Hall (ROG1) [40 m]	NLOS	5 (110 m $\leq d \leq$ 135 m)
28 GHz Brooklyn Measurements (RX: 1.5 m) (TX/RX Antenna Az. HPBW: 28.8°/10.9°)		
Rogers Hall (ROG1) [40 m]	NLOS	4 (110 m $\leq d \leq$ 135 m)

azimuth angles, all with a fixed TX downtilt elevation of −10°, where a PDP was acquired at each distinct azimuth pointing increment at the RX. One TX antenna sweep was conducted as well, resulting in 10 total azimuth sweeps for each TX-RX combination. This approach allowed us to measure the vast majority of received multipath power over 3-D, without wasting time to exhaustively measure every possible spherical pointing direction at the TX and RX. By having a sufficient number of PDPs that substantially represented all of the possible measured power at each location, omnidirectional channel models were created, as described in Section IV. T-R separation distances ranged from 31 m to 425 m, but PDPs were not measurable beyond 200 m. Table II shows a description of TX sites and separation distances for LOS and NLOS environments where signal was recorded for corresponding TX sites, while site layouts and detailed descriptions of the measurement procedures are given in [3], [62], [73]. For the remainder of this article, 28 GHz *narrowbeam* measurements will refer to those conducted in Manhattan with steerable antennas having HPBW of 10.9° at both the TX and RX, whereas *widebeam* measurements will refer to measurements conducted in Brooklyn using a steerable 28.8° HPBW antenna at the TX and a 10.9° HPBW antenna at the RX.

2) 38 GHz Measurement Descriptions:

a) Base Station-to-Mobile Access Scenario: 38 GHz cellular measurements were conducted with four TX locations chosen on buildings at the UTA campus in the summer of 2011, with a maximum RF transmit power of 21.2 dBm over an 800 MHz first null-to-null RF bandwidth and a maximum measurable dynamic range of 160 dB, for RX locations in the surrounding campus using narrowbeam TX antennas (7.8° Az. HPBW) and narrowbeam (7.8° Az. HPBW) or widebeam (49.4° Az. HPBW) RX antennas. A total of 43 TX-RX location combinations were measured for narrowbeam measurements (with T-R separation distances ranging from 29 m to 930 m) and 22 TX-RX location combinations were measured for widebeam measurements (with T-R separation distances between 29 m and 728 m), as given in [36]. Fig. 2 in [35] presents a map of the measurement locations of the 38 GHz campaign, where for each TX-RX location combination, PDPs for several TX and RX antenna azimuth and elevation pointing angle combinations were recorded. Table I provides hardware specifications for the 38 GHz measurements. For the remainder of this article, 38 GHz *narrowbeam* measurements will refer to a 25 dBi gain antenna with 7.8° HPBW at both the TX and RX, whereas *widebeam* measurements will refer to a 13.3 dBi gain antenna with 49.4° HPBW at the RX and a 7.8° HPBW antenna at the TX.

b) Peer-to-Peer Scenario: Peer-to-Peer (P2P, also called device-to-device (D2D)) measurements were made using identical 38 GHz Ka-Band vertically polarized antennas with gains of 25 dBi (7.8° Az. HPBW) at the TX and RX. A single TX and ten random RX locations with T-R separation distances ranging from 19 m to 129 m were selected around a pedestrian walkway area surrounded by many buildings on the UTA campus. Several PDPs for both LOS and NLOS scenarios were recorded. The directional antennas were also rotated in the azimuth plane, but in a systematic way to search for large scatterers from all possible azimuthal directions [34]. A map of the P2P measurement locations is displayed in Fig. 1 in [34].

3) 60 GHz Measurement Descriptions:

a) Peer-to-Peer Scenario: 60 GHz P2P measurements were similar to those recorded at 38 GHz, including the same single TX and ten random RX locations, with a maximum RF transmit power of 5 dBm over 1.5 GHz first null-to-null RF bandwidth and a maximum measurable dynamic range of 150 dB. Similar to the 38 GHz measurements, a set of 25 dBi gain horn antennas (7.3° Az. HBPW) were used at the TX and RX. See [61] and [34] for detailed descriptions of the 60 GHz P2P measurement layout and specifications.

b) Vehicular Scenario: The 60 GHz vehicular propagation measurements were aimed at investigating car-to-signpost and car-to-car communications at mmWave frequencies. Measurements were conducted in a parking lot on the UTA campus in 2011. The RX antenna was placed at head level of a seated passenger, inside a standard-sized sedan automobile, and the 1.5 m high TX antenna was placed 4 m, 12 m, and 23 m away from the car with horn antennas having 25 dBi of gain directed from the TX to the vehicle. The T-R separation distances represented distances corresponding to a single lane of traffic, a two-way street, and a multi-lane highway, respectively [74]. Measurements were taken at two RX sites within the vehicle: the driver position and a rear passenger position, as shown in

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TABLE III
T-R SEPARATION DISTANCES FOR SPECIFIC TX LOCATIONS AT 73 GHz IN MANHATTAN WHERE SIGNAL WAS RECORDED AT THE RX FOR ACCESS AND BACKHAUL MEASUREMENTS. LOS ENVIRONMENTS ARE WHEN THE TX AND RX LOCATIONS HAD A CLEAR OPTICAL PATH TO ONE ANOTHER. NLOS ENVIRONMENTS CONTAIN OBSTRUCTIONS BETWEEN THE TX AND RX

73 GHz Access (RX: 2 m) Manhattan Measurements (TX/RX Antenna Az. HPBW: 7°)		
TX Location (Abbr.) [height]	Environment	# of Locations with Signal
Coles Sports Center 1 (COL1) [7 m]	LOS	1 (d = 30 m)
	NLOS	7 (53 m ≤ d ≤ 104 m)
Coles Sports Center 2 (COL2) [7 m]	LOS	1 (d = 50 m)
	NLOS	5 (91 m ≤ d ≤ 139 m)
Kaufman (KAU) [17 m]	LOS	2 (48 m ≤ d ≤ 54 m)
	NLOS	9 (59 m ≤ d ≤ 181 m)
Kimmel Center 1 (KIM1) [7 m]	NLOS	3 (50 m ≤ d ≤ 190 m)
Kimmel Center 2 (KIM2) [7 m]	LOS	1 (d = 40 m)
	NLOS	1 (d = 182 m)
73 GHz Backhaul (RX: 4.06 m) Manhattan Measurements (TX/RX Antenna Az. HPBW: 7°)		
TX Location (Abbr.) [height]	Environment	# of Locations with Signal
Coles Sports Center 1 (COL1) [7 m]	NLOS	4 (58 m ≤ d ≤ 140 m)
Coles Sports Center 2 (COL2) [7 m]	NLOS	11 (70 m ≤ d ≤ 148 m)
Kaufman (KAU) [17 m]	LOS	2 (49 m ≤ d ≤ 54 m)
	NLOS	9 (59 m ≤ d ≤ 181 m)
Kimmel Center 1 (KIM1) [7 m]	NLOS	3 (50 m ≤ d ≤ 190 m)
Kimmel Center 2 (KIM2) [7 m]	LOS	2 (27 m ≤ d ≤ 80 m)
	NLOS	1 (d = 182 m)

[61, Fig. 3]. NLOS paths for both receivers were measured when the RX antennas were pointed away from the TX. Several PDPs were recorded over all three T-R separation distances for both RX locations [61], with both the TX and RX antennas pointed zero degrees in elevation (on the horizon). Details pertaining to the measurement hardware are given in Table I and [61].

4) 73 GHz Measurement Descriptions: The 73 GHz outdoor propagation measurements were conducted in downtown Manhattan around the NYU campus, with a maximum RF transmit power of 14.6 dBm over an 800 MHz first null-to-null RF bandwidth, yielding a maximum measurable dynamic range of 181 dB. The measurements consisted of five TX locations and 27 RX locations with a few of them repeated for more than one TX location, for both base station-to-mobile and backhaul-to-backhaul scenarios. RX antenna heights of 2 m and 4.06 m were used to emulate base station-to-mobile access and wireless backhaul scenarios, respectively. Two TX sites were located on the Coles Sports Center rooftop (7 m above ground level (AGL), with the TX located on the northwest and northeast corners of the roof), two TX sites were placed on the 2nd-floor balcony of the Kimmel center of NYU (7 m AGL, with the TX situated on the northwest and southeast corners of the balcony), and one TX site was located on the fifth-story balcony of the Kaufman Business School (17 m AGL). For each TX location, up to 11 RX locations within 200 meters[§] of the TX were selected, yielding a total of 36 unique mobile access and 38 unique backhaul link measurement combinations (six of the mobile TX-RX combinations and six of the backhaul TX-RX combinations experienced outage over all distances measured). Similar to the approach used in the 28 GHz measurement campaign, PDPs were recorded using rotatable 27 dBi gain antennas at the TX and RX to capture azimuthal sweeps in 8° (approximately the antenna HPBW) increments using many RX antenna elevation angles for different fixed TX antenna azimuth and elevation angles. In addition, azimuthal TX sweeps were performed with the RX antenna fixed in the azimuth and elevation planes. Up to ten RX azimuthal sweeps and up to two TX azimuthal sweeps were conducted for each TX-RX location combination for both mobile and backhaul measurement scenarios, resulting in up to 540 total PDPs recorded for a single TX-RX location combination. The use of high precision gimbals enabled many more elevation angle measurements at 73 GHz compared to 28 GHz, via a LabVIEW GUI controller that allowed us to easily search and find the strongest received power elevation angles. The specifics of the measurement sweeps and detailed methodology are given in [65]. [75, Fig. 1] shows a map of the TX locations and surrounding RX locations for the 73 GHz measurement campaign. Table III indicates the measurement locations and T-R separation distances where PDPs were recorded at 73 GHz in LOS and NLOS environments for each corresponding TX location and scenario (backhaul or mobile) [41], and Table I provides the channel sounder hardware specifications for all 4 mmWave bands.

[§]One NLOS T-R separation distance was greater than 200 m (216 m) for both backhaul and mobile measurements, but did not have sufficient received power, thus resulting in an outage.

III. DIRECTIONAL PATH LOSS MODELS

A. Path Loss Modeling

Since directional, rotatable horn antennas were used for the measurement campaigns in all four mmWave bands (see Table I), we generated path loss and coverage models for directional beamforming, e.g., directional antennas, as well as for omnidirectional antennas (see Section IV). For link budget and interference calculations, path loss as a function of straight

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line 3-D propagation distance is needed for system coverage and interference analysis and design. The relationship between propagation path loss and the 3-D T-R separation distance is based on both the antenna heights and a straight line drawn on a map, passing through obstructions, represented by a single model parameter, the PLE, n, which describes the attenuation of a signal as it propagates through a channel. Eq. (2) is a fundamental path loss model, usable in LOS and NLOS environments, where d_0 is the close-in free space reference distance:

$$\mathrm{PL}(d)[\mathrm{dB}] = \mathrm{PL}(d_0) + 10\overline{n}\log_{10}\left(\frac{d}{d_0}\right) + X_\sigma, \quad \text{for } d \geq d_0 \qquad (2)$$

where $\mathrm{PL}(d_0)$ is the close in free space path loss (FSPL) in dB, and is a function of wavelength (or frequency) given by $10\log_{10}\left(\frac{4\pi d_0}{\lambda}\right)^2$, with $d_0 = 1$ m for this work [30], and $\overline{n}$ is the best fit minimum mean square error (MMSE) PLE over all measurements from a particular measurement campaign. X_σ is a zero mean Gaussian random variable with a standard deviation σ in dB, also known as the shadow factor, representing large-scale signal fluctuations resulting from shadowing by large obstructions in the wireless channel [30]. In previous published mmWave work, our close-in free space reference distance path loss models used various d_0 values such as 3 m [34], 4 m [65], and 5 m [3], [13], depending on different researchers' desires to calibrate the channel sounder in free space using the far-field (Fraunhofer) distance for different directional antennas. In hindsight, standardizing to a reference distance of 1 m would have made comparisons of measurements and models simpler, and would provide a standard definition for the PLE. As shown in this section, the benefit of using a $d_0 = 1$ m reference distance in (2) provides for easy comparison of various measurement campaigns by different researchers in different environments, and at different frequencies and use cases. In this work, we have recast all of the measurements from the four campaigns (published in [3], [13], [14], [34]–[36], [44], [61], [62], [64], [65]) into path loss models that use $d_0 = 1$ m as the FSPL anchor point, in order to standardize the use of (2) and to help standards bodies and industry compare their respective models.

As shown in [29], the most substantial difference in path loss across all mmWave bands occurs in the very first meter of propagation from the TX, motivating the use of a 1 m reference distance in (2) for both LOS and NLOS environments. It is a very simple matter to refer any calibrated channel sounder, regardless of antenna gain and Fraunhofer distance, back to a 1 m free space reference distance—one simply extrapolates free space propagation back from the Fraunhofer distance to the 1 m reference distance in the measured path loss data, after free space calibration is performed. We have used such an approach in this paper for all of our measurements, as it both assures that proper far field measurements were conducted, and also provides data for a path loss model using a standardized 1 m close-in free space reference distance.

Emerging mmWave mobile systems will have very few users within a few meters of the antenna (in fact, no users are likely to be in the near field, since transmitters will be mounted on a lamppost or ceiling), and close in users in the near field would have such strong signals or will be power controlled compared to typical users much farther from the transmitter such that any path loss error in the near-field (between 1 m and the Fraunhofer distance) would be so much smaller than the dynamic range of signals experienced by users in a commercial system. Furthermore, in a typical mobile system with uniformly distributed users, very few users are close to the TX antenna, meaning that propagation model errors close to the TX have minimal impact on system design. Using a reference distance greater than 1 m in (2) is physically plausible for both LOS and NLOS channels, since transmitting antennas are generally mounted in the clear with a large zone of free space around them, and radiation from a TX antenna will experience free space for many meters or tens of meters before encountering clutter, but optimizing for the best reference distance adds model complexity while only reducing the standard deviation by less than a dB in typical outdoor scenarios. Thus, we advocate a standardized 1 m reference distance, even if the calibration distance or free space zone surrounding the TX antenna is greater than 1 m.

An alternative to the close-in free space reference distance path loss model is the *floating intercept*, or *alpha-beta* model of (3) used in the WINNER II and 3GPP channel models [50], [76]. This model has no physical reference or basis, but merely fits the best line to the measured data (via a least-squares regression) to create a floating intercept linear equation model [14], that is only valid over the specific distances for which measurements were made.

$$\mathrm{PL}[\mathrm{dB}] = \alpha + 10 \cdot \beta \log_{10}(d) + X_\sigma \qquad (3)$$

In (3), α is the intercept in dB, β is the slope, and X_σ is a zero mean Gaussian random variable with a standard deviation σ in dB. A common error made by engineers when interpreting path loss models is to assume that β is the same as PLE—it is not. β simply serves to be a particular value of slope that offers the best fit to a scatter plot of data, and has no physical basis or frequency dependence whatsoever [1], [14], [77]. β only has a physical meaning, like PLE, when α is set equal to the free space reference distance close to the antenna. As discussed in [14] and [48], the standard deviation is reduced by only 1 dB or so when using (3) instead of using (2) with $d_0 = 1$ m, yet there is no physical basis for (3), and different researchers cannot immediately extract insightful information from two model parameters, α or β. Given that both (2) and (3) typically have 7 to 12 dB of standard deviation (not a terribly good model, albeit a simple one), we believe it makes sense to use a single parameter model for $d_0 = 1$ m in (2) [48], rather than to have every propagation researcher create their own model where α and β have no physical relevance.

Both the close-in free space reference distance model and floating intercept model may be used to characterize mmWave channels in both LOS and NLOS environments, but we advocate the use of (2) with $d_0 = 1$ m for mmWave path loss channel modeling, because of the simpler form, the physical basis, and the additional benefit of having an agreed-upon standard that is usable with reasonable accuracy across many environments, scenarios, and frequency bands.

While early cellular UHF models used 1 km or 100 m as the d_0 reference distance due to tall base station antennas that were "in the clear" and provided larger cell sizes, 1 m is more relevant for mmWave since there are generally no obstructions

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TABLE IV
PATH LOSS TERMINOLOGY FOR DIRECTIONAL PATH LOSS MODELS

Setting	Description
LOS	Path loss when the TX and RX antennas are pointed at each other, aligned on boresight, with no obstructions between them.
NLOS	Path loss when the TX and RX antennas are separated by obstructions and there is no clear optical path between the antennas. This scenario also includes the case where the TX and RX antennas have a clear line-of-sight path to one another, but the antennas are not aligned on boresight.
NLOS-best	Path loss for the unique antenna pointing angles (in the azimuth and elevation planes) resulting in the strongest received power for each specific TX-RX location combination. This results from the single strongest measured PDP from the *NLOS* data at each TX-RX location combination.

around antennas within the first meter, and cell sizes will have radii up to a few hundred meters [1], [30].

B. Mobile Access and Backhaul Directional Close-in Free Space Reference Distance Path Loss Models

The directional propagation models for 28, 38, and 73 GHz based on our measurements were formed from all measured antenna pointing angles between the TX and RX antennas. Base station-to-mobile (access) measurements were conducted at 28, 38, and 73 GHz, and base station-to-base station (backhaul) measurements were conducted at 73 GHz. Table IV describes the terminology used for directional path loss models. Fig. 1 shows measured data and close-in free space reference distance ($d_0 = 1$ m) directional path loss models for the 73 GHz hybrid (RX heights of 4.06 and 2 m) measurements, for each setting described in Table IV. Fig. 1 plots path loss obtained by integrating the power under PDPs obtained from all of the individual unique antenna pointing angles between the TX and RX over all measurements. The close-in free space reference distance $d_0 = 1$ m yields 69.8 dB path loss in the first meter of propagation at an RF carrier frequency of 73.5 GHz, and is the y-axis anchor point for the MMSE fit.

Table V provides the close-in free space reference distance ($d_0 = 1$ m) directional path loss models of (2) for the different 28, 38, and 73 GHz campaigns. The LOS PLE for the 28 and 38 GHz campaigns are comparable, as they are $\bar{n} = 1.9$. The smaller σ value for 28 GHz LOS measurements can be attributed to different channel types (NYC vs. Austin) as compared to 38 GHz measurements. As for the 73 GHz LOS PLE being approximately $\bar{n} = 2.3$ for all scenarios, this can be attributed to the difficulty in aligning very narrowbeam directional horn antennas perfectly on boresight for the T-R separation distances measured, and this indicates the sensitivity of beam pointing in future mmWave wireless systems. To improve LOS field measurements, laser pointers can be used to ensure boresight alignment, or a power-alignment scheme between the TX and RX antennas may be employed. Overall, the LOS PLEs for the 28, 38, and 73 GHz measurements compare well with the theoretical FSPL of $n = 2$ (20 dB of attenuation per decade of distance).

For NLOS conditions with narrowbeam antennas, the 38 GHz campaign had the smallest (least lossy) directional PLE of 3.3, compared to 4.5 for 28 GHz and 4.7 for all 73 GHz channels. The UTA measurements only looked for

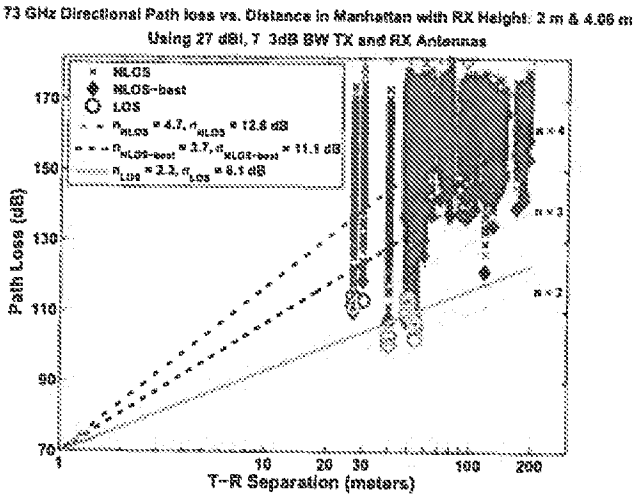

Fig. 1. 73 GHz directional close-in free space reference distance ($d_0 = 1$ m) path loss models for the hybrid scenario with RX antenna heights of 2 m and 4.06 m in Downtown New York City. Each red cross represents NLOS path loss values measured at each unique antenna pointing angle between the TX and RX (provided signal could be received), blue diamonds represent the particular TX-RX pointing angle that resulted in the lowest path loss measured for each specific NLOS TX-RX location combination, and green circles represent LOS path loss values.

strong paths (stronger than were encountered on the antenna sweeps at 28 and 73 GHz), and the campus has more foliage, more undulating terrain, and is less urban than New York City, thus the transmitted signal did not encounter as many blockages in the propagation channel. The shadow factor or standard deviation about the mean path loss line is comparable for all three frequency bands, around 10 dB, although the standard deviation increases with carrier frequency. The 73 GHz NLOS PLEs for each TX height scenario are all larger than the narrowbeam and widebeam NLOS PLEs at 28 GHz, and are also greater than the narrowbeam and widebeam NLOS PLEs at 38 GHz in Austin. Because 73 GHz signals have shorter wavelengths than 28 GHz and 38 GHz, the propagating wave attenuates more as it encounters rough surfaces of buildings that cause diffuse scattering, as well as undergoing 8.3 dB more path loss in the first meter of free space propagation compared to 28 GHz.

As presented in Table IV, the *NLOS-best* setting is for the single strongest received power antenna pointing angle orientation between the TX and RX antennas for each NLOS TX-RX location combination (i.e. the lowest measured path loss for each location). That is, NLOS-best is equivalent to directional beamforming (BF) using the best single beam at both the TX and RX. From the measured path loss values at each location an MMSE *NLOS-best* line is fit to the NLOS data to generate models following (2). Path loss models, when considering the strongest received power pointing angles, show a decrease in attenuation (much better coverage), compared to the arbitrary pointing angle models at each frequency. Future mmWave adaptive array algorithms will be used to determine these preferred pointing angles at both the TX and RX [1], [6], [78]. When using the single strongest beam angles, Table V shows the PLE reduces by 7 dB, 6 dB, and 10 dB per decade of distance for the 28 GHz, 38 GHz, and 73 GHz NLOS narrowbeam measurements, respectively, compared to

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TABLE V

DIRECTIONAL CLOSE-IN FREE SPACE REFERENCE DISTANCE ($d_0 = 1$ m) PATH LOSS MODELS (EQ. (2)) FOR BASE STATION-TO-MOBILE (ACCESS) AND BASE STATION-TO-BASE STATION (BACKHAUL) SCENARIOS. PLE IS THE PATH LOSS EXPONENT AND σ IS THE STANDARD DEVIATION OF THE ZERO-MEAN GAUSSIAN RANDOM VARIABLE (SHADOW FACTOR). HPBW IS THE 3 dB BEAMWIDTH OF THE TX AND RX ANTENNAS, G IS THE GAIN OF EITHER THE TX OR RX ANTENNA, AND h IS THE HEIGHT ABOVE GROUND OF EITHER THE TX OR RX ANTENNA. THE 2 m, 4.06 m, AND COMBINED 2 m AND 4.06 m RX HEIGHTS FOR THE 73 GHz MEASUREMENTS ARE THE ACCESS, BACKHAUL, AND HYBRID SCENARIOS, RESPECTIVELY

Directional Close-in Reference Distance Path Loss Models for $d_0 = 1$ m										
	TX/RX HPBW (°)	G_{TX}/G_{RX} (dBi)	h_{TX}(m)	h_{RX}(m)	LOS		NLOS		NLOS (best)	
					PLE	σ [dB]	PLE	σ [dB]	PLE	σ [dB]
28 GHz (Man.)	10.9 / 10.9	24.5 / 24.5	7, 17	1.5	1.9	1.1	4.5	10.0	3.8	9.1
38 GHz (BK)	28.8 / 10.9	15 / 24.5	40		-	-	4.1	7.1	3.5	3.3
38 GHz (Austin)	7.8 / 7.8	25 / 25	8, 23, 36	1.5	1.9	4.6	3.3	12.3	2.7	10.2
	7.8 / 49.4	25 / 13.3			1.9	3.5	2.8	10.3	2.3	7.9
73 GHz (Man.)	7 / 7	27 / 27	2, 17	2	2.2	5.2	4.7	12.6	3.6	10.6
				4.06	2.4	6.3	4.7	12.7	3.7	11.2
				2, 4.06	2.3	6.1	4.7	12.6	3.7	11.1

TABLE VI

DIRECTIONAL FLOATING INTERCEPT PATH LOSS MODELS AT 28 GHz, 38 GHz, AND 73 GHz. α IS THE FLOATING INTERCEPT, β IS THE SLOPE OF THE LEAST SQUARES LINE, AND σ IS THE STANDARD DEVIATION OF THE ZERO-MEAN GAUSSIAN RANDOM VARIABLE (SHADOW FACTOR) ABOUT THE LEAST SQUARES LINE

Directional Floating Intercept (*alpha-beta*) Path Loss Models												
	TX/RX HPBW (°)	G_{TX}/G_{RX} (dBi)	h_{TX}(m)	h_{RX}(m)	LOS			NLOS			NLOS (best)		
					α [dB]	β	σ [dB]	α [dB]	β	σ [dB]	α [dB]	β	σ [dB]
28 GHz (Man.)	10.9 / 10.9	24.5 / 24.5	7, 17	1.5	45.3	2.9	0.01	57.6	4.7	10.0	41.2	4.7	8.9
28 GHz (BK)	28.8 / 10.9	15 / 24.5	40		-	-	-	144.7	0.2	7.1	158.2	-1.1	2.2
38 GHz (Austin)	7.8 / 7.8	25 / 25	8, 23, 36	1.5	68.8	1.7	4.4	125.4	0.55	8.3	107.8	0.8	7.8
	7.8 / 49.4	25 / 13.3			73.3	1.5	3.1	108.4	0.80	7.3	92.3	1.1	6.3
73 GHz (Man.)	7 / 7	27 / 27	2, 17	2	126.2	1.2	4.1	122.6	1.8	11.2	33.2	4.9	10.3
				4.06	126.2	1.1	4.8	114.2	2.3	11.5	34.6	5.5	10.6
				2, 4.06	127.9	1.2	4.6	118.2	2.1	11.3	38	5.3	10.5

arbitrary pointing angles. This reduction in attenuation is significant and motivates beam combining and beamforming at mmWave frequencies in order to improve link margin and SNR, and can also result in lower RMS delay spreads [1], [44], [49], [64], [72]. Antenna beamwidth at the RX also impacts the received signal level, as Table V shows that 38 GHz PLEs are lower for widebeam RX antennas, as they were able to capture energy in a wider azimuth spread than narrowbeam antennas in a NLOS setting, but did not capture signals with high path loss due to the smaller antenna gain. This reduces the dynamic range of the measurement system (due to lower antenna gains) compared to the use of narrowbeam RX antennas. A comprehensive list of the minimum, average, and maximum directional path loss values for each NLOS TX-RX combination, as well as RMS delay spread data, tested for the 28 GHz and 73 GHz campaigns are given in [49].

C. Mobile Access and Backhaul Directional Floating Intercept Path Loss Models

The floating intercept model of Eq. (3) is a least squares fit to the propagation data without a constraint, over the range of measurement distances, but does not have a physical basis because there is no physically-based anchor point like in the close-in reference distance model (2). The close-in free space reference distance model can be extended past the measured T-R separation distances because it is referenced to a known FSPL; however, the floating intercept model cannot, since (3) is a best fit line to a set of data with a form similar to Eq. (2), but with no physical basis for the values of α and β. For the 28 and 73 GHz campaigns, T-R separation distances ranged from approximately 50 to 200 m for the NLOS floating intercept model, whereas the 38 GHz measurements had distances ranging from 29 m to more than 900 m. The floating intercept model finds a slightly better fit to measured data without a constraint and usually results in a slightly lower standard deviation (shadow factor: σ) about the best fit line on a scatter plot, although in most cases the difference is much less than 1 dB [14], [38], [94].

The values in Table VI have no physical basis as is clearly seen by the fact that some of the best fit line slopes β are close to zero or even negative, caused by fitting a least squares line over a large range of path loss values measured over many T-R separation distances [14]. In some cases, the slope (β) of the best fit line for NLOS pointing angles with the strongest power is larger than the close-in reference distance PLE for the NLOS-best models. The floating intercept model is also very sensitive, such that even changing some post-processing techniques or noise floor thresholding can significantly change the values computed for these unique pointing angle models; therefore, at mmWave frequencies, we propose to use the close-in free space reference distance model with a 1 m reference distance due to its physical basis, stability, and the benefit of having a standard model to compare many measurements and scenarios from groups worldwide.

IV. OMNIDIRECTIONAL PATH LOSS MODELS

Directional path loss models are important for systems using narrowbeam directional antennas since mmWaves will take advantage of beamforming and beam combining techniques [49].

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However, standards bodies have historically been interested in omnidirectional models, especially for NLOS channels, since all legacy wireless systems have used quasi-omnidirectional antennas at the user equipment (UE), and arbitrary antenna patterns and MIMO processing may be easily analyzed and simulated with omnidirectional models. In this section, omnidirectional close-in free space reference distance ($d_0 = 1$ m) path loss and floating intercept models are presented. The raw data used to compute omnidirectional path loss models at 28, 38 and 73 GHz are provided in tabular form in [94]. To create these models, the received power from unique pointing angle combinations between the TX and RX antennas for each TX-RX location combination were synthesized. Originally, directional measurements were made for i TX locations and j RX locations for arbitrary TX antenna pointing angles θ_t and ϕ_t in the azimuth and elevation planes, respectively, and for arbitrary RX antenna pointing angles θ_r and ϕ_r in the azimuth and elevation planes, respectively. Received power (or area under a PDP) was measured at every unique TX and RX azimuth/elevation antenna pointing angle combination for every distinct TX-RX location pair. The θ and ϕ angle values for every distinct pointing angle combination correspond to received power $\widetilde{Pr}_{i,j}(\theta_r, \phi_r, \theta_t, \phi_t)$ for every directional measurement. TX and RX antenna gains (in dB) were removed for each received power level $\widetilde{Pr}_{i,j}(\theta_r, \phi_r, \theta_t, \phi_t)$ such that $Pr_{i,j}(\theta_r, \phi_r, \theta_t, \phi_t) = \widetilde{Pr}_{i,j}(\theta_r, \phi_r, \theta_t, \phi_t) - G_{TX} - G_{RX}$. Then for each distinct TX-RX location combination measured, the received powers for each and every unique TX and RX azimuth and elevation angle combination (with antenna gains removed) were summed together in linear scale (mW) to recover an omnidirectional received power from which an omnidirectional path loss model was computed. The omnidirectional received power can be synthesized in this way because each narrowbeam angle spread measured over the entire 4π steradian sphere can be regarded as an orthogonal non-overlapping spatial segment, obviating the need to de-embed the antenna pattern when calculating the omnidirectional received power. We proved the accuracy of this approach by carefully studying and comparing the summed versions of adjacent directional measurements that were separated by HPBW increments. Additionally, the measured data at 28 GHz showed that using nine adjacent 10.9° HPBW antennas in the azimuth and elevation plane yields virtually identical received power (area under the PDP) as using one 28.8° HPBW antenna (where the HPBW of the widebeam antenna is about three times that of the narrowbeam antenna), which further validates the synthesizing method. Thus, for each TX-RX location pair, omnidirectional path loss was recovered from the unique pointing angle received powers using

$$PL_{i,j}[\text{dB}] = Pt_{i,j}[\text{dBm}] - 10\log_{10}\left[\sum_{z}\sum_{y}\sum_{x}\sum_{w} Pr_{i,j}(\theta_{r_w}, \phi_{r_x}, \theta_{t_y}, \phi_{t_z})\,[\text{mW}]\right] \quad (4)$$

where $Pt_{i,j}$ is the transmit power in dBm. A more detailed description of how the directional measurements were aggregated together to create omnidirectional models similar to those in [39] and [40] was presented in [38]. The LOS and NLOS terminology for the omnidirectional model follows the traditional sense and is explained in Table VII.

TABLE VII
PATH LOSS TERMINOLOGY FOR OMNIDIRECTIONAL PATH LOSS MODELS

Setting	Description
LOS	Path loss when there is a clear optical path between the TX and RX site.
NLOS	Path loss when the TX and RX sites are separated by obstructions and there is no clear direct path between the antennas.

The omnidirectional close-in free space reference distance path loss models are presented for LOS and NLOS environments as described by parameters in Table VIII, along with a NLOS floating intercept model. Fig. 2 shows the omnidirectional LOS and NLOS close-in reference distance ($d_0 = 1$ m) FSPL models and the NLOS floating intercept model for the 73 GHz hybrid scenario. The LOS PLE for the hybrid case is $\tilde{n} = 2$, consistent with theoretical FSPL of 20 dB per decade of distance. The standard deviation about the mean FSPL line is relatively low at 4.8 dB. The computed NLOS PLE was 3.4 meaning that with omnidirectional and isotropic 0 dBi gain antennas at the TX and RX, a 73 GHz wideband signal will attenuate by 34 dB per decade of distance. Fig. 2 also shows the omnidirectional NLOS floating intercept model with a slope of 2.9 and standard deviation of 7.8 dB, only 0.1 dB less than the close-in reference NLOS omnidirectional FSPL model, showing that the *alpha-beta* model does not meaningfully reduce the standard deviation. While the slope of the NLOS floating intercept model is lower than the close-in reference distance PLE, it is only valid over the ~50 m to 200 m measurement range. A path loss model at 1.9 GHz for the NLOS environment in San Francisco using omnidirectional antennas with a base station antenna height of 3.7 m and a mobile RX antenna height of 1.7 m is also displayed in Fig. 2 with a PLE of 2.6 and a standard deviation of 7.7 dB [79]. This comparison to the 73 GHz path loss line shows that the PLEs are not vastly different. The difference lies in both the additional free space path loss in the first meter of propagation attributed by Friis' free space path loss equation where path loss is proportional to the square of the carrier frequency, as well as additional attenuation by the environment at mmWave frequencies. Fig. 2 shows that 8 dB per decade of distance more loss is experienced at 73 GHz than at 1.9 GHz. This difference in the propagation at mmWaves can be made up by using directional, high gain antennas in addition to beamforming and beam combining techniques [49], [64].

Given the omnidirectional path loss parameters for 28, 38, and 73 GHz in Table VIII, it is apparent that the LOS PLEs are almost identical to true FSPL of $n = 2$. The NLOS omnidirectional PLEs are significantly lower compared to the directional models, where for 28 GHz measurements the NLOS omnidirectional path loss is 11 dB and 6 dB per decade of distance lower compared to the narrowbeam and widebeam directional cases, respectively. At 38 GHz, the NLOS omnidirectional path loss is 5 dB and 4 dB per decade of distance lower compared to the narrowbeam and widebeam models, respectively. The greatest difference between directional and omnidirectional path loss models is at 73 GHz. The access, backhaul, and hybrid NLOS omnidirectional path loss values are all 10 dB per decade of

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TABLE VIII
OMNIDIRECTIONAL CLOSE-IN FREE SPACE REFERENCE DISTANCE ($d_0 = 1$ m) AND FLOATING INTERCEPT PATH LOSS MODELS FOR ALL MEASURED DATA FOR BASE STATION-TO-MOBILE (ACCESS) AND BASE STATION-TO-BASE STATION (BACKHAUL) SCENARIOS. α IS THE FLOATING INTERCEPT, β IS THE SLOPE OF THE MMSE LINE, AND σ IS THE STANDARD DEVIATION OF THE ZERO-MEAN GAUSSIAN RANDOM VARIABLE (SHADOW FACTOR) ABOUT THE LEAST SQUARES BEST FIT LINE FOR THE RANGE OF DISTANCES SPECIFIED FOR EACH FREQUENCY BAND. MAN. STANDS FOR MANHATTAN

Omnidirectional Path Loss Models ($d_0 = 1$ m)												
	TX RX scenario	TX Ht (m)	RX Ht (m)	NLOS Meas Range: d (m)	LOS		NLOS		NLOS (Floating)		
					PLE	σ [dB]	PLE	σ [dB]	α [dB]	β	σ [dB]
28 GHz (Man.)	Narrow/Narrow	7, 17	1.5	$61 \le d \le 187$	2.1	3.6	3.4	9.7	79.2	2.6	9.6
38 GHz (Austin)	Narrow/Narrow	23	1.5	$61 \le d \le 150$	2.0	2.4	2.8	9.1	39.1	4.0	8.9
		36		$75 \le d \le 377$	1.9	3.6	2.6	10.8	122.2	0.1	9.2
		23, 36		$61 \le d \le 377$	1.9	3.4	2.7	10.5	100.9	1.0	9.6
		8, 23, 36		$29 \le d \le 377$	1.9	4.4	2.7	10.1	96.2	1.3	9.1
	Narrow/Wide	23	1.5	$d \ge 101$	1.8	2.4	2.6	-	-	-	-
		36		$75 \le d \le 728$	1.8	1.8	2.2	4.1	81.7	1.5	3.4
		23, 36		$75 \le d \le 728$	1.8	2.1	2.3	4.9	88.6	1.2	3.4
		8, 23, 36		$29 \le d \le 728$	1.8	3.2	2.3	7.4	88.2	1.3	5.7
73 GHz (Man.)	Access	7, 17	2	$48 \le d \le 190$	2.0	5.2	3.3	7.6	81.9	2.7	7.5
	Backhaul		4.06	$50 \le d \le 190$	2.0	4.2	3.5	7.9	84.0	2.8	7.8
	Hybrid		2, 4.06	$48 \le d \le 190$	2.0	4.8	3.4	7.9	80.6	2.9	7.8

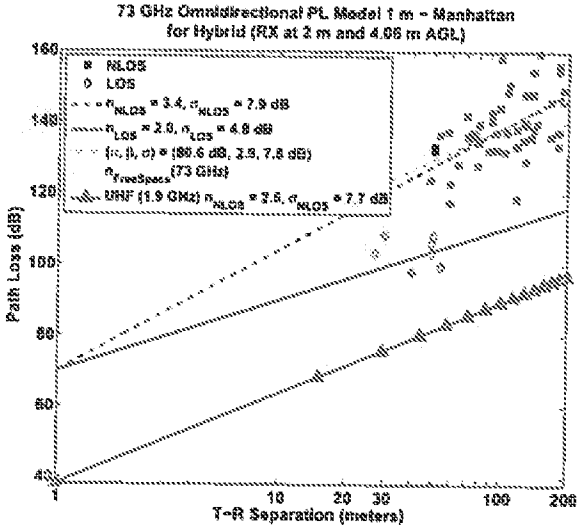

Fig. 2. 73 GHz omnidirectional close-in free space reference distance ($d_0 = 1$ m) and floating intercept (NLOS) path loss models for the hybrid scenario with RX antenna at heights of 2 m and 4.06 m in New York City. Blue squares represent NLOS omnidirectional path loss values and red diamonds represent LOS omnidirectional path loss values. An omnidirectional NLOS path loss model for the 1.9 GHz band measured in San Francisco is also displayed on the figure for comparison [79].

distance lower than their respective directional models. The 73 GHz campaign had a larger data set and explored many more azimuth and elevation plane combinations between the transmit and receive antennas that were used to create the omnidirectional model, perhaps resulting in a more accurately synthesized model. With more narrowbeam measurements in the azimuth and elevation planes at 28 and 38 GHz, we would expect the omnidirectional PLEs to be slightly lower compared to their respective directional PLEs, like in the 73 GHz cases. We note that the data suggests PLE tends to increase slightly with frequency in a given environment, meaning that higher mmWave frequencies experience slighty more loss per distance due to the environment (in addition to the dominant first meter free space loss). This is most likely due to more rough surface/diffuse scattering and less reflectivity in the physical environment as the wavelength shrinks.

Similar to the directional floating intercept path loss models, the omnidirectional floating intercept path loss models have no physical basis. As noticed for the NLOS directional floating intercept models, the NLOS omnidirectional floating intercept models also reveal a small reduction in the shadow factor (σ), but the changes are minimal (typically less than one dB). In addition, the floating intercept model is only valid over the T-R separation distances measured during the campaign, whereas the close-in free space reference distance model can be extended, due to its physical basis, to distances farther than the measurement range. The floating intercept model parameters for the 28 and 73 GHz campaigns are slightly different here than those described in [40], due to an updated PDP thresholding algorithm that uses a more stringent 5 dB SNR threshold, and by separating the TX-RX path loss data points by RX antenna height, as described in [38]. The values in Table VIII can be used to model the propagation environment, using simple equations with a 1 m free space reference distance as shown for the general form in Eq. (5).

$$\mathrm{PL}(\mathrm{envr}, f_c, d)[\mathrm{dB}] = \mathrm{FSPL}(f_c, d_0 = 1) + \overline{n_{\mathrm{envr},f_c}} \cdot 10\log_{10}(d) + X_\sigma(\mathrm{envr}, f_c)[\mathrm{dB}] \quad (5)$$

where:

$$\mathrm{FSPL}(f_c, d_0 = 1)[\mathrm{dB}] = 20\log_{10}\left(\frac{4\pi}{c/f_c}\right) \quad (6)$$

for distances d, speed of light c and the environment (envr), whether LOS or NLOS, and for the appropriate carrier frequency, f_c. The omnidirectional models presented here are useful for mmWave standards bodies and have not been previously presented over so many frequency bands in a unified format.

Using (5) and data such as given in Table VIII, the optimum averaged PLE value in (2) can be found for an operating environment (e.g. LOS or NLOS) or scenario (e.g., UMi or UMa) over many frequencies and distances by computing the path loss, in dB, for each measurement campaign (table entry),

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and then subtracting out the 1 m free space path loss for each campaign. It is important to compute the PLE in (2) based on the propagation beginning at 1 m (with the first meter of free space path loss subtracted out), and to not be tempted to simply average PLE values across frequencies, since the first meter of propagation can induce 32 to 72 dB of loss from 1 to 100 GHz. In other words, the first meter of propagation has an important, physically-based frequency-dependent effect that should not be averaged, but should be represented separately as shown in (5), where the PLE represents the environmental effects of propagation (which become slightly more lossy at higher mmWave frequencies). Solving for the optimum PLE in (2) is done by subtracting the first meter of free space propagation loss from the path loss data, and then finding a MMSE fit on all of the path loss data (with 1 m free space loss removed) over all frequencies and distances simultaneously. Using (2) for a particular operating environment or scenario can provide an accurate, stable, robust, and yet very simple path loss model over a wide range of mmWave frequencies. The simple, one parameter close-in free space reference distance path loss model given by (2) and (5) could be of value to standard bodies, since it is physically based and standardizes around an inherent 1 m free space reference distance that is frequency dependent. Optimizing (2) to find the best-fit close-in reference distance, or using a table lookup procedure for PLE values at different frequencies, or using a PLE value that is a function of frequency and/or distance to minimize the shadowing standard deviation, and adding loss parameters to account for the environment or frequency are all possible variations of the close-in free space reference distance model. More measurements, however, are needed to validate its accuracy in comparison to other models.

V. Beam Combining

As the mmWave wideband regime continues to grow, it is apparent that the number of antenna elements on a device will increase as the RF carrier frequency increases. In conjunction with this, high gain directional antennas are envisaged as crucial elements in order to detect mmWave signals with reasonable SNR. Since devices will employ very directional, high gain antennas, beam combining techniques and beamforming algorithms will need to be developed to actively search for and find the strongest departing and incoming directional beams at the TX and RX, respectively [49], [64]. By determining the strongest received power angle combinations, multiple antenna elements can be used to increase the SNR of the incoming signal, and may reduce the path loss observed at the RX, compared to any arbitrary antenna pointing angle. Work presented in [44], [64], [72] shows the reduction in PLEs when combining the few strongest beam powers at the RX for 28 and 73 GHz for both coherent and non-coherent beam combining. Reducing the PLE is synonymous with extending the coverage distance of a cell. While the results in [44], [64], [72] showed beam combining for different reference distances and for the NLOS environments described in Table IV, here we present all beam combining results following the NLOS descriptions presented in Table VII (does not include non-boresight LOS measurements) with respect to a 1 m close-in free space reference distance.

Beam combining may be performed coherently or non-coherently. Most current wireless systems are coherently based; however, this does not mean that future 5G and mmWave systems will necessarily be coherent. Coherent beam combining assumes multipath components at different angles can be time-aligned and is performed by taking the square root of the strongest individual total received powers in Watts from PDPs recorded for a given TX-RX link, summing together the equivalent voltages, and then squaring the summed result. Only unique angle combinations are used here such that the same beam is not considered twice. The method for determining received power for coherent beam combining is shown in Eq. (7):

$$P_{\text{coherent}} = \left(\sum_{i=1}^{N} \sqrt{P_i}\right)^2 \tag{7}$$

where P_i are the individual strongest received powers from unique TX-RX antenna pointing angle combinations, and N is the number of strongest beams considered. Non-coherent beam combining assumes detection of each unique beam and then sums the received powers in Watts of the strongest beam combinations:

$$P_{\text{non-coherent}} = \sum_{i=1}^{N} P_i \tag{8}$$

Combining the strongest directional beams for each NLOS TX-RX location combination results in reduced PLEs and shadow factors as presented in Table IX, and are all with respect to a 1 m close-in free space reference distance. Table IX also shows *distance extension exponents* (DEEs) used to determine the extended distance where a user would experience the same path loss for combining the best beams compared to the single best beam [41], [44], [72], and is shown in (9), where d denotes the coverage distance:

$$d_{(\text{multibeam})} = \left[d_{(1\ \text{beam})}\right]^{\text{DEE}} \tag{9}$$

where the path loss experienced at a distance $d_{(1\ \text{beam})}$ for the single best beam, is the same path loss experienced at a distance $d_{(\text{multibeam})}$ when combining multiple beams, and is determined using the DEEs specified in Table IX.

From the results in Table IX [1] it is obvious that coherently combining the beams with the strongest measured powers for a particular location reduces the PLE more than non-coherently combining. When coherently combining beams, the resulting PLE may sometimes be lower than the omnidirectional PLE. Non-coherent combining is the same procedure used for determining the omnidirectional path loss models shown in Table VIII (simply summing the powers), and it is expected that the non-coherent PLE would converge to the omnidirectional PLE as the number of beams increases. When comparing the PLE for any arbitrary pointing angle with respect to (w.r.t.) a 1 m close-in free space reference distance versus coherently combining the four best unique beams to determine the PLE, significant reductions in the PLE are noticed for all frequency bands, but the distance extension effect as defined in [41] may not be apparent. For instance, the path loss observed at 200 meters for the single (strongest) best measured beam at 28 GHz is also observed at a distance of 450 m when coherently combining the four strongest measured beams,

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TABLE IX

DIRECTIONAL CLOSE-IN FREE SPACE REFERENCE DISTANCE (d_0 = 1 m) BEAM COMBINING PATH LOSS MODELS AT 28 GHz, 38 GHz, AND 73 GHz IN NLOS ENVIRONMENTS. *PLE* IS THE PATH LOSS EXPONENT, σ IS THE STANDARD DEVIATION OF THE ZERO-MEAN GAUSSIAN RANDOM VARIABLE (SHADOW FACTOR) ABOUT THE MMSE LINE, *Beams* IS THE NUMBER OF MEASURED BEAMS USED FOR THE COHERENT AND NON-COHERENT BEAM COMBINING PROCEDURE, AND DEE [41] IS THE *Distance Extension Exponent* USED TO DETERMINE THE EXTENDED COVERAGE DISTANCE WHEN COMBINING MULTIPLE BEAMS. THE ARBITRARY POINTING ANGLE PLEs ARE ALSO DISPLAYED FROM TABLE V TO COMPARE THE MODELS FOR BEST (STRONGEST MEASURED) BEAMS AND ANY ARBITRARY BEAM

NLOS Directional Beam Combining Path Loss Models (d_0 = 1 m)											
Frequency	TX Height (m)	RX Height (m)	TX / RX Antenna HPBW								
28 GHz (Man.)	2, 17	1.5	10.9° / 10.9°		PLE (Over all angles) = 4.556						
					Coherent			Non-Coherent			
				Beams	PLE	σ [dB]	DEF	PLE	σ [dB]	DEF
				1	3.812	9.1	-	3.812	9.1	-
				2	3.548	9.1	1.074	3.697	9.2	1.031
				3	3.486	9.2	1.119	3.631	9.2	1.050
				4	3.389	9.2	1.153	3.591	9.2	1.082
38 GHz	8, 23, 36	1.5	7.8° / 7.8°		PLE (Over all angles) = 3.295						
					Coherent			Non-Coherent			
				Beams	PLE	σ [dB]	DEF	PLE	σ [dB]	DEF
				1	2.801	12.2	-	2.801	12.2	-
				2	2.651	10.8	1.056	2.756	11.5	1.016
				3	2.529	10.6	1.086	2.741	11.4	1.023
				4	2.531	10.3	1.107	2.731	11.3	1.026
			7.8° / 49.4°		PLE (Over all angles) = 2.826						
					Coherent			Non-Coherent			
				Beams	PLE	σ [dB]	DEF	PLE	σ [dB]	DEF
				1	2.588	8.9	-	2.588	8.9	-
				2	2.463	7.9	1.095	2.497	8.3	1.036
				3	2.339	7.3	1.137	2.461	7.9	1.052
				4	2.191	6.9	1.182	2.443	7.8	1.060
73 GHz	2, 17	2	7° / 7°		PLE (Over all angles) = 4.687						
					Coherent			Non-Coherent			
				Beams	PLE	σ [dB]	DEF	PLE	σ [dB]	DEF
				1	3.728	7.6	-	3.728	7.6	-
				2	3.466	7.3	1.076	3.613	7.4	1.032
				3	3.327	7.2	1.121	3.557	7.3	1.048
				4	3.255	7.2	1.152	3.523	7.3	1.058
		4.06			PLE (Over all angles) = 4.660						
					Coherent			Non-Coherent			
				Beams	PLE	σ [dB]	DEF	PLE	σ [dB]	DEF
				1	3.823	8.9	-	3.823	8.9	-
				2	3.578	8.5	1.067	3.718	8.6	1.028
				3	3.436	8.1	1.110	3.667	8.3	1.043
				4	3.351	7.8	1.140	3.632	8.1	1.051
		2, 4.06			PLE (Over all angles) = 4.675						
					Coherent			Non-Coherent			
				Beams	PLE	σ [dB]	DEF	PLE	σ [dB]	DEF
				1	3.779	8.4	-	3.779	8.4	-
				2	3.578	8.0	1.072	3.670	8.1	1.030
				3	3.446	7.7	1.115	3.616	7.9	1.045
				4	3.353	7.6	1.146	3.582	7.8	1.055

corresponding to a DEE of 1.153 [41]. The *distance extension factor* (DEF) was also derived in [41] that resulted in a DEF of 2.25 when coherently combining the four single strongest measured beams at 28 GHz. The reduced PLEs for the 38 GHz campaign are not as significant as the 28 GHz and 73 GHz campaigns because fewer measurements were made (perhaps because only one or two substantially strong beams were detected at some locations) and the environment was less cluttered, meaning that a smaller number of MPCs would reach the RX with significant energy. As shown in Tables V and IX, the PLEs determined through antenna beam searching and combining are much smaller than the PLEs for pointing antennas in arbitrary directions, and this is an important fact for mmWave 5G communications systems. Note that the angular search for power in the 28 GHz and 38 GHz measurements was less extensive than at 73 GHz, where a larger portion of the 4π steradian sphere was measured. It should also be noted that we systematically found the strongest received power angle combinations between the TX and RX antennas at 73 GHz such that our measurements sweeps covered the azimuth and elevation planes with the most energy. Overall, these results show that for any mmWave band, coherently combining beams can significantly improve the SNR of the received signal as seen in Table IX, where coherently combining the best four beams for the 73 GHz case with a 2 m RX height reduces the signal attenuation by approximately 14.5 dB per

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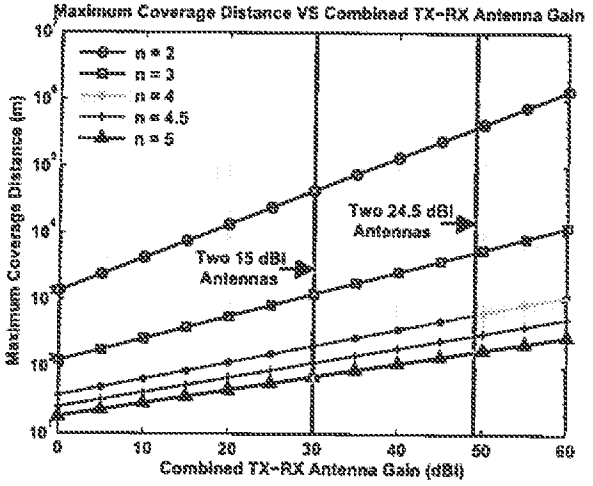

Fig. 3. Maximum coverage distance at 28 GHz for a system with 129 dB maximum measurable path loss (with 0 dBi gain antennas at the TX and RX) and a 5 dB SNR as a function of the TX and RX antenna gains, for PLEs ranging from two to five. The two solid vertical lines correspond to 15 dBi and 24.5 dBi antennas used at both the TX and RX in the 28 GHz outdoor measurements [3].

decade of distance. Reducing the PLE extends the coverage distance or increases SNR that enables higher order modulation constellations [1].

High gain directional antennas are a departure from today's cellular systems that generally use omnidirectional receivers at the handset and widebeam antennas at the base station. More flexibility exists for systems at mmWave frequencies to use many more high gain directional antennas, because the form factor is so much smaller at higher frequencies [1], [4], [5], [34], [78]. Fig. 3 modified from [3] displays the maximum coverage distance attainable at 28 GHz for a system with 129 dB maximum measurable path loss (before accounting for antenna gains) and a 5 dB SNR as a function of different TX and RX antenna gains, with PLEs ranging from two to five. It is apparent from the figure that for a specific PLE, the maximum coverage distance grows exponentially with increasing TX-RX antenna gains, indicating that the use of high gain directional steerable antennas along with beam combining and beamforming algorithms will allow for new degrees of freedom in radio link management [1], [43], [44], [57].

VI. mmWave Outage Studies

Extensive outage studies are necessary to determine coverage distances and system configurations for mmWave wireless communications networks. Due to the extra attenuation in free space path loss at mmWaves because of the "first meter" loss attributable to the increase in frequency, as well as environmental and rain attenuation, it is predicted that cell radii of several hundred meters will provide favorable coverage with dense base station and UE deployment in urban areas, to reach multi-Gbps speeds [3], [80]. A 200 m cell radius means that the distance between base stations (i.e., inter-site distance) is 400 m. However, it is predicted that 5G mmWave systems will have multiple access points on every street corner in dense UMi environments [3], [10]. Previous work for outage studies at mmWaves, specifically the LMDS band around 28 GHz, showed poor coverage distance, high signal attenuation, deep fading, and unfavorable multipath conditions for cell radii 300 m or greater [81]. Other work by Seidel and Arnold showed that building obstructions at LMDS frequencies are a major limitation in providing good coverage in a cell [11]. They did show that the LOS component was very strong, but that NLOS conditions were unfavorable. Their limiting view was based on cell sizes that were on the order of several kilometers at the time. With the concept of compact cells due to smaller form factors and newer technologies, more positive assertions can be made from the data given here.

An outage study at 38 GHz conducted in the summer of 2011 on the UTA campus provided probabilities for path loss measurable up to 160 dB [80]. Table X displays the outage probabilities from [80], for coverage distances within 200 m and up to 500 m, for base stations with heights of 18 m and 36 m. The coverage regions for both transmitters are shown in [80, Figs. 2 and 3]. The study revealed that all locations within 200 m of the base station (LOS and NLOS) had detectable signal for a system with 160 dB maximum measurable path loss [35].

An outage study at 28 GHz in downtown Manhattan was first mentioned in [3] and then presented in [82]. Some of the initial results reported in [82] were incorrect, as some outages were computed for distances up to 200 m, and some were computed using all locations with distances up to 425 m. Those numbers are corrected here in Table XI for T-R separation distances up to 200 m, and up to 425 m for the 28 GHz measurement campaign. The 50% outage value in Table XI for KAU includes many locations that would not be used in a practical installation, due to obvious blockage by tall buildings. Using a 90 degree azimuthal coverage zone, the outage was found to be less than 20% for this TX [82]. As described in [82], two transmitters at heights of 7 m and one TX at a height of 17 m, with RX heights of 1.5 m were used to measure outage with maximum measurable path loss of 178 dB for recordable links and acquirable PDPs, with outage probabilities displayed in Table XI. It is important to keep in mind that only three different fixed elevation angles were used at the RX, and only one TX elevation angle was used, meaning that the very "best" elevation angles at the TX and RX were not necessarily found in the 28 GHz campaign (this was done in the 73 GHz campaign). While the 28 GHz measurement locations were chosen arbitrarily, mmWave systems lend themselves to site-specific deployment so that outages can be predicted ahead of deployment. Outage probabilities using data in Table XI were computed to find the probability of an outage p_{outage}, and the probabilities of LOS, or NLOS link as a function of T-R separation distance, similar to the model presented in [39], where three states are chosen for the statistical model having the form:

$$p_{outage}(d) = \max\left(0,\ 1 - \exp^{-a_{out}d + b_{out}}\right) \quad (10a)$$

$$P_{LOS}(d) = \left(1 - p_{outage}(d)\right)\exp^{-a_{los}d} \quad (10b)$$

$$P_{NLOS}(d) = 1 - p_{outage}(d) - p_{LOS}(d) \quad (10c)$$

where the parameters a_{los}, a_{out}, and b_{out} are determined by fitting the equations to the empirical data via maximum likelihood estimation. The results are based on 74 unique TX-RX location combinations measured for outage. The form of these equations is similar to those found in [83] and [84]. Fig. 4 shows

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TABLE X
38 GHz OUTAGE PROBABILITIES IN AUSTIN, TEXAS OUT TO 500 m [80]. PL STANDS FOR PATH LOSS (FROM [35], [80])

TX Location	TX Height (m)	RX Height (m)	% Outage (PL > 160 dB)	% Outage (PL > 150 dB)
TX 1 ENS	36	8.5	18.9% (all d), 9% (d < 200 m)	52.8% (all d), 27.3% (d < 200 m)
TX 2 WRW	18		39.6% (all d), 8% (d < 200 m)	52.8% (all d), 10% (d < 200 m)

TABLE XI
28 GHz OUTAGE PROBABILITIES IN NEW YORK CITY FOR T-R SEPARATION DISTANCES UNDER 200 m AND FOR ALL T-R SEPARATION DISTANCES UP TO 425 m [82]

TX ID	h_{TX} (m)	h_{RX} (m)	# of RXs	% Outage (PL > 178 dB)
COL1	7	1.5	10 (d < 200 m)	20.0%
			25 (d <425 m)	68.0%
COL2	7		9 (d < 200 m)	11.1%
			25 (d <425 m)	68.0%
KAU	17		20 (d < 200 m)	50.0%
			24 (d < 425 m)	58.3%
Overall Outage			39 (d < 200 m)	33.3%
			74 (d <425 m)	61.9%

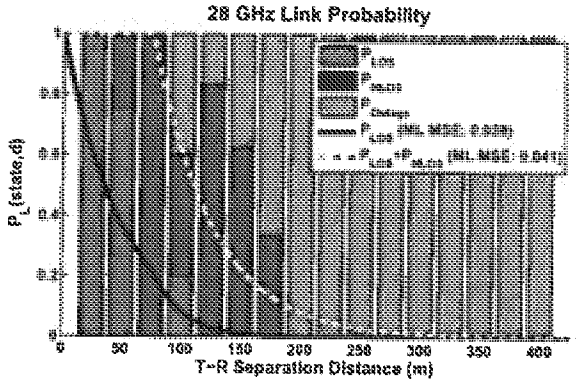

Fig. 4. 28 GHz outage probabilities in New York City for T-R separation distances up to 425 m including measured data and synthesized models [39], [82]. The maximum likelihood mean square error (MSE) is displayed for both fitted curves.

the fractions of outage types for the three observable states in bins of 25 m as well as the probability density functions in Eq. (10) (parameter values are shown in Table XII). Note that Fig. 4 and corresponding values in Table XII differ from those that appear in [39], the result of [39] blending bin widths together for 50 m rather than 25 m. In addition, the outage model in Table XII and Fig. 4 uses an updated database with more TX-RX combinations for outage.

A similar outage study was conducted for the 73 GHz measurement campaign [82], and is updated here. Table XIII displays the outage information for TX height diversity for ranges up to 216 m, as one TX-RX combination tested was farther than 200 m for both mobile and backhaul measurements. Link probability for the 73 GHz campaign was dependent upon observing a signal with 181 dB maximum measurable path loss. Table XIII shows outages for specific transmitters for the mobile and backhaul scenarios in addition to overall outage for the mobile, backhaul, and hybrid scenarios. Fig. 5 displays an outage probability graph for 73 GHz and Table XII shows the estimated parameters, similar to the 28 GHz outage probabilities. The outage results show that mmWave coverage with

TABLE XII
28 GHz AND 73 GHz OUTAGE PROBABILITY PARAMETERS [39], [83], [84]

Frequency	$1/a_{out}$	b_{out}	$1/a_{los}$
28 GHz	50 m	1.8	50 m
73 GHz	45.5 m	3.3	37 m

The 28 GHz measurements used a limited number of fixed elevation pointing angles when compared to the 73 GHz measurements, resulting in more outages at 28 GHz than at 73 GHz. We would expect similar if not slightly less outage probabilities at 28 GHz as compared to 73 GHz, as a function of distance, if identical locations and similar antenna pointing approaches were used at both frequencies.

high gain directional antennas is sufficient for distances up to 200 m for a Manhattan environment in which the 28 and 73 GHz measurements were conducted.

Using the 28 and 73 GHz measurements from this paper as a test case, a novel site-specific ray tracing method given in [93] was shown to provide excellent prediction for the LOS and NLOS probabilities, offering a better fit than (10). Raw data for 28, 38 and 73 GHz omnidirectional path loss that includes outage information are found in [94].

VII. MULTIPATH COMPONENTS AND RMS DELAY SPREAD AT MMWAVE

A. Multipath Effect

In the early days of wireless communications, multipath was considered a negative aspect of the propagation channel due to intersymbol interference (ISI). However, researchers over time have developed algorithms and systems to take advantage of multipath. MmWave systems in NLOS dense urban environments will use beam combining and beamforming techniques, as described in Section V, to exploit multipath fading in the environment, in perhaps different ways than current 4G/LTE systems do [49]. Numerous antenna elements at the RX will be used to increase the received SNR or reduce interference

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TABLE XIII
73 GHz Outage Probabilities in New York City for T-R Separation Distances Up to 200 m and Over All Distances Measured for Mobile (h_{RX} = 2 m), Backhaul (h_{RX} = 4.06 m), and Hybrid (Mobile & Backhaul) Scenarios [82]

TX ID	h_{TX} (m)	h_{RX} (m)	# of RXs	% Outage (PL > 178 dB)
COL1	7	2	11 (d < 200 m)	27.3%
			11 (d < 216 m)	27.3%
COL2	7		8 (d < 200 m)	25.0%
			9 (d < 216 m)	33.3%
KAU	17		11 (d < 200 m)	0.0%
			11 (d < 216 m)	0.0%
KIM1	7		3 (d < 200 m)	0.0%
			3 (d < 216 m)	0.0%
KIM2	7		2 (d < 200 m)	0.0%
			2 (d < 216 m)	0.0%
Overall Mobile Outage			35 (d < 200 m)	14.3%
			36 (d < 216 m)	16.7%
COL1	7	4.06	7 (d < 200 m)	42.9%
			7 (d < 216 m)	42.9%
COL2	7		13 (d < 200 m)	15.4%
			14 (d < 216 m)	21.4%
KAU	17		11 (d < 200 m)	0.0%
			11 (d < 216 m)	0.0%
KIM1	7		3 (d < 200 m)	0.0%
			3 (d < 216 m)	0.0%
KIM2	7		3 (d < 200 m)	0.0%
			3 (d < 216 m)	0.0%
Overall Backhaul Outage			37 (d < 200 m)	13.5%
			38 (d < 216 m)	15.8%
Overall Hybrid Outage			72 (d < 200 m)	13.9%
			74 (d < 216 m)	16.2%

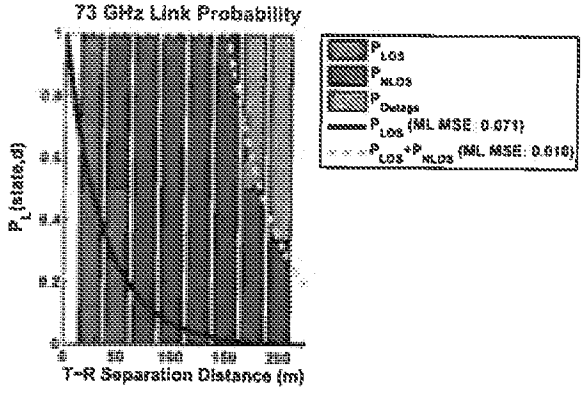

Fig. 5. 73 GHz outage probabilities for the hybrid scenario in New York City for T-R separation distances up to 216 m [39], [82]. The maximum likelihood mean square error (MSE) is displayed for both fitted curves.

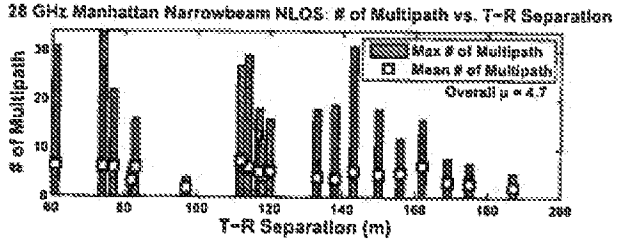

Fig. 6. 28 GHz unique antenna azimuth and elevation pointing angle NLOS maximum and mean MPCs as a function of T-R separation distance for narrowbeam antenna measurements in Manhattan. The overall mean number of MPCs over all TX-RX antenna pointing angle combinations and T-R separation distances is also presented.

via beam combining or beamforming techniques, by combining multipath from many AOAs and excess delays [49]. It is expected that tens to hundreds of miniature on-chip electrically steerable antennas will be used in mmWave devices to find the strongest multipath AOAs at the RX for improving SNR, and to extend coverage distances [78].

The maximum and average number of resolvable MPCs at arbitrary antenna azimuth and elevation pointing angles as a function of T-R separation distance for the 28 GHz narrowbeam measurements in Manhattan in a NLOS environment are displayed in Fig. 6. The maximum and average number of resolvable MPCs at arbitrary antenna azimuth and elevation pointing angles as a function of T-R separation distance for 73 GHz base station-to-mobile access and backhaul measurements in a NLOS scenario are displayed in Fig. 7.

A peak-finding algorithm rather than a binning technique was used to determine the number of MPCs in each PDP at both 28 GHz and 73 GHz. For the 28 GHz measurements, the average number of MPCs follows a uniform trend over all T-R separation distances with a mean value of 4.7 over all unique pointing angles and distances. At 73 GHz, the average number of MPCs detected at any unique pointing angle for NLOS is generally uniform for both access and backhaul measurements, and the mean value over all unique pointing angles and distances is 3.3 and 2.9 for access and backhaul, respectively. Because the mobile RX is lower to the ground, the signal may encounter more ground reflections. When rounding, there are on average three resolvable MPCs detectable for any

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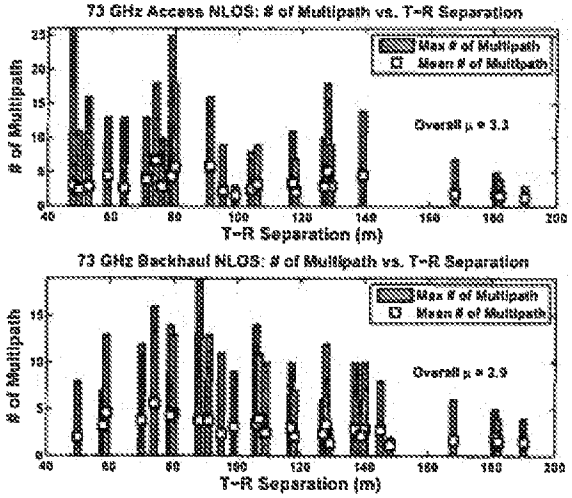

Fig. 7. 73 GHz unique antenna azimuth and elevation pointing angle NLOS maximum and mean MPCs as a function of T-R separation distance for narrowbeam antenna access and backhaul measurements. The overall mean number of MPCs over all TX-RX antenna pointing angle combinations and T-R separation distances is also presented.

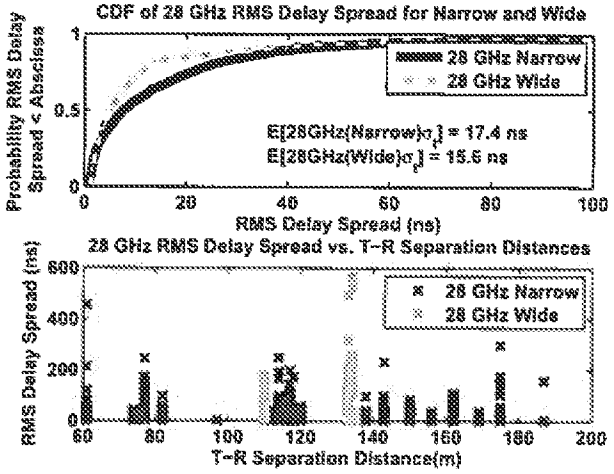

Fig. 8. 28 GHz NLOS directional RMS delay spread CDFs and as a function of T-R separation distance for narrowbeam (Manhattan) and widebeam (Brooklyn) antenna measurements.

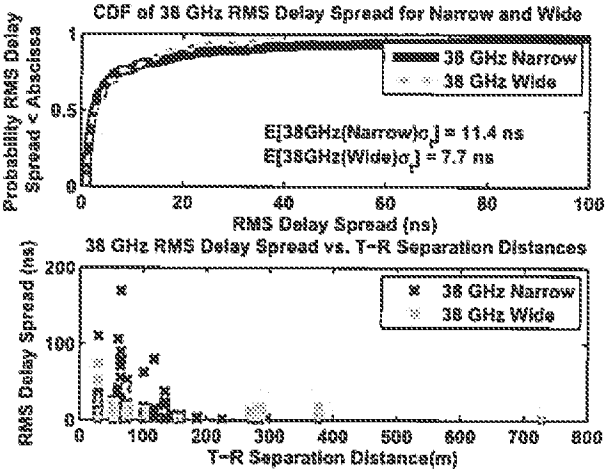

Fig. 9. 38 GHz NLOS directional RMS delay spread CDFs and as a function of T-R separation distance for narrowbeam and widebeam antenna measurements in Austin.

unique antenna pointing angle combination between the TX and RX at 73 GHz in a NLOS environment.

Overall, there are more resolvable MPCs as a function of T-R separation distance in NLOS environments at 28 GHz compared to 73 GHz, attributed to stronger signals (less free space loss in the first meter) and the larger wavelengths at 28 GHz, which allow the signal to reflect more and scatter less. The 73 GHz signals have a smaller wavelength and a higher possibility of getting caught in tiny building cracks and rough surfaces, leading to diffusion. Another key observation is that for both the 28 and 73 GHz measurements, the maximum number of NLOS MPCs detected at an arbitrary pointing angle combination between the RX and TX decreases with distance. This does not necessarily mean that there is less multipath at farther T-R separation distances; this observation is more likely attributed to the noise floor of our detection system since MPCs become weaker as the T-R separation distance or propagation path distance increases.

B. RMS Delay Spread with Directional Antennas

RMS delay spread is an important characteristic of a radio propagation channel [85]. The RMS delay spread values presented here are for LOS environments at 28 and 73 GHz, in addition to NLOS environments at 28, 38, and 73 GHz. Measurements across all three bands consistently show that when directional antennas are used, the LOS channel provides virtually no delay spread (the RMS delay spread is the width of the channel sounder's impulse response). This is clear from Fig. 11 (below) [41], [49]; however, if antenna beams are not aligned on boresight in LOS environments, RMS delay spreads much greater than 50 ns can occur [13], [72]. For the narrowbeam (Manhattan) and widebeam (Brooklyn) 28 GHz measurements, the RMS delay spread cumulative distribution functions (CDFs) follow similar trends. From Fig. 8, it is apparent that 90% of the RMS delay spreads were below 50 ns for both narrowbeam and widebeam measurements, with the widebeam antenna providing slightly more delay spreads below 40 ns, and with a larger mean delay spread of 17.4 ns for narrowbeam in Manhattan, compared to 15.6 ns for widebeam in Brooklyn. The slightly larger mean RMS delay spread for narrowbeam measurements can be attributed to the tail behavior of larger values due to the larger dynamic range of our 28 GHz channel sounder system with higher gain antennas compared to the reduced path loss measurement range using a widebeam TX antenna in Brooklyn. Fig. 8 also displays the RMS delay spreads as a function of T-R separation distance, and is distributed relatively uniformly across all distances for narrowbeam measurements.

Fig. 9 shows the RMS delay spread CDF for the 38 GHz narrowbeam and widebeam measurements. For 38 GHz, it is apparent that 90% of the RMS delay spreads are below 40 ns for both narrowbeam and widebeam measurements, similar to 28 GHz measurements. In addition, the mean RMS delay spread is 11.4 ns for narrowbeam and 7.7 ns for widebeam measurements. The RMS delay spread as a function of T-R separation distance follows a decreasing trend as the T-R

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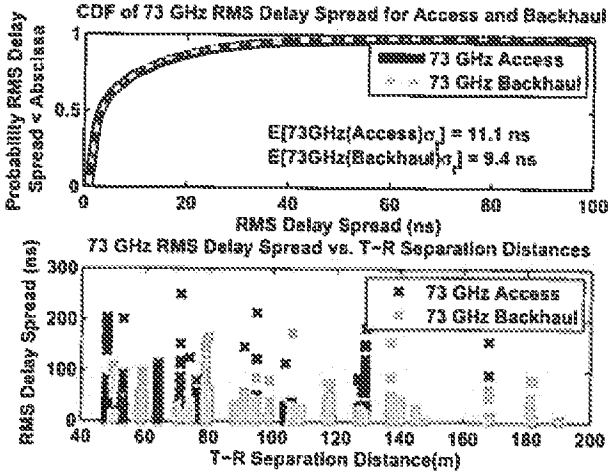

Fig. 10. 73 GHz NLOS directional RMS delay spread CDFs and as a function of T-R separation distance for narrowbeam antenna access and backhaul measurements in Manhattan.

separation distance increases. This is expected in a less cluttered environment like Austin since the farther the separation distance, the more the signal will be attenuated in the absence of large scatterers, thus falling below the detectable range of the system.

Fig. 10 shows the RMS delay spread for the access and backhaul scenarios at 73 GHz for the NLOS unique pointing angle scenario. The trend here shows that a majority of the RMS delay spreads are below 25 ns for unique pointing angle measurements. The access measurements have a slightly larger mean RMS delay spread, and this can be attributed to more reflected paths reaching the RX at a lower height, as compared to backhaul RX antenna heights. Similar to the 28 GHz and 38 GHz bands, at 73 GHz it is apparent that the RMS delay spread decreases as the T-R separation distance increases, but the urban New York City measurements do not decrease as rapidly, due to the scattering and reflections from large buildings.

The mean RMS delay spreads at 38 and 73 GHz are smaller than at 28 GHz, due to the more reflective environment of Manhattan and greater energy being scattered at lower mmWave frequencies (where the first meter of free space path loss is lower). Wavelengths at 73 GHz are smaller than at 28 and 38 GHz, giving rise to more diffuse scattering during propagation which results in weaker paths not detectable at the RX. A normalized mean square error (NMSE) [90] method is employed to fit a simple exponential model to the distribution of measured RMS delay spread values at 28, 38, and 73 GHz, by setting the empirical mean RMS delay spread values (from the CDFs of measured data) equal to the mean of the exponential model. The distribution parameters and goodness of fit (GOF) are given in Tables XIV, XV, and XVI, where the NMSE GOF measure ranges from $-\infty$ to 1, where $-\infty$ indicates a poor fit, and 1 indicates a perfect fit. It can be seen that the range of RMS delay spread values are reasonably well modeled by a simple exponential distribution.

RMS delay spread and maximum excess delay (MED) spreads from PDPs may be useful for designing mmWave

TABLE XIV
28 GHz RMS Delay Spread Distribution Fit and Goodness of Fit Via NMSE

28 GHz (10.9° Az. HPBW RX) RMS Delay Spread Goodness of Fit		
Location	Distribution	GOF
Manhattan (10.9° Az. HPBW TX)	exponential (μ = 17.4 ns)	0.60
Brooklyn (28.8° Az. HPBW TX)	exponential (μ = 15.6 ns)	0.35

TABLE XV
38 GHz RMS Delay Spread Distribution Fit and Goodness of Fit via NMSE

38 GHz (7.8° Az. HPBW TX) RMS Delay Spread Goodness of Fit		
RX Antenna	Distribution	GOF
Narrowbeam (7.8° Az. HPBW)	exponential (μ = 11.4 ns)	0.40
Widebeam (49.4° Az. HPBW)	exponential (μ = 7.7 ns)	0.83

TABLE XVI
73 GHz RMS Delay Spread Distribution Fit and Goodness of Fit via NMSE

73 GHz (7° Az. HPBW TX & RX) RMS Delay Spread Goodness of Fit		
Scenario	Distribution	GOF
Access	exponential (μ = 11.1 ns)	0.46
Backhaul	exponential (μ = 9.4 ns)	0.57

directional systems that rely on beam searching algorithms. Temporal statistics for the best unique antenna pointing directions at the TX and RX in the elevation and azimuth planes that result in the lowest path loss may be useful for standards contributions. For both the 28 and 73 GHz bands, RMS delay spread, MED 10 dB down from the maximum peak, and MED 20 dB down from the maximum peak were determined for the TX-RX beams that resulted in the lowest path loss over all locations, and are displayed in Table XVII, with comprehensive tables for each TX-RX location combination given in [49].

Fig. 11 shows the RMS delay spread CDFs for the single strongest PDP for each TX-RX location combination for the 28 and 73 GHz access measurements[‡] [41]. Both 28 and 73 GHz LOS measurements show that a majority of the RMS delay spreads are below 2 ns. In NLOS environments, 90% of the RMS delay spreads are below 60 ns and 20 ns when considering the unique antenna pointing angle with the strongest received power for the 28 GHz narrowbeam and 73 GHz mobile measurements, respectively. The 73 GHz backhaul measurements follow the same trend in LOS and NLOS environments as the 73 GHz mobile measurements. From Table XVII we can see that the minimum RMS delay spread, MED 10 dB, and MED 20 dB for the LOS environment are comparable at both 28 and 73 GHz and their various scenarios. The same holds true for the minimum NLOS values for each band and the various scenarios. The values presented in Table XVII provide insight for systems that systematically search for the strongest TX and RX antenna pointing angles that result in low RMS delay spreads (so that simple equalization methods may be used). The temporal statistics for these strong

[‡]Five locations were used for the 28 GHz statistics as the sixth LOS location had a larger than normal RMS delay spread (153.5 ns) since the TX and RX antennas were not properly aligned on boresight for that T-R separation distance.

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TABLE XVII
THE MINIMUM, MAXIMUM, AND MEAN RMS DELAY SPREAD, MED 10 dB DOWN FROM THE MAXIMUM PEAK, AND MED 20 dB DOWN FROM THE MAXIMUM PEAK, FOR THE DIRECTIONAL BEAMS WITH THE LOWEST PATH LOSS FROM THE 28 AND 73 GHz MEASUREMENTS. MED 10 dB REFERS TO MAXIMUM EXCESS DELAY 10 dB DOWN FROM THE MAXIMUM PEAK, AND MED 20 dB REFERS TO MAXIMUM EXCESS DELAY 20 dB DOWN FROM THE MAXIMUM PEAK

Delay Spreads for Directional Beams with Lowest Path Loss										
Environment		LOS								
		RMS Delay Spread (ns)			MED 10 dB (ns)			MED 20 dB (ns)		
Freq.	Scenario	min	max	mean	min	max	mean	min	max	mean
28 GHz	Narrowbeam	0.83	153.6	0.85	4.3	36.29	76.1	5.0	405.7	85.3
73 GHz	Access	0.81	1.7	1.2	4.3	25.1	12.4	4.9	25.8	13.8
73 GHz	Backhaul	0.93	1.9	1.5	4.6	24.7	19.5	7.6	28.2	22.6
Environment		NLOS								
		RMS Delay Spread (ns)			MED 10 dB (ns)			MED 20 dB (ns)		
Freq.	Scenario	min	max	mean	min	max	mean	min	max	mean
28 GHz	Narrowbeam	0.96	165.1	25.7	5.1	221.3	53.7	6.3	1384.8	152.3
28 GHz	Widebeam	1.4	20.0	7.1	5.4	18.6	8.9	11	171.6	56
73 GHz	Access	0.92	30.3	7.1	4.3	95.2	27.1	5.5	159.1	39.1
73 GHz	Backhaul	0.92	48.5	5.6	4.4	109.6	22.6	4.9	171.3	30.7

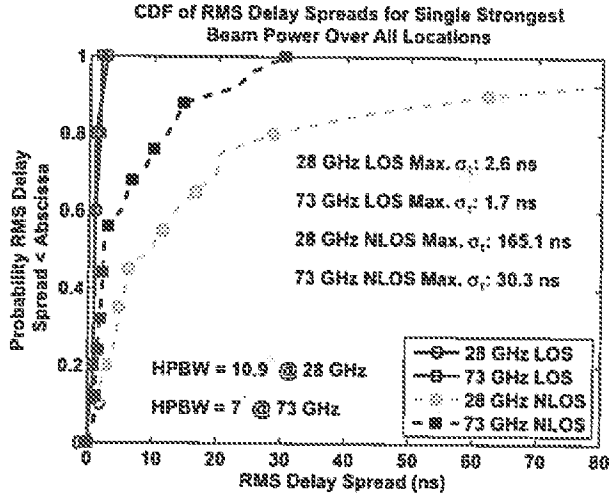

Fig. 11. 28 GHz and 73 GHz Access CDFs of RMS delay spreads for the single strongest received power for each TX-RX location combination that resulted in the lowest path loss in LOS and NLOS environments [41].

directional beams may help define the channel matrix used to describe the LOS and NLOS mmWave channels.

VIII. SPATIAL STATISTICS FOR MMWAVE CHANNELS

A. Spatial Lobes

MmWave transmissions will be very directional as a result of the high-gain antennas needed at the base station and mobile handset to make up for the increased free space path loss, a major shift from today's fixed sectorized cells and omnidirectional receivers. Our 28 GHz and 73 GHz measurements have revealed that energy tends to depart and arrive at a few principal AOD and AOA spatial lobes, where we define a spatial lobe to represent a main direction of arrival (departure) at which groups of traveling MPCs arrive (depart) over a contiguous range of angles in azimuth and elevation over several hundreds of nanoseconds. Spatial lobes model the phenomenon of spatial directionality in mmWave channel characterization, and have been used successfully to model the 2-D and 3-D spatial channels at 28 GHz based on our field measurements [3], [13], [45], [46], [62], [65].

3GPP and WINNER II channel models represent spatial clusters of MPCs by assigning one group of traveling MPCs to one random AOA. We have observed from field measurements that multiple groups of multipath clusters can arrive at the same unique pointing angle in azimuth and elevation but at different time delays, and we therefore generalize spatial clusters into spatial lobes, where a spatial lobe can receive more than one traveling cluster. This observation was possible due to the measurement system of Table I that enables 2.5 ns MPC resolution and highly directional channel measurements, thus enabling the detection of clusters of MPCs over several hundreds of nanoseconds in excess delay.

Channel characterization of the impulse response has thus far focused on modeling the time domain, the AOA in the azimuth plane [86], [87], and/or the AOA and AOD in the azimuth and elevation planes [76], [88], to account for directionality at the TX and RX. We generalize this by introducing directionality at the TX and RX, in both the azimuth and elevation planes, by extracting spatial lobe statistics from field measurements. Spatial lobe statistics are easily extracted from 3-D power spectra by defining a power threshold, where all contiguous power levels above such a threshold belong to one 3-D spatial lobe [45], [46], [62]. This spatial thresholding technique allows us to extract RMS lobe angular spreads, a new statistic that quantifies directional spreads at the TX and RX.

Directional spatial statistics can be used to model spatial directionality at both the TX and RX. Table XVIII shows the 3-D RMS lobe angular spreads extracted from our 28 GHz and 73 GHz field measurements, in both LOS and NLOS environments (where 3-D RMS lobe angular spread is defined in [46]), using a −10 dB lobe threshold. Field measurements provided enough data to separate the NLOS scenarios by different frequencies, while the LOS measurements were too few (only three locations at 28 GHz, and six locations at 73 GHz), motivating us to pool measured data from both frequencies to find statistics (e.g. model parameters) for a joint frequency scenario. The LOS RMS lobe azimuth spreads are on average slightly larger than the NLOS RMS lobe azimuth spreads, indicating that energy arrives in narrow lobes at the RX, while being more distributed over space and stronger in LOS environments (see Figs. 17 and 18). In NLOS environments, the 28 GHz 3-D lobe

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TABLE XVIII
SUMMARY OF 3-D SPATIAL LOBE STATISTICS FOR JOINT 28 GHz AND 73 GHz LOS, 28 GHz NLOS, AND 73 GHz ACCESS NLOS ENVIRONMENTS, OBTAINED USING A -10 dB LOBE THRESHOLD [46]

Frequency Scenario	LOS	NLOS	
	Joint 28-73 GHz	28 GHz	73 GHz
AOA RMS Lobe Azimuth Spread (μ [ ], σ [ ])	(7.0, 4.2)	(6.8, 4.8)	(8.7, 2.3)
AOA RMS Lobe Elevation Spread (μ [ ], σ [ ])	(7.0, 4.7)	(6.7, 2.3)	(2.2, 1.7)

TABLE XIX
38 AND 60 GHz P2P CLOSE-IN FREE SPACE REFERENCE DISTANCE (d_0 = 1 m) DIRECTIONAL PATH LOSS MODELS. PLE IS THE PATH LOSS EXPONENT, σ IS THE STANDARD DEVIATION OF THE ZERO-MEAN GAUSSIAN RANDOM VARIABLE (SHADOW FACTOR) ABOUT THE MMSE LINE. 60 GHz VEHICULAR MODELS ARE ALSO PRESENTED

P2P Directional Path Loss Models (d_0 = 1 m)								
			LOS		NLOS		NLOS best	
Frequency	TX Height (m)	RX Height (m)	PLE	σ [dB]	PLE	σ [dB]	PLE	σ [dB]
38 GHz	1.5	1.5	2.0	3.8	3.9	10.6	3.1	7.7
60 GHz			2.2	2.0	3.6	9.0	3.3	9.2
Vehicular Directional Path Loss Models (d_0 = 1 m)								
			LOS		NLOS		NLOS best	
Frequency	TX Height (m)	RX Height (m)	PLE	σ [dB]	PLE	σ [dB]	PLE	σ [dB]
60 GHz	1.5	1.5	2.5	3.5	5.1	11.8	3.6	10.9

azimuth spreads are larger than at 73 GHz, indicating that 28 GHz propagation is more spatially prominent than at 73 GHz, i.e., stronger energy comes from a larger number of angles at lower mmWave frequencies. The 73 GHz measurement system uses an increased overall measurement range to offset some additional free space loss as compared to the 28 GHz system (see Table I), hence the smaller angular spreads at 73 GHz may be due to the narrower TX antenna, as well as to increased environmental scattering that dampens energy over a wider field of view.

IX. PEER-TO-PEER AND VEHICULAR CHANNEL RESPONSES

Wideband P2P measurements as described in [34] were conducted at UTA along a pedestrian walkway surrounded by buildings at both 38 and 60 GHz, over T-R separation distances ranging from 19 to 129 meters. Similar to the directional path loss models presented for base station-to-mobile (access) and base station-to-base station (backhaul) scenarios described in Section III, directional path loss models with respect to a 1 m close-in free space reference distance are presented in Table XIX. The LOS boresight-to-boresight measurements yielded measured PLEs and shadow factors of 2.0 and 3.8 dB, and 2.2 and 2.0 dB, at 38 GHz and 60 GHz, respectively, indicating a relatively good fit to free space propagation ($n \approx 2$) with small large-scale signal fluctuations resulting most likely from coherent combining of the direct LOS path and ground-bounces. The NLOS measurements showed increased signal attenuation over distance, with measured PLEs and shadow factors of 3.9 and 10.6 dB, and 3.6 and 9.0 dB, at 38 GHz and 60 GHz, respectively, resulting from random signal level fluctuations caused by large scatterers such as building surfaces and trees. The slight increase of the LOS PLE at 60 GHz, above free space, is expected due to increased oxygen absorption [34], [61]. When selecting the strongest beam at each measured TX-RX location, the specific increases in link margin over distance are 6 dB/decade and 3 dB/decade at 38 GHz and 60 GHz, respectively.

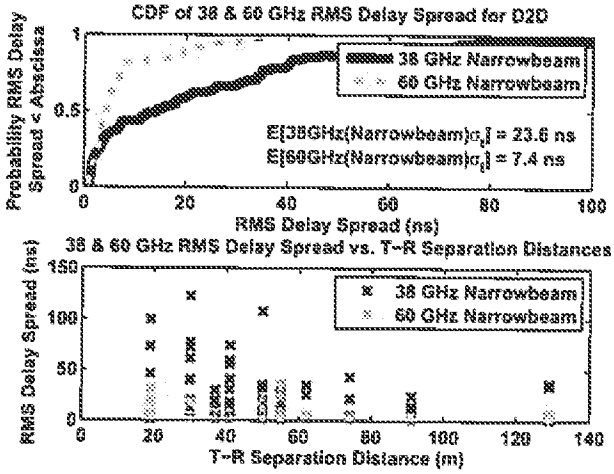

Fig. 12. 38 and 60 GHz directional antenna P2P RMS delay spread CDF and as a function of T-R separation distance.

TABLE XX
38 GHz AND 60 GHz P2P RMS DELAY SPREAD DISTRIBUTION FIT AND GOODNESS OF FIT VIA NMSE

P2P RMS Delay Spread Goodness of Fit		
Frequency	Distribution	GOF
38 GHz (7.8° Az. HPBW TX & RX)	Exp (μ = 23.6 ns)	0.67
60 GHz (7.3° Az. HPBW TX & RX)	Exp (μ = 7.4 ns)	0.78

Fig. 12 shows the P2P RMS delay spread CDFs and RMS delay spreads as a function of T-R separation distances, obtained from the 38 GHz and 60 GHz P2P measurements. The 60 GHz RMS delay spreads are much lower than the 38 GHz RMS delay spreads. This can be accounted for with two explanations. First, the 60 GHz transmit power was only 5 dBm whereas the 38 GHz transmit power was 22.1 dBm, thus weaker components that the 38 GHz system detected were not able to be detected by the 60 GHz system. Second, air attenuation a 60 GHz is much greater than at 38 GHz and scattering is also more diffuse, resulting in less detectable energy. Table XX shows the exponential distributions that were fit to

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the empirical RMS delay spread values from the P2P measurements at 38 GHz and 60 GHz. The mean values of the empirical RMS delay spread CDFs were used to generate exponential distribution models using the NSME method, and the corresponding GOF measures between the modeled and empirical distributions are given in Table XX at both 38 GHz and 60 GHz.

The mean value of the RMS delay spreads for all vehicular measurements was 2.7 ns. Overall, the results are favorable for short-range communications in a vehicle-to-vehicle or in-vehicle mmWave system. The NLOS PLE of 5.4 (see Table XIX) is rather high for the 60 GHz vehicular scenario as the signal attenuates by 54 dB/decade of distance, due to signal blockage of other vehicles and within the vehicle, and increased oxygen absorption, but short range communications such as P2P and vehicular to vehicular (V2V), will be able to withstand such loss.

X. 28 GHz mmWave Wideband Channel Statistics

The 28 GHz propagation measurements were used to create a 3-D statistical channel impulse response model capable of generating omnidirectional PDPs and 3-D power spectra at the transmitter and receiver, which recreated the statistics of the measured channels [45], [46]. Previous work considered 2-D channel models, which have been reported in [1], [45], [46], and were used for mmWave system-wide simulations and capacity analyses in a MIMO system, showing that multiple beams can be exploited to achieve significant spatial multiplexing and beamforming gains from MPCs departing from multiple distinct directions at the base station [49].

Among the many results discovered, it is worth mentioning that energy was observed to arrive at distinct *spatial lobes* [45]. Field measurements revealed that MPCs not only travel close together in space and time, but can also arrive at the receiver at much larger delays than previously considered in current UHF/Microwave channel models, when taking high-gain directional horn antennas into account.

The widespread 3GPP and WINNER II channel models do not distinguish a spatial cluster from a time cluster. In our model, we introduce concepts of time clusters and spatial lobes, where a spatial lobe can receive multiple time clusters, as observed from field measurements with high-gain antennas. Intra-cluster statistics revealed that time clusters are subdivided into smaller microscopic subpath components, whose power levels exhibited (on average) an exponential fall-off behavior as shown in Fig. 16. This phenomenon was found in both LOS and NLOS environments as displayed in Figs. 13 and 14 at unique pointing angles. Fig. 14 illustrates cluster subpaths as measured from a unique RX antenna pointing angle. Five distinct time clusters and intra-cluster subpaths can be observed occurring at discrete excess time delays.

Fig. 15 shows a PDP obtained at a unique azimuth and elevation pointing angle combination, clearly showing two groups of MPCs arriving at excess delays of 0 ns and 360 ns, with the two time clusters composed of multiple intra-cluster subpaths. It is worth mentioning that previous published work used intra-cluster subpaths to successfully model the indoor multipath channel [86], [87], [89]. In our work, a group of MPCs traveling close in time and space are referred to as a

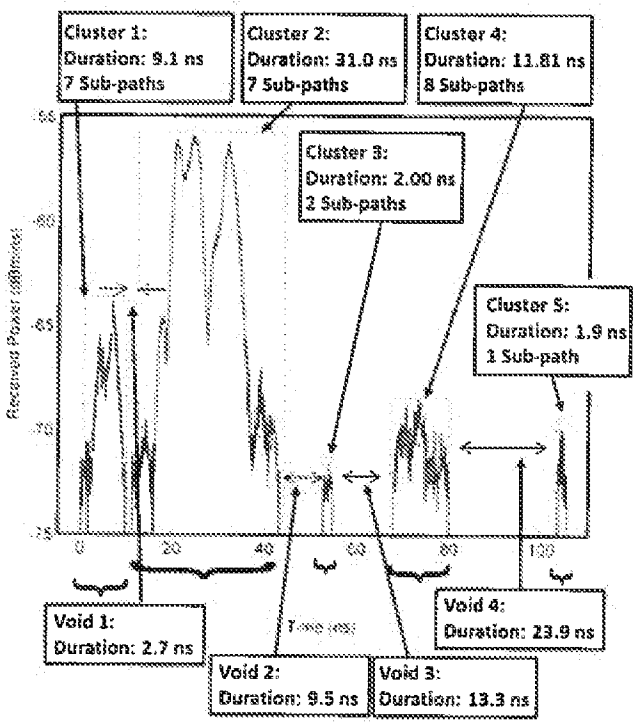

Fig. 13. Typical power delay profile measured at a unique antenna pointing angle. Five distinct time clusters with different cluster time durations are observed, ranging from 9.1 ns to 31 ns. Each time cluster is composed of intra-cluster subpath components occurring within each cluster at discrete time delays [45], [46].

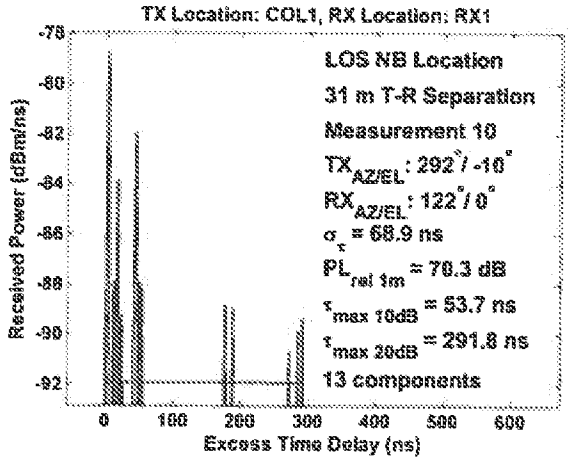

Fig. 14. Typical power delay profile measured at a unique pointing angle in a LOS environment for a T-R separation distance of 31 m. In this PDP, multiple time clusters and intra-cluster subpaths are observed.

time cluster, or temporal cluster [45]. Time statistics were extracted by defining a minimum inter-cluster void interval of 25 ns, and subsequently counting the number of time clusters, the number of intra-cluster subpaths, and extracting cluster and subpath power levels in synthesized 3-D omnidirectional PDPs [45], [46]. This simple clustering scheme can resolve multipath channel dynamics in great detail within the smallest multipath time resolution offered by the 3GPP and WINNER models (20 ns) [50] [76], and is easily adjustable to resolve temporal statistics over arbitrary time resolutions using a different minimum inter-cluster void interval. Multipath components

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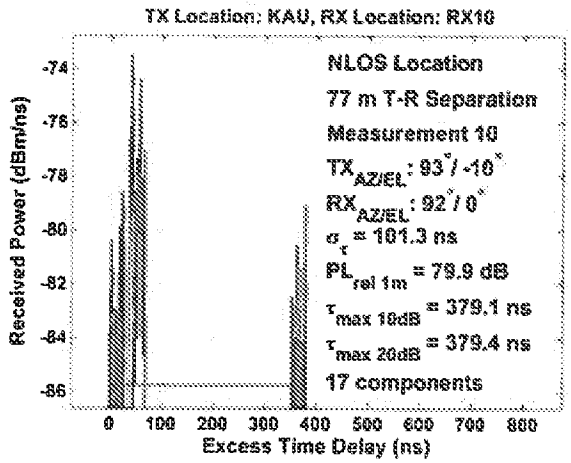

Fig. 15. Typical power delay profile measured at a unique pointing angle in a NLOS environment for a T-R separation distance of 77 m. In this PDP, two time clusters and many intra-cluster subpaths are observed.

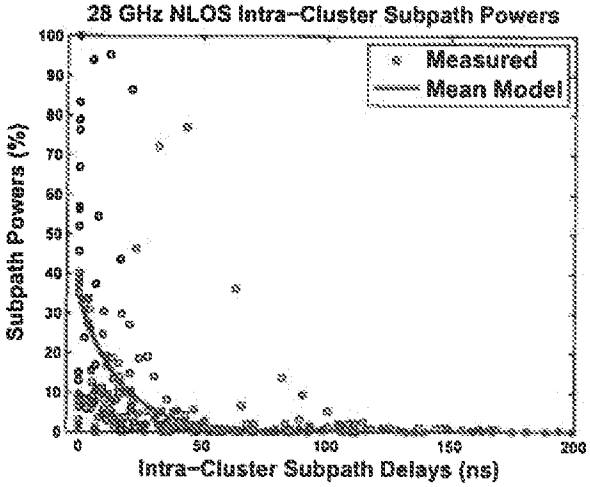

Fig. 16. Intra-cluster subpath power levels (normalized to cluster powers) as a function of intra-cluster subpath delay obtained from the 28 GHz synthesized omnidirectional PDPs in NLOS, extracted using a 25 ns minimum inter-cluster void interval. The power levels are observed to fall-off exponentially. Random fluctuations in power levels may be added using a lognormal random variable with $\sigma \approx 6$ dB [46].

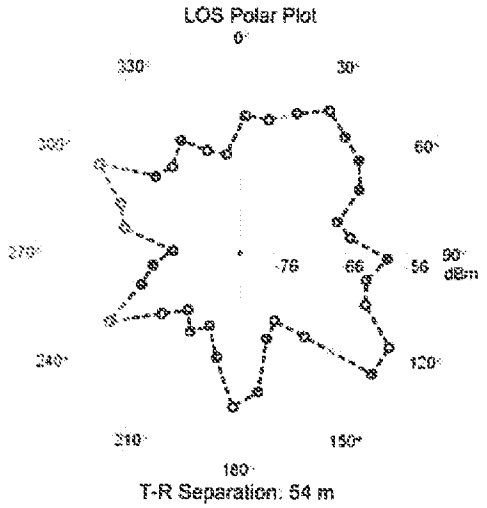

Fig. 17. 28 GHz LOS polar plot for a T-R separation distance of 54 m showing that energy arrives in all measured directions within a 10 dB dynamic range.

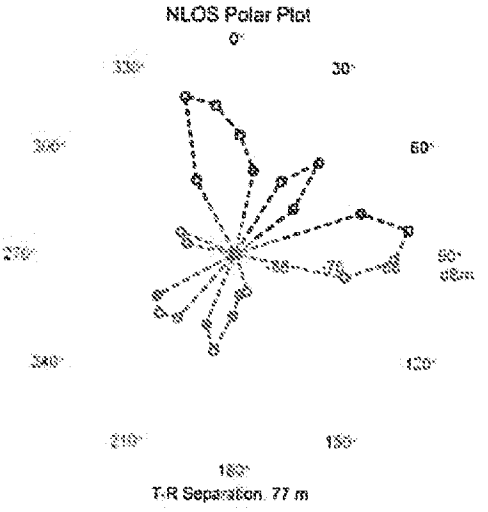

Fig. 18. 28 GHz NLOS polar plot for a T-R separation distance of 77 m showing that energy arrives at distinct AOAs, motivating the use of beamforming and beam combining in mmWave MIMO systems.

tend to arrive at the receiver at many different time delays and angular directions (a result of walkways and streets between buildings, that have typical spatial dimensions of 8 m—roughly 25 ns in propagation delay) in the dense urban propagation environment). The inter-cluster void interval is adjustable and may differ depending on city street layout dimensions. The clustering approach provided models for the time cluster and intra-cluster subpath power levels, yielding an accurate fit to the empirical omnidirectional RMS delay spreads over a large ensemble of simulated PDPs. Note that our previous work considered a 2.5 ns minimum inter-cluster void interval when considering synthesized omnidirectional PDPs in 2-D [45]. We subsequently found this was too small of a value to obtain accurate RMS delay spread tail behavior in monte carlo simulations. Spatial lobe statistics were extracted by applying a −10 dB threshold with respect to the maximum received power angular segment in the 3-D power spectrum [46], while a −20 dB power threshold was used in [45]. We found a −10 dB threshold in space is more meaningful for keeping the salient features of a model built from a vast amount of measured data. In our work, we de-coupled time and space by extracting temporal and spatial statistics independently, and then assigned time clusters in a random manner to spatial lobes in order to re-couple the time and space dimensions to produce an accurate joint spatial-temporal channel model (see Step 12 in [46]).

Our 3-D stochastic channel models follow from the 3GPP and WINNER II models, and include simple extensions to account for intra-cluster delays and power levels (based on our field data), and also provide a detailed methodology for generating segmented AOD and AOA power spectra with a 1° resolution in the azimuth and elevation planes. Accurate reproduction of measured channel PDPs and a complete step-by-step procedure for generating mmWave omnidirectional PDPs and power spectra has been presented in [46].

There are significant differences in the spatial properties of LOS and NLOS mmWave channels. Figs. 17 and 18 show

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two typical polar plots obtained from measurements in a LOS and NLOS environment, respectively, where each 'dot' corresponds to the total received power (area under the PDP) at each measured unique pointing angle in azimuth, and at an elevation of 0° (parallel to the horizon). The contrast in spatial power variation encountered in LOS environments as compared to NLOS environments as displayed in Figs. 17 and 18 is significant, indicating a great deal of azimuthal sparsity of energy and more sharply defined AOAs in NLOS environments.

XI. Conclusion

This paper presents the first combined contribution of wideband mmWave outdoor propagation measurements and channel models at 28, 38, 60, and 73 GHz for base station-to-mobile (access), base station-to-base station (backhaul), peer-to-peer, and vehicular (V2V) scenarios. The measurement results include channel characteristics such as path loss models for each frequency, multipath delay spread, number of multipath components, outage probabilities, and initial mmWave statistical spatial channel model (SSCM) statistics. In general, path loss exponents are larger in New York City than in Austin due to the highly populated urban environment of the former, but are not markedly different from today's UHF cellular systems. Directional and omnidirectional path loss models were both presented with respect to a 1 m close-in free space reference distance. Using a close-in reference distance path loss model is advantageous because of the standard use, the frequency dependence, and the ease by which measurements across different bands and scenarios may be compared, whereas the *alpha-beta* model is only sufficient across the specific measurement range and is difficult to use for comparison at different frequencies or environments. The omnidirectional PLE ranges from 1.8 to 2.1, and from 2.4 to 3.5 in LOS and NLOS environments, respectively, at 28, 38, and 73 GHz, not much different than today's UHF/Microwave path loss models. The measurements and models provided here suggest that PLE tends to increase slightly with an increase in frequency for a given environment, due to the diffuse scattering of signals with smaller wavelengths. The close-in reference distance path loss models allow comparisons using the Distance Extension Exponent (DEE) and Distance Extension Factor (DEF) for either increasing SNR or extending coverage distance when combining beams with the strongest received powers. Coherently combining the four best measured beams at both 28 and 73 GHz has shown that coverage distance can be extended by more than a factor of 2.

Multipath has proven to be advantageous in increasing SNR and signal strength in current 4G/LTE systems, but it is still up for debate whether mmWave systems will employ the same algorithms and technologies. The average number of resolvable MPCs in any arbitrary antenna pointing direction is larger at 28 GHz (4.7) than 73 GHz (3.3) in NLOS environments for the base station-to-access scenario, likely due to the larger wavelength and more pronounced reflected and scattered energy at 28 GHz. The average NLOS RMS delay spread for 28, 38, and 73 GHz is 17.4, 11.4, and 11.1 ns, respectively, using arbitrarily pointed narrowbeam antennas in the base station-to-access scenario, and decreases when widebeam antennas are used. The mean NLOS RMS delay spreads below 20 ns compare well with previous outdoor measurements at 60 GHz [28]. RMS delay spread is generally inversely proportional to the T-R separation distance in less urban environments such as Austin, and is much larger in New York City than in Austin, because of the highly reflective dense urban environment. We have also shown that the single strongest directional link between the TX and RX in dense urban environments often results in the link with low RMS delay spread, and this knowledge will be important for future mmWave systems that will be highly directional with numerous antenna elements. The outage studies show better coverage at 38 GHz in Austin than in New York City at 28 GHz and 73 GHz, since New York City is a dense urban environment with tall buildings that provide more obstructions in propagating paths. However, studies at all three bands show that a majority of links can be made for T-R separation distances less than 200 m.

The first 3-D measurement-based mmWave wideband statistical channel impulse response model and key parameters were presented for 28 GHz propagation. Indoor and small-scale outdoor measurements are currently under way for the 28 and 73 GHz bands to build a larger database of mmWave measurements and to generate more diverse models. The data and models presented in this article will allow for the development of channel models and system analysis for next-generation mmWave small cell wireless communications systems, and may assist in the global comparison of models from other researchers.

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Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!

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ABSTRACT The global bandwidth shortage facing wireless carriers has motivated the exploration of the underutilized millimeter wave (mm-wave) frequency spectrum for future broadband cellular communication networks. There is, however, little knowledge about cellular mm-wave propagation in densely populated indoor and outdoor environments. Obtaining this information is vital for the design and operation of future fifth generation cellular networks that use the mm-wave spectrum. In this paper, we present the motivation for new mm-wave cellular systems, methodology, and hardware for measurements and offer a variety of measurement results that show 28 and 38 GHz frequencies can be used when employing steerable directional antennas at base stations and mobile devices.

INDEX TERMS 28GHz, 38GHz, millimeter wave propagation measurements, directional antennas, channel models, 5G, cellular, mobile communications, MIMO.

I. INTRODUCTION

The rapid increase of mobile data growth and the use of smartphones are creating unprecedented challenges for wireless service providers to overcome a global bandwidth shortage [1], [2]. As today's cellular providers attempt to deliver high quality, low latency video and multimedia applications for wireless devices, they are limited to a carrier frequency spectrum ranging between 700 MHz and 2.6 GHz. As shown in Table 1, the global spectrum bandwidth allocation for all cellular technologies does not exceed 780 MHz, where each major wireless provider has approximately 200 MHz across all of the different cellular bands of spectrum available to them. Servicing legacy users with older inefficient cellphones as well as customers with newer smartphones requires simultaneous management of multiple technologies in the same band-limited spectrum. Currently, allotted spectrum for operators is dissected into disjoint frequency bands, each of which possesses different radio networks with different propagation characteristics and building penetration losses. This means that base station designs must service many different bands with different cell sites, where each site has multiple base stations (one for each frequency or technology usage e.g. third generation (3G), fourth generation (4G), and Long Term Evolution - Advanced (LTE-A)) [3], [4]. To procure new spectrum, it can take a decade of administration through regulatory bodies such as the International Telecommunication Union (ITU) and the U.S. Federal Communications Commission (FCC). When spectrum is finally licensed, incumbent users must be moved off the spectrum, causing further delays and increasing costs.

TABLE 1. Current 2G, 3G, 4G, & LTE-A spectrum and bandwidth allocations [5].

700 MHz	746-763	776-793	
AWS	1710-1755	2110-2155	
ISM Extension	2500-2570	2620-2690	
GSM 900	880-915	925-960	
UMTS Core	1920-1980	2110-2170	
GSM 1800	1710-1785	1805-1880	
PCS 1900	1850-1910	1930-1990	
Cellular 850	824-849	869-894	
Digital Dividend	470-854		

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Mobile broadband networks need to support ever-growing consumer data rate demands and will need to tackle the exponential increase in the predicted traffic volumes. An efficient radio access technology combined with more spectrum availability is essential to achieve the ongoing demands faced by wireless carriers.

A. THE WIRELESS EVOLUTION

To date, four generations of cellular communication systems have been adopted in the USA with each new mobile generation emerging every 10 years or so since around 1980: first generation analog FM cellular systems in 1981; second generation digital technology in 1992, 3G in 2001, and 4G LTE-A in 2011 [6]. The evolution from 1G to 4G is summarized in Table 2.

TABLE 2. Requirements and realities of 1G through 4G cellular systems [7].

Generation	Requirements	Comments
1G	No official requirements Analog technology	Deployed in the 1980s
2G	No official requirements Digital technology	First digital systems Deployed in the 1990s New services such as SMS and low rate data Primary technologies include IS-95 CDMA and GSM
3G	ITU's IMT-2000 required 144 kbps mobile, 384 kbps pedestrian, 2 Mbps indoors	Primary technologies include CDMA2000 1xEV-DO and UMTS-HSPA WiMAX now an official 3G technology
4G	ITU's IMT-Advanced requirements include ability to operate in up to 40 MHz radio channels and with very high spectral efficiency	No technology meets requirements today IEEE 802.16m and LTE Advanced being designed to meet requirements

First generation cellular networks were basic analog systems designed for voice communications. A move to early data services and improved spectral efficiency was realized in 2G systems through the use of digital modulations and time division or code division multiple access. 3G introduced high-speed Internet access, highly improved video and audio streaming capabilities by using technologies such as Wideband Code Division Multiple Access (W-CDMA) and High Speed Packet Access (HSPA). HSPA is an amalgamation of two mobile telephony protocols, High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA), which extends and improves the performance of existing 3G mobile telecommunication networks utilizing WCDMA protocols. An improved 3GPP (3rd Generation Partnership Project) standard, Evolved HSPA (also known as HSPA+), was released in late 2008 with subsequent worldwide utilization beginning in 2010. HSPA has been deployed in over 150 countries by more than 350 communications service providers (CSP) on multiple frequency bands and is now the most extensively sold radio technology worldwide [8], although LTE is closing the gap rapidly.

The International Mobile Telecommunications-Advanced (IMT-Advanced) standard is the next-generation of mobile communications technology defined by the ITU and includes capabilities outstripping those of IMT-2000 (3G) mobile communication. ITU refers to IMT-Advanced as a 4G mobile communications technology, although it should be noted that there is no universally accepted definition of the term 4G. LTE radio access technology has been developed by the 3GPP to offer a fully 4G-capable mobile broadband platform [9]. LTE is an orthogonal frequency-division multiplexing (OFDM)-based radio access technology that supports a scalable transmission bandwidth up to 20 MHz and advanced multi-antenna transmission. As a key technology in supporting high data rates in 4G systems, Multiple-Input Multiple-Output (MIMO) enables multi-stream transmission for high spectrum efficiency, improved link quality, and adaptation of radiation patterns for signal gain and interference mitigation via adaptive beamforming using antenna arrays [10]–[12]. The coalescence of HSPA and LTE will increase the peak mobile data rates of the two systems, with data rates exceeding 100 Mbps, and will also allow for optimal dynamic load balancing between the two technologies [8].

As the demand for capacity in mobile broadband communications increases dramatically every year, wireless carriers must be prepared to support up to a thousand-fold increase in total mobile traffic by 2020, requiring researchers to seek greater capacity and to find new wireless spectrum beyond the 4G standard [13]. To improve the existing LTE network, the wireless technology roadmap now extends to IMT-Advanced with LTE-Advanced defined to meet IMT-Advanced requirements, which will be theoretically capable of peak throughput rates that exceed 1 Gigabit per second (Gbps). LTE-Advanced supports heterogeneous networks with co-existing large macro, micro, and pico cells, and Wi-Fi access points. Low cost deployment will be realized by self-organizing features and repeaters/relays

As fifth generation (5G) is developed and implemented, we believe the main differences compared to 4G will be the use of much greater spectrum allocations at untapped mm-wave frequency bands, highly directional beamforming antennas at both the mobile device and base station, longer battery life, lower outage probability, much higher bit rates in larger portions of the coverage area, lower infrastructure costs, and higher aggregate capacity for many simultaneous users in both licensed and unlicensed spectrum (e.g. the convergence of Wi-Fi and cellular). The backbone networks of 5G will move from copper and fiber to mm-wave wireless connections, allowing rapid deployment and mesh-like connectivity with cooperation between base stations.

B. EARLY GLOBAL ACTIVITIES FOR Beyond 4G (B4G) AND 5G WIRELESS

The evolution of wireless communication systems requires global collaboration, involving worldwide mobile communication companies and governments. The Electronics and Telecommunication Research Institute (ETRI) in Korea has actively contributed to the development of 4G systems. In 2002, the Mobile Communication Research Laboratory

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(MCRL) of ETRI initiated the R&D of the 4G radio transmission system for HSPA and proposed their vision of 4G radio mobile communications [14]. According to ETRI, the 4G system would satisfy the data rate requirement of 100 Mbps for high mobility with Systems Beyond IMT-2000 (SBIMT) and would provide high quality service for both low-tier and high-tier cellular systems.

In the early 2000s, aiming at integrating voice and web data in an IP-based mobile communications system (i.e. 4G wireless network), Sun Microsystems engineers were designing and implementing mobile IP-based protocols and tools to implement secure, versatile and responsive wireless communication technologies [15], [16].

A memorandum of understanding (MoU) was signed by the government of Karnataka in India with Charmed Technologies Inc. from Beverly Hills, California, and Software Technology Parks of India in Karnataka to develop "4G" wireless technology in the year 2001 [17].

In 2005, Samsung envisaged the increasing demands of higher data rates, and the eventual convergence of digital multimedia and ubiquitous computing [18]. Samsung's 4G vision has mainly focused on digital convergence including implementations of bi-directional HDTV, increasing e-health and e-education services, and ubiquitous wireless network services. With an evolution from fixed broadband to mobile broadband, more converged, personalized, convenient and seamless secure services will be achieved, and Samsung has recently made contributions in the area of mm-wave wireless [2], [12].

Recently, Korea has carried out a series of R&D activities toward beyond 4G evolution [19]. It aims to establish "Giga Korea" during 2013 to 2020 for hyper connected IT infrastructure deployment. Those activities include the acquisition of wider spectrum, green networks and devices, special purpose networks, and new network topologies and media [19].

Nokia Siemens Networks (NSN) has conducted research activities in radio, together with industry and research partners, making contributions to the 3GPP LTE standard. NSN believes that with improvement in digital processing power, radio implementation bandwidth, and the availability of optical fiber, the radio evolution will continue. The next evolutionary stage, beyond 4G, is likely to support up to 1,000 times higher traffic volumes than 2010 traffic levels, with peak and cell edge rates higher than 10 Gbps and 100 Mbps respectively with latency less than 1 ms for local area networks [20], and will realize wide scale small cell (heterogeneous) deployments, fast interference coordination and cancellation, Cognitive Radio Networks (CRNs), and Self Organizing Networks (SONs) [13]. Further, future networks may require the combinations of diverse radio access technologies such as LTE, HSPA, Wi-Fi, and B4G [13].

The University of Surrey, England, has set up a world research hub for 5G mobile technology with a goal to expand UK telecommunication research and innovation [21]. New York University (NYU) and NYU-Poly recently established the NYU WIRELESS research center, to create new technologies and fundamental knowledge for future mm-wave wireless devices and networks [36].

C. A MILLIMETER WAVE SOLUTION FOR FUTURE 5G CELLULAR NETWORKS

Despite industrial research efforts to deploy the most efficient wireless technologies possible, the wireless industry always eventually faces overwhelming capacity demands for its currently deployed wireless technologies, brought on by the continued advances and discoveries in computing and communications, and the emergence of new customer handsets and use cases (such as the need to access the internet). This trend will occur in the coming years for 4G LTE, implying that at some point around 2020, wireless networks will face congestion, as well as the need to implement new technologies and architectures to properly serve the continuing demands of carriers and customers. The life cycle of every new generation of cellular technology is generally a decade or less (as shown earlier), due to the natural evolution of computer and communications technology. Our work contemplates a wireless future where mobile data rates expand to the multi gigabit-per-second range, made possible by the use of steerable antennas and mm-wave spectrum that could simultaneously support mobile communications and backhaul, with the possible convergence of cellular and Wi-Fi services.

Recent studies suggest that mm-wave frequencies could be used to augment the currently saturated 700 MHz to 2.6 GHz radio spectrum bands for wireless communications [2]. The combination of cost-effective CMOS technology that can now operate well into the mm-wave frequency bands, and high-gain, steerable antennas at the mobile and base station, strengthens the viability of mm-wave wireless communications [22], [23] Further, mm-wave carrier frequencies allow for larger bandwidth allocations, which translate directly to higher data transfer rates. Mm-wave spectrum would allow service providers to significantly expand the channel bandwidths far beyond the present 20 MHz channels used by 4G customers [1]. By increasing the RF channel bandwidth for mobile radio channels, the data capacity is greatly increased, while the latency for digital traffic is greatly decreased, thus supporting much better internet-based access and applications that require minimal latency. Mm-wave frequencies, due to the much smaller wavelength, may exploit polarization and new spatial processing techniques, such as massive MIMO and adaptive beamforming [24]. Given this significant jump in bandwidth and new capabilities offered by mm-waves, the base station-to-device links, as well as backhaul links between base stations, will be able to handle much greater capacity than today's 4G networks in highly populated areas. Also, as operators continue to reduce cell coverage areas to exploit spatial reuse, and implement new cooperative architectures such as cooperative MIMO, relays, and interference mitigation between base stations, the cost per base station will drop as they become more plentiful and more densely distributed in urban areas, making wireless backhaul

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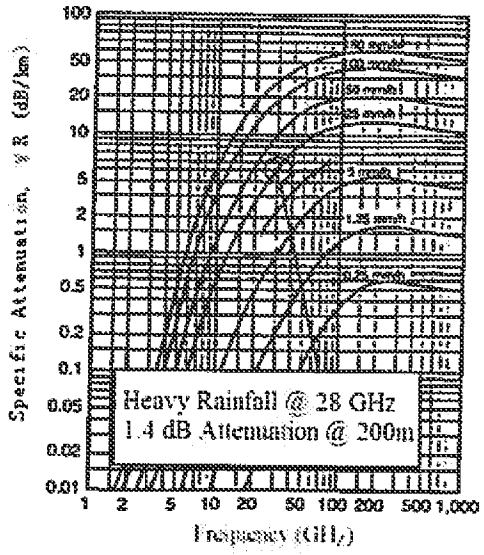

FIGURE 1. Rain attenuation in dB/km across frequency at various rainfall rates [26]. The rain attenuation at 28 GHz has an attenuation of 7 dB/km for a very heavy rainfall of 25 mm/hr (about 1 inch per hour). If cell coverage regions are 200 m in radius, the rain attenuation will reduce to 1.4 dB.

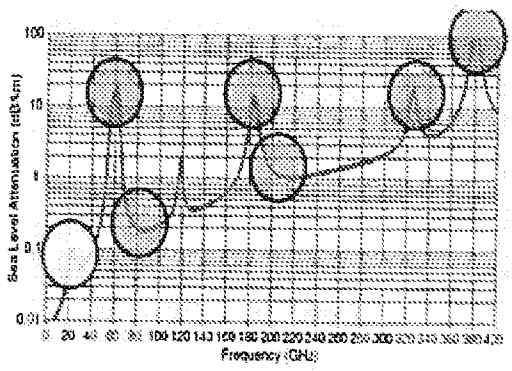

FIGURE 2. Atmospheric absorption across mm-wave frequencies in dB/km [1]. The attenuation caused by atmospheric absorption is 0.012 dB over 200 m at 28 GHz and 0.016 dB over 200 m at 38 GHz. Frequencies from 70 to 100 GHz and 125 to 160 GHz also have small loss.

essential for flexibility, quick deployment, and reduced ongoing operating costs. Finally, as opposed to the disjointed spectrum employed by many cellular operators today, where the coverage distances of cell sites vary widely over three octaves of frequency between 700 MHz and 2.6 GHz, the mm-wave spectrum will have spectral allocations that are relatively much closer together, making the propagation characteristics of different mm-wave bands much more comparable and "homogenous". The 28 GHz and 38 GHz bands are currently available with spectrum allocations of over 1 GHz of bandwidth. Originally intended for Local Multipoint Distribution Service (LMDS) use in the late 1990's, these licensees could be used for mobile cellular as well as backhaul [25].

A common myth in the wireless engineering community is that rain and atmosphere make mm-wave spectrum useless for mobile communications. However, when one considers the fact that today's cell sizes in urban environments are on the order of 200 m, it becomes clear that mm-wave cellular can overcome these issues. Fig. 1 and Fig. 2 show the rain attenuation and atmospheric absorption characteristics of mm-wave propagation. It can be seen that for cell sizes on the order of 200 m, atmospheric absorption does not create significant additional path loss for mm-waves, particularly at 28 GHz and 38 GHz. Only 7 dB/km of attenuation is expected due to heavy rainfall rates of 1 inch/hr for cellular propagation at 28 GHz, which translates to only 1.4 dB of attenuation over 200 m distance. Work by many researchers has confirmed that for small distances (less than 1 km), rain attenuation will present a minimal effect on the propagation of mm-waves at 28 GHz to 38 GHz for small cells [26].

B. *Mm-WAVE CELLULAR MEASUREMENTS: UNDERSTANDING THE CHANNEL*

Future wireless technologies must be validated in the most urban environments, such as New York City. In order to improve capacity and service quality, the cellular network architecture needs to support higher spatial reuse. Massive MIMO base stations and small-cell access points are two promising approaches for future cellular. Massive MIMO base stations allocate antenna arrays at existing macro base stations, which can accurately concentrate transmitted energy to the mobile users [24]. Small cells offload traffic from base stations by overlaying a layer of small cell access points, which actually decreases the average distance between transmitters and users, resulting in lower propagation losses and higher data rates and energy efficiency [24]. Both of these important trends are readily supported and, in fact, are enhanced by a move to mm-wave spectrum, since the tiny wavelengths allow for dozens to hundreds of antenna elements to be placed in an array on a relatively small physical platform at the base station, or access point, and the natural evolution to small cells ensures that mm-wave frequencies will overcome any attenuation due to rain.

Understanding the radio channel is a fundamental requirement to develop future mm-wave mobile systems as well as backhaul techniques. With a firm technical understanding of the channel, researchers and industry practitioners may then explore new methods for the air interface, multiple access, architectural approaches that include cooperation and interference mitigation and other signal enhancement techniques. In order to create a statistical spatial channel model (SSCM) for mm-wave multipath channels, extensive measurements must be made in typical and worst-case operating conditions and environments. We have conducted extensive propagation measurements in urban environments in New York City and suburban environments in Austin, Texas in order to understand the mm-wave channel.

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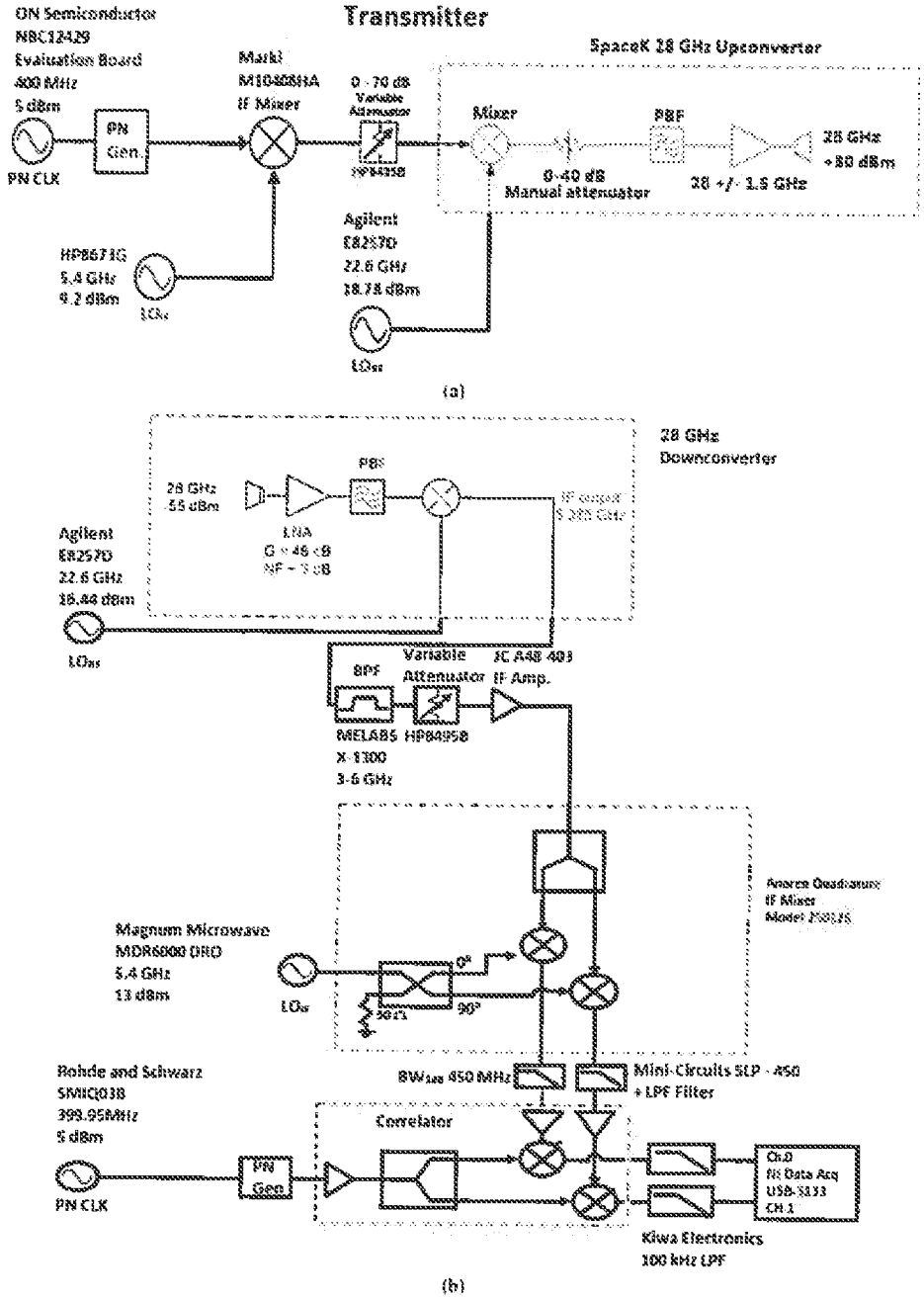

FIGURE 3. Block diagram of the (a) TX and (b) RX for the mm-wave propagation measurements at 28 GHz in New York City.

II. 28 GHZ BUILDING PENETRATION AND REFLECTION CAMPAIGN IN NEW YORK CITY

A. 28 GHZ BROADBAND CHANNEL SOUNDING HARDWARE

Using a 400 Mcps sliding correlator channel sounder with 2.3 ns multipath resolution, we conducted extensive mm-wave propagation measurements at 28 GHz in New York City in 2012. The block diagram of the transmitter (TX) and receiver (RX) is given in Fig. 3. A pseudo-random noise (PN) sequence sliding correlator was utilized as the probing signal, which was modulated to a 5.4 GHz intermediate frequency (IF) and upconverted to 28 GHz after mixing with a 22.6 GHz local oscillator (LO), in a manner similar to [27]. The transmitter power was +30 dBm (a typical value for lower power femtocells), fed to a steerable 10° beamwidth 24.5 dBi horn antenna or a 30° beamwidth 15 dBi horn antenna that was mechanically rotated. The receiver used the

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TABLE 3. Summary of penetration losses through various common building materials at 28 GHz. Both of the horn antennas have 24.5 dBi gains with 10° half power beamwidth [28].

Environment	Location	Material	Thickness (cm)	Received Power – Free Space (dBm)	Received Power – Material (dBm)	Penetration Loss (dB)
Outdoor	ORH	Tinted Glass	3.8	-34.9	-75.0	40.1
	WWH	Brick	185.4	-34.7	-63.1	28.3
Indoor	MTC	Clear Glass	<1.3	-35.0	-38.9	3.9
	WWH	Tinted Glass	<1.3	-34.7	-59.2	24.5
		Clear Glass	<1.3	-34.7	-38.3	3.6
		Wall	36.1	-34.0	-40.9	6.8

TABLE 4. Penetration losses for multiple indoor obstructions in an office environment at 28 GHz. Weak signals are denoted by locations where the SNR was high enough to distinguish signal from noise but not enough for the signal to be acquired, i.e. penetration losses were between 64 dB to 74 dB relative to a 5 m free space test. No signal detected denotes an outage, where penetration loss is greater than 74 dB relative to a 5 m free space test [28].

RX ID	TX-RX Separation (m)	# of Partitions				Transmitted Power (dBm)	Power Received – Free Space (dBm)	Received Power – Test Material (dBm)	Penetration Loss (dB)
		Wall	Door	Cubicles	Elevator				
1	4.7	2	0	0	0	5.6	-34.4	-58.8	24.4
2	7.8	3	0	0	0	8.6	-38.7	-79.8	41.1
3	11.4	3	1	0	0	11.6	-21.9	-67.0	45.1
3	35.6	4	0	2	0	21.4	-19.0	-64.1	45.1
4	30.1	3	2	0	0	21.4	-30.4	Weak Signal Detected	
6	38.7	4	0	2	0	21.4	-38.5		
7	32.2	5	2	2	0	21.4	-39.9		
8	35.6	5	0	2	1	21.4	-31.9	No Signal Detected	

TABLE 5. Comparison of reflection coefficients for various common building materials at 28 GHz. Both of the horn antennas have 24.5 dBi gains with 10° half power beamwidth [28].

Environment	Location	Material	Angle (°)	Reflection Coefficient Γ (dB)
Outdoor	ORH	Tinted Glass	10	0.896
		Concrete	10	0.815
			45	0.623
Indoor	MTC	Clear Glass	10	0.740
		Drywall	10	0.704
			45	0.628

same type of horn antennas as the transmitter. In order to achieve increased measurement dynamic range for increased coverage distance, we used a sliding correlator spread spectrum system [5]. Total measured dynamic range was approximately 178 dB between the transmitter and receiver using the most directional horn antennas in order to obtain an SNR of 10 dB, on the order of future small cells. All propagation measurement equipment used AC power outlets that were available from various buildings, thus avoiding any battery depletion problem.

B. 28 GHz BUILDING PENETRATION AND REFLECTION MEASUREMENT

To understand the mm-wave propagation environment in urban areas, signal penetration and reflection properties of common building materials with typical smooth and rough surfaces are required for both indoor and outdoor cases [26]. We conducted penetration and reflection measurements at 28 GHz throughout the summer of 2012 in New York City [28]. Penetration and reflection measurements for common materials were conducted at three locations at the NYU campus in New York City: (a) the 10th floor of 2 MetroTech Center (MTC) in Brooklyn, (b) the Othmer Residence Hall (ORH) in Brooklyn, and (c) Warren Weaver Hall (WWH) in Manhattan [28]. The block diagram of the channel sounding hardware used in this campaign is shown in Fig. 3.

Penetration losses through building materials were collected by first performing a 5-meter free space reference measurement resulting in 75.3 dB path loss, and then positioning the TX and RX on opposite sides of the test material at the

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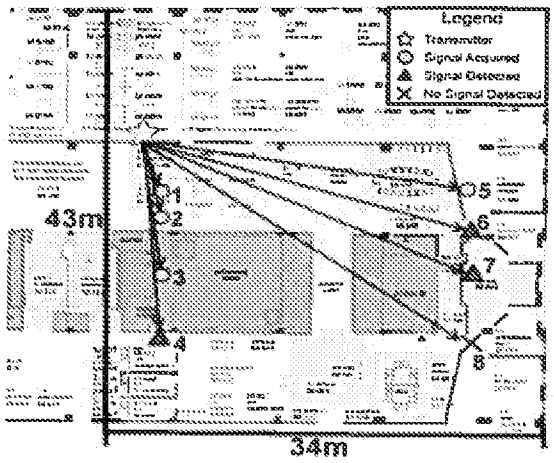

FIGURE 8. Map of the penetration measurements through multiple obstructions in an office environment located at the 10th floor of 2 MetroTech Center in Brooklyn, New York. The TX location is represented by a yellow star, the RX locations where signals can be acquired are represented by green circles, and the RX locations where weak signals can be detected are in red triangles. The black cross denotes an outage [28].

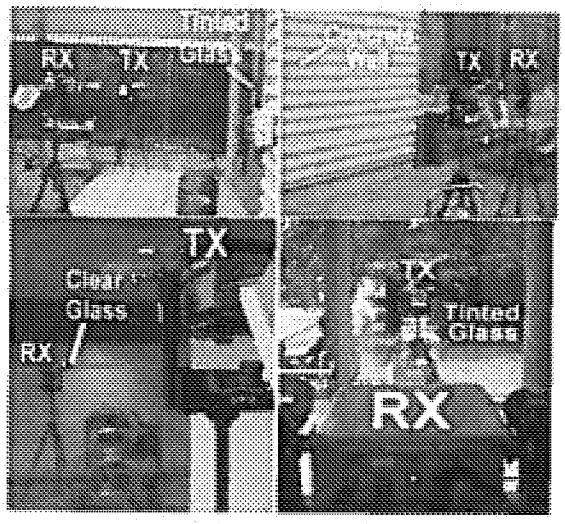

FIGURE 5. Images of the 28 GHz reflection measurement for outdoor tinted glass at ORH (top left), outdoor concrete wall at ORH (top right), penetration loss measurement for indoor clear non-tinted glass at MTC (bottom left) and tinted glass at ORH (bottom right) [28].

same distance. Materials tested for penetration loss include: tinted glass, brick, clear non-tinted glass, and drywall. Table 3 summarizes the penetration loss results for these common building materials [28]. As shown in Table 3, tinted glass and brick pillars (typical exterior surfaces of urban buildings) have high penetration losses of 40.1 dB and 28.3 dB, respectively. This illustrates the fact that building penetration of mm-waves will be difficult for outdoor transmitters, thus providing high isolation between outdoor and indoor networks. On the other hand, common indoor materials such as clear non-tinted glass and drywall only have 3.6 dB and 6.8 dB of losses, respectively, which are relatively low.

In addition to penetration measurements for individual materials, penetration measurements were also made through multiple obstructions in typical office environments, to determine overall average partition losses, as was done in [29] using "primary ray tracing" where a single ray is drawn between the TX and RX, and attenuations of obstructions are determined through measurements. As shown in Fig. 4, multiple indoor obstructions in an office building environment were characterized using 8 RX locations, in which each RX location was selected to determine penetration through increasing layers of obstructions. Partition layers included multiple walls, doors, cubicles, and an elevator bank (RX 8) [28]. We used lower TX power which limited the maximum measurable path loss to about 169 dB.

Table 4 presents a summary of the number and type of obstructions between the TX and RX, as well as the 28 GHz penetration loss results caused by multiple obstructions in a typical office environment. Note that the RX locations are ordered in increasing TX-RX separation distances. Data is grouped into three subsections: signal acquired (with values listed), signal detected, and no signal detected. Signal acquired is defined as a location where the SNR is sufficiently high for accurate acquisition, i.e. penetration loss relative to 5 meters free space test is less than 64 dB. Signal detected is a location where the SNR is high enough to slightly distinguish a signal from noise but not strong enough to be acquired, i.e. penetration loss between 64 dB to 74 dB relative to a 5 m free space test. No signal detected denotes an outage, where the penetration loss is at least 74 dB greater than the 5 m free space test. As shown in Table 4, penetration loss does not greatly depend on the TX-RX separation distance, but mostly depends on the number and type of obstructions. The RX sites with TX-RX separation distances of 25.6 m and 11.4 m have virtually identical measured penetration losses of 45.1 dB; however, the site with 25.6 m separation distance has obstructions of four walls and two cubicles while the other site with 11.4 m separation distance has obstructions of three walls and one door. Note that one outage was found at the RX site with a separation distance of 35.8 m, a result of the large separation distance and the inability of RF waves to penetrate the metallic elevator bank.

Table 5 summarizes and compares the reflection coefficients for common indoor and outdoor building materials. As indicated in Table 5, the outdoor materials have larger reflection coefficients of 0.896 for tinted glass and 0.815 for concrete at a 10° incident angle, as compared to clear non-tinted glass and drywall, which have lower reflection coefficients of 0.740 and 0.704, respectively. The results for outdoor tinted glass in ORH consistently show that a large portion of the signal ($\approx$ 0.896) is reflected and could not penetrate through the glass. In contrast, the clear non-tinted glass located inside the MTC building has a smaller reflection coefficient ($\approx$ 0.740) and causes only 3.9 dB of penetration loss compared to the 40.1 dB loss for the outdoor tinted glass in ORH. The high penetration loss through outdoor building materials and low attenuation through indoor materials suggest that RF energy can be contained in intended areas within

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buildings which reduces interference, yet making outdoor-to-indoor building penetration more difficult. Fig. 5 presents photographs of the penetration and reflection measurements of common building materials at 28 GHz.

III. 28 GHz URBAN PROPAGATION CAMPAIGN IN NEW YORK CITY

A. MEASUREMENT PROCEDURE

The hardware system of Fig. 3 was used in the outdoor propagation measurement campaign in New York City. We selected one TX and 11 RX measurement locations at the NYU-Poly campus in downtown Brooklyn. The distance between the TX and RX ranged from 75 m to 125 m. At the NYU campus in Manhattan, 3 TX and 75 RX locations (with 25 RX sites for each TX site) were chosen with TX-RX separations varying from 19 m to 425 m to emulate future cellular base stations. At three of the measurement locations in Brooklyn, the RX was moved on an automated linear track of 10 wavelengths (107 mm) in half-wavelength (5.35mm) increments to study small scale signal level variations, i.e. small scale fading. At each track position, a 360° azimuthal sweep was performed in steps of 10° (if using the 10° beamwidth 24.5 dBi narrow-beam horn antenna), or 30° (if using the 30° beamwidth 15 dBi wide-beam horn antenna). Large scale propagation characteristics were investigated in the remaining eight RX locations in Brooklyn and all the Manhattan measurements using 24.5 dBi narrow beam antennas. At each TX and RX location, extensive measurements were conducted for three different TX azimuth angles, −5° , 0° , and +5° from boresight to the receiver, and for three different RX elevation angles of −20° , 0° , and +20° creating nine possible antenna pointing combinations between TX and RX. For each of the nine antenna pointing combinations, the RX antenna was swept 360° in the azimuth plane in 10° steps, and measurements were recorded if energy was received. Finally, cross polarization measurements were done at all Brooklyn RX sites where both vertical and horizontal electric polarization fields were measured.

Propagation measurements were conducted in New York City around the NYU campuses in Manhattan and Brooklyn. Each location had the potential to collect 324 power delay profiles (PDPs) for all combinations (36 RX azimuth angles, 3 TX azimuth angles, and 3 RX elevation angles). Not all azimuth angles yielded a detectable signal.

B. PATH LOSS AND SIGNAL OUTAGE ANALYSIS

Given the highly reflective outdoor environment, PDPs displayed numerous multipath with large excess delay for both line-of sight (LOS) and non-line-of-sight (NLOS) environments. The average number of resolvable multipath components in a LOS environment was 7.2 with a standard deviation of 2.2 for a TX-RX separation of less than 200 meters. NLOS measurements with TX-RX separation less than 100 meters showed that the number of average received multipath components is 6.8 with a standard deviation equal to that of a LOS case. With a 52 meter separation, in a LOS environment,

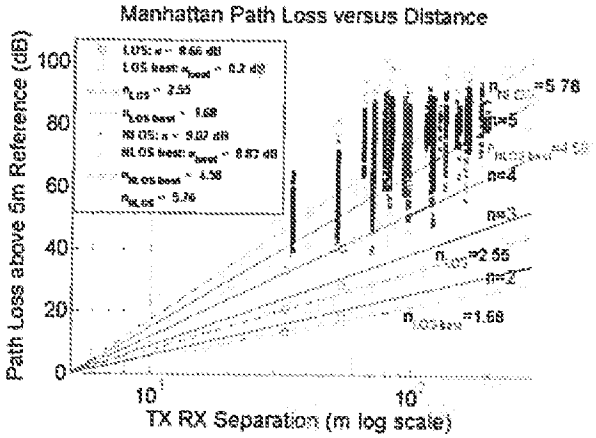

FIGURE 6. Measured path loss values relative to 5 m free space path loss for 28 GHz outdoor cellular channels. These path loss values were measured using a 24.5 dBi narrow beam antenna. The antennas were rotated in the azimuth plane, recording measurements at 10° incremental steps. The values in the legend represent the PLE of each environment (LOS and NLOS) [31].

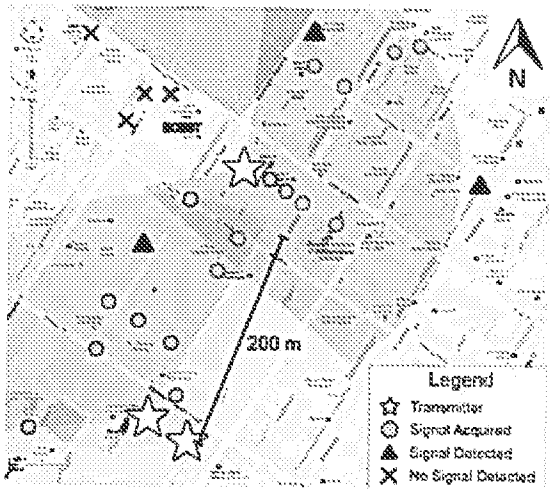

FIGURE 7. Map showing all Manhattan coverage cells with radii of 200 m and their different sectors. Measurements were recorded for each of the 25 RX sites from each of the three TX sites (yellow stars). Signal Acquired means that signal was detected and acquired. Signal Detected means that signal was detected, but low SNR prevented data acquisition by the system [31].

a large 753.5 ns excess delay was observed, and a NLOS excess delay over 423 meters extended to 1388.4 ns. While these results were not commonly observed, these cases are evidence that enough signal strength can propagate through a highly reflective environment over a long distance to create a TX-RX link. When path loss was calculated for all locations, the best LOS path loss exponent (PLE) was $n = 1.68$ (here "best" means "smallest"). The LOS PLE resulting from all the measurements acquired in New York City was $n = 2.55$ (which included many cases where the TX and RX had an optical LOS environment between them but the directional antennas were not precisely lined up on boresight). The average PLE over all NLOS locations increased to $n = 5.76$, as

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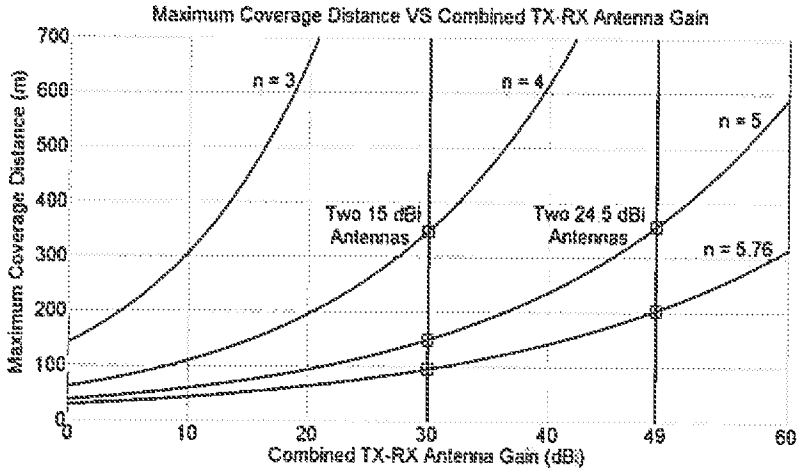

FIGURE 8. Maximum coverage distance at 28 GHz with 119 dB maximum path loss dynamic range without antenna gains and 10 dB SNR, as a function of path loss exponent n.

shown in Fig. 6. However, the NLOS PLE was significantly reduced when pointing the TX and RX directional antennas to the best angle combination at each RX location, resulting in an average "best" NLOS PLE of $n = 4.58$, an improvement of 11.8 dB/decade in path loss, which is significant to cellular providers for range extension. By finding the best antenna orientations at any location, the NLOS PLE of $n = 4.58$ is virtually identical to NLOS path loss experienced in today's 700 MHz – 2.6 GHz bands [30].

An outage study was conducted in Manhattan, New York, to find the locations and distances where energy could not be detected [31]. As seen in Fig. 7, the map is sectioned into sectors corresponding to TX locations. Signal acquired by the RX for all cases was within 200 meters. While most of the RX locations within the range of 200 meters from the TX detected a signal, in some instances, signal-to-noise ratio (SNR) was not high enough for a signal to be acquired by the hardware. Of the measurements taken in Manhattan, it was found that 57% of locations were outages due to the obstructive nature of the channel with most outages occurring beyond 200 m from the TX.

The outage probability is greatly affected by the transmitted power, antenna gains as well as the propagation environment. Fig. 8 displays the relationship between the maximum coverage distance of the base station and the combined TX-RX antenna gain. To calculate the maximum coverage distance, we subtracted the 49 dBi combined antenna gain from the total measurable path loss of 178 dB (which was obtained using the two 24.5 dBi antennas), resulting in the dynamic range without the antenna gain. Since our system requires approximately 10 dB SNR for a reliable detecting level, the actual maximum measureable path loss is 119 dB without including antenna gains, and this was used to compute the coverage distances corresponding to various antenna gains. The four blue curves denote the cases for PLEs equal to 3, 4, 5 and 5.76. The red squares in Fig. 8 highlight the coverage distance corresponding to the two 15 dBi horn antennas and 24.5 dBi horn antennas at the TX and RX. Obviously, the maximum coverage distance increases with increasing antenna gains and a decrease of the PLE. For example, the radio waves can propagate about 200 m in a highly obstructed environment with a PLE of 5.76 when the combined TX-RX antenna gain is 49 dBi, which agrees with our measured values (200 m) very well. This suggests that we can enlarge the coverage region of a base station by increasing antenna gains, and may use less antenna gain (or TX power) when in LOS conditions.

C. 28 GHz AOA AND AOD ANALYSIS

By employing highly directional steerable horn antennas to simulate an antenna array, we were able to obtain angle of arrival (AOA) and angle of departure (AOD) data necessary to determine the multipath angular spread at the transmitter for AOD and at the receiver for AOA. By completing a 360° exhaustive sweep of the TX and RX antennas, we were able to determine the angles with the highest received power. Data collected at environments classified as LOS, partially obstructed LOS, and NLOS provide a basis for the development of a spatial channel model. The path loss and root mean squared (RMS) delay spreads can be used to accurately characterize the channel [31].

Fig. 9 demonstrates a polar plot of received power at the RX on the corner of Greene and Broadway in downtown Manhattan, a location categorized as a NLOS environment. The distance between the TX and RX was 78 m. In the figure, each dot represents the received power level in dBm (denoted on the radius of the polar plot) at the corresponding RX azimuth angle. The number of resolvable multipath components, path loss in dB with respect to the 5 m free space reference, and RMS delay spread in nanoseconds are displayed from left to right on the periphery of the plot. As can be seen, TX-RX links were successfully established

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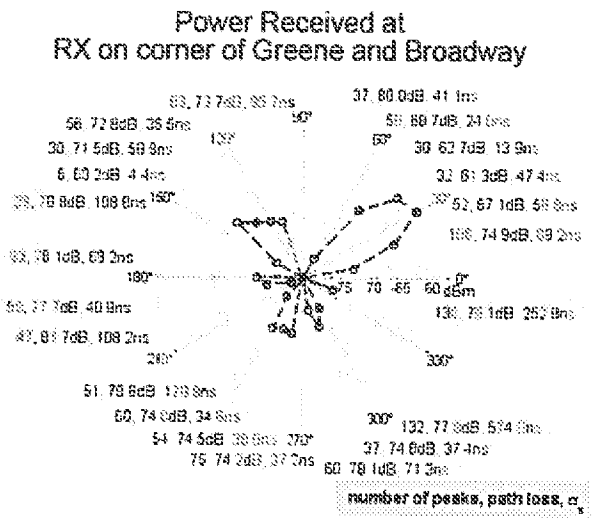

FIGURE 9. Polar plot showing the received power at a NLOS location. This plot shows an AOA measurement at the RX on Greene and Broadway from the TX on the five-story Kaufman building (78 m T-R separation). The polar plot shows the received power in dBm, the number of resolvable multipath components, the path loss in dB with respect to the 5 m free space reference, and RMS delay spread with varying RX azimuth angles [31].

at 22 out of 36 RX azimuth angles. Furthermore, it is obvious that a wealth of multipath components exist at numerous different pointing angles, providing great diversity which can be utilized for beam combining and link improvement in future 5G systems.

Small scale fading has also been explored by moving the RX at half-wavelength (5.35 mm) increments along a small scale linear track of 10 wavelengths (107 mm), while the TX was fixed at a certain location [32]. Fig. 10 shows the 3D power delay profiles of small scale fading for the TX-RX angle combination for the strongest received power. The maximum and minimum received signal powers were −68 dBm/ns and −74 dBm/ns, respectively, yielding merely ±3 dB fading variation. This outcome indicates that movements over the small scale track exert little influence on the AOA or the received power level of multipath signals.

IV. 38 GHz CELLULAR URBAN PROPAGATION CAMPAIGN IN AUSTIN

A. 38 GHz BROADBAND CHANNEL SOUNDING HARDWARE AND MEASUREMENT PROCEDURE

An 800 MHz null-to-null bandwidth spread spectrum sliding correlator channel sounder was employed in the 38 GHz propagation measurement campaign in Austin. The PN sequence was operating at 400 Meps and 399.9Meps at the TX and RX, respectively, to offer a slide factor of 8000 and adequate processing gain [33]. The PN sequence was modulated by a 5.4 GHz IF signal, which was input into the upconverter that contained LO frequency multipliers to generate a carrier frequency of 37.625 GHz with a +22 dBm output power before the TX antenna. A 25-dBi gain Ka-band vertically polarized

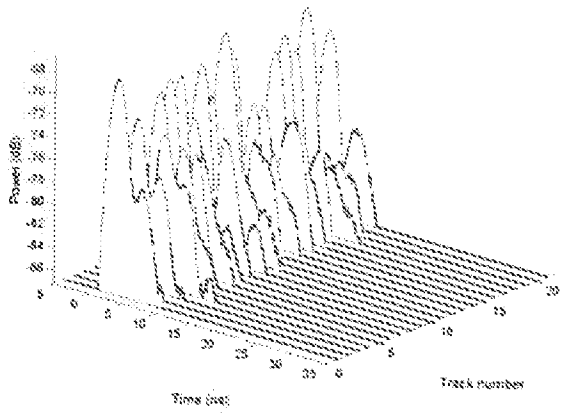

FIGURE 10. Power delay profiles measured over a 10-wavelength linear track at 28 GHz. The RX was 135 meters away from the TX. The TX and RX were pointed for maximum signal power. Track step size was half wavelength using 24.5 dBi horn antennas with beamwidths of 10.9° on the TX and RX.

horn antenna with 7.8° half-power beamwidth was utilized at the TX, and an identical antenna (and also a wider beam 13.3-dBi gain (49.4° beamwidth) vertically polarized horn antenna) were used at the RX. The maximum measurable path loss was about 160 dB [23], [33]–[35].

38 GHz cellular propagations measurements were conducted in Austin, Texas at the University of Texas main campus [33]. TX locations were placed on four rooftops with different heights, WRW-A (23 meters), ENS-A (36 meters), ENS-B (36 meters), and ECJ (8 meters). A total of 43 TX-RX combinations were measured with up to 12 various antenna configurations for each measurement location [33]. The RX was positioned in a number of LOS, partially obstructed LOS, and NLOS locations representative of an outdoor urban environment including foliage, high-rise buildings, and pedestrian and vehicular traffic. At each receiver location, measurements were acquired using a circular track with 8 equally spaced local area measurement points separated by 45° increments. The radius of the circular track yielded a 10λ separation distance between consecutive points along the circular track. For LOS links, the TX and RX were pointed directly at each other in both azimuth and elevation. The captured PDPs for each complete track measurement were then averaged and a new RX location was selected. NLOS conditions were taken over the circular track and a subsequent 360° azimuth exhaustive signal search was conducted.

B. 38 GHz OUTDOOR MEASUREMENT RESULTS

AOA measurements were shown to be most common when the RX azimuth angle was between −20° and +20° about the boresight of the TX azimuth angle [34]. After examining data for all RX locations for each corresponding TX, it was shown that a lower base station height is more likely to have more links with varying the TX azimuth angle. However, the site specific location of the RX impacts the observed AOA and multipath response. Designing for future base stations will require site specific deployment technologies.

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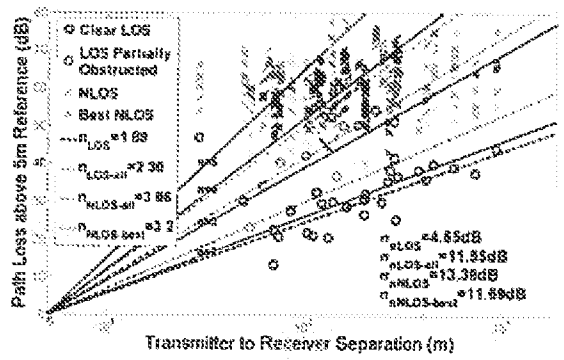

FIGURE 11. Path loss scatter plot using 25dBi Rx antenna at 38 GHz. LOS and NLOS measurements have path loss exponents of 2.30 and 3.86, respectively, while the best NLOS links have a path loss exponent of 3.2 [35].

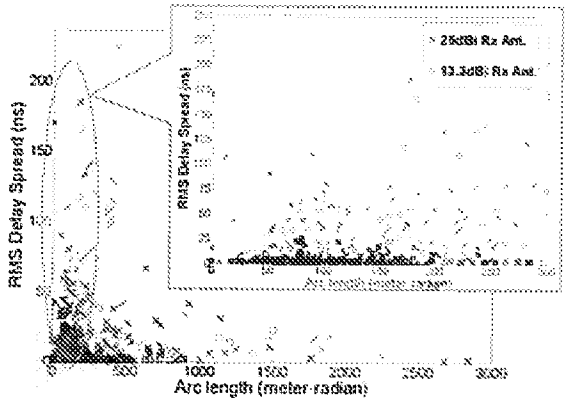

FIGURE 12. RMS delay spread as a function of arc length at 38 GHz. The delay spread decreases over longer arc lengths, which indicates that distance surmounts angle in determining delay spread. Nevertheless, a close-up of low arc lengths shows the angle playing a larger role in determining delay spread [35].

Path loss was determined for 38 GHz in Austin using 13.3 dBi and 25 dBi horn antennas [35]. For all TX locations, measurements at ECJ yielded the highest path loss using both antennas. The LOS PLE for the 25 dBi horn antennas was measured to be n = 2.30 and NLOS PLE was measured to be n = 3.86, as demonstrated in Fig. 11. Compared to measurements in Manhattan at 28 GHz, where the LOS PLE and NLOS PLE were 2.55 and 5.76 respectively, it is clear that PLE at 38 GHz in the light urban environment in Austin is considerably lower.

Analysis of the RMS delay spread at 38 GHz showed sensitivity to antenna gains [23], [33]–[35]. While all cumulative distribution functions (CDF) for LOS and NLOS links are similar, a lower antenna gain was shown to have a higher RMS delay spread, whereas the 25 dBi antenna showed lower delays with greater TX-RX separation. Fig. 12 shows RMS delay spreads for the 25 dBi and 13.3 dBi steerable receiver antennas plotted as a function of arc length.

By conducting an outage study in Austin, we were able to further establish that lower base station heights provide better close-in coverage. By comparing ENS and WRW, 36 and 18 meters in height respectively, we found that no

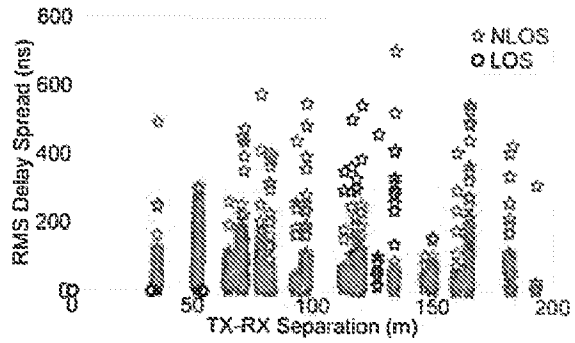

FIGURE 13. RMS delay spread as a function of TX-RX separation for all links using all possible pointing angles at 28 GHz in New York City. The green stars and blue circles denote the RMS delay spread in the NLOS and LOS measurement locations, respectively.

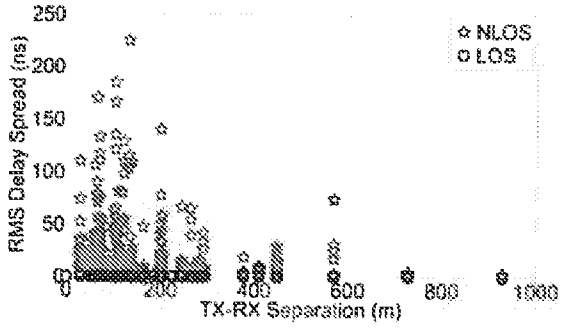

FIGURE 14. RMS delay spread as a function of TX-RX separation for all links using all possible pointing angles at 38 GHz in Austin, Texas. The green stars and blue circles denote the RMS delay spread in the NLOS and LOS environment, respectively.

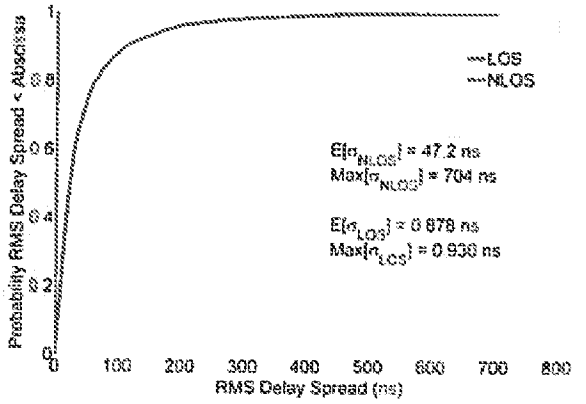

FIGURE 15. Cumulative distribution function (CDF) of the RMS delay spread at 28 GHz measured for all links using all possible pointing angles in the dense urban environment in New York City. The CDFs for LOS and NLOS links over all TX-RX locations are distinguished by the extremely low delay spread in LOS, and extremely mutative spreads in NLOS.

outages occurred within a 200 m cell radius. However, beyond 200 m, 52.8% of locations were outages, 10% of those belong to WRW, and 27.3% to ENS. The coverage radius of 200 m is identical to that measured in New York City, thus suggesting that 200 m is a very achievable cell size for future 5G mm-wave cellular communications systems [23], [33]–[35].

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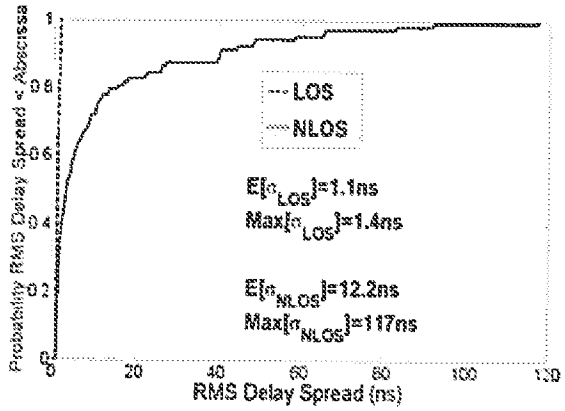

FIGURE 16. CDF of the RMS delay spread of the 38 GHz cellular channel for all links using all possible pointing angles measured in Austin, Texas [23].

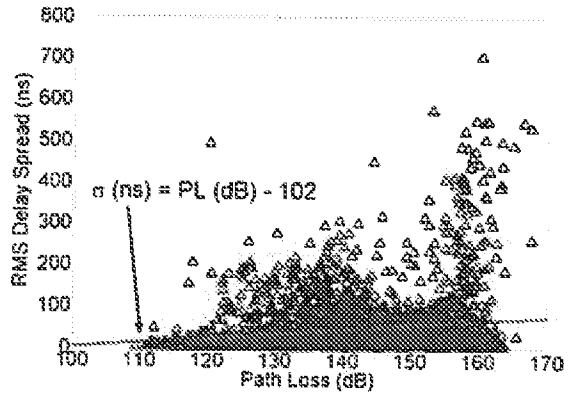

FIGURE 17. RMS delay spread as a function of path loss over all visible pointing angles at 28 GHz in New York City. The blue triangles represent the measured RMS delay spread and the red line denotes a linear fit for the average RMS delay spread.

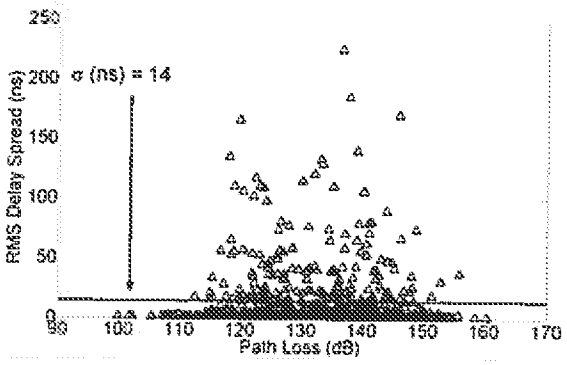

FIGURE 18. RMS delay spread as a function of path loss over all visible pointing angles at 38 GHz in Austin, Texas. The blue triangles represent the measured RMS delay spread, and the red line denotes a linear fit for the average RMS delay spread.

V. STATISTICAL MODELS FOR RMS DELAY SPREAD

Fig. 13 shows the relationship between RMS delay spread and TX-RX separation for the 28 GHz New York City measurements. We note that the maximum value of RMS delay spread appears to be roughly even up to 170-m TX-RX separation, and then decreases for distances greater than 170 m. The delay spread at relatively large TX-RX separations is caused by multipath, which illustrates the highly reflective nature of the dense urban environment in New York City. Yet, when the distance between the TX and RX is too large (close to or exceeding 200 m), the path loss is so great that the power of the transmitted signal declines to zero before reaching the RX, resulting in fewer or no received multipath. The relationship between RMS delay spread and TX-RX separation for 38 GHz Austin measurements is shown in Fig. 14. As seen in Fig. 14, signals in Austin, Texas could still be acquired for TX-RX distances greater than 200 m, and the average RMS delay spread is much lower than that at 28 GHz, thus indicating the relatively sparse urban environment of the UT-Austin campus, where there were fewer buildings to cause obstructions or reflections.

The cumulative distribution function (CDF) of the RMS delay spread at 28 GHz in New York City is illustrated in Fig. 15. In LOS cases, the TX and RX antennas were directly pointed at each other, and very few multipath existed, thus resulting in virtually non-existent RMS delay spread. In NLOS cases, the majority of measured multipath components have RMS delay spreads below 200 ns, while some are as high as 700 ns. As a comparison, the average and maximum RMS delay spread in NLOS cases obtained from 38 GHz cellular measurements in Austin, Texas are 12.2 ns and 117 ns, respectively (see Fig. 16), which are much lower than those at 28 GHz, further demonstrating the propagation conditions in the less cluttered, less dense nature of the urban environment measured in Austin, Texas.

The variation of RMS delay spread versus path loss in NLOS for all TX-RX location combinations at 28 GHz in New York City is displayed in Fig. 17. It is clear from the plot that RMS delay spread increases with path loss, which is similar to the result at 1.9 GHz in [30]. A linear model is adopted to investigate the relationship between RMS delay spread and path loss for the 28 GHz measurements in Manhattan, where σ denotes the average RMS delay spread in nanoseconds for a particular value of path loss, and PL is the path loss in decibels ranging from 109 dB to 168 dB. Combined with Fig. 6, the path loss and RMS delay spread models can be utilized to predict outage ranges in microcell mm-wave communication systems. A similar fit is done in Fig. 18 for 38 GHz measurement data from Austin, wherein the average RMS delay spread is found to be virtually identical (14 ns) over the path loss range of 100 dB to 160 dB.

VI. CONCLUSION

Given the worldwide need for cellular spectrum, and the relatively limited amount of research done on mm-wave mobile communications, we have conducted extensive propagation measurement campaigns at 28 GHz and 38 GHz to gain insight on AOA, AOD, RMS delay spread, path loss, and building penetration and reflection characteristics for

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the design of future mm-wave cellular systems. This work presents data collected in the urban environments around the University of Texas at Austin (38 GHz) and New York University (28 GHz). Outage studies conducted at 28 GHz and 38 GHz showed that consistent coverage can be achieved by having base stations with a cell-radius of 200 metres. Path loss was larger in New York City than in Austin, due to the nature of the denser urban environment. In New York City, reflection coefficients for outdoor materials were significantly higher, for example, 0.896 for tinted glass, and 0.740 for clear non-tinted glass, compared with those of indoor building materials. Similarly, penetration losses were larger for outdoor materials in New York City. Since signals cannot readily propagate through outdoor building materials, indoor networks will be isolated from outdoor networks and this suggests that data showers, repeaters, and access points may need to be installed for handoffs at entrances of commercial and residential buildings.

By observing the measured path loss and delay spread values from the heavy urban environment of New York City and the light urban environment of Austin, Texas, we found substantial differences in propagation parameters.

Multipath delay spread is found to be much larger in New York City than in Austin, due to the highly reflective nature of the dense urban environment.

Small scale fading, a key factor for the design of urban cellular, has been tested and shows little change in received power and impulse response when highly directional antennas and 400 Mcps signals are used.

The data collected over the course of these measurement campaigns allows for development of statistical channel models for urban environments, and are highly valuable for the development of 5G cellular communications at mm-wave bands in the coming decade.

ACKNOWLEDGMENT

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He is an Outstanding Electrical and Computer Engineering Alumnus and Distinguished Engineering Alumnus from his alma mater. He holds the David Lee/Ernst Weber Chair in Electrical and Computer Engineering at Polytechnic Institute, New York University (NYU-Poly), Brooklyn, NY, USA, and is a Professor of computer science and Professor of radiology at NYU. In 2012, he founded NYU WIRELESS, a multidisciplinary research center involving NYU's engineering, computer science, and medical schools. Earlier in his career, he founded the Wireless Networking and Communications Group (WNCG), University of Texas at Austin (UT), TX, USA. Prior to UT, he was on the electrical and computer engineering faculty of Virginia Polytechnic Institute and State University, Blacksburg, VA, USA, where he founded the Mobile and Portable Radio Research Group (MPRG), one of the world's first university research and teaching centers dedicated to the wireless communications field. In 1989, he founded TSR Technologies, Inc., Blacksburg, VA, USA, a cellular-radio/personal-communications-services software radio manufacturer that pioneered cellular E-911 and test equipment that he sold in 1993 to what is now CommScope, Inc. In 1995, he founded Wireless Valley Communications Inc., Austin, TX, USA, and a site-specific wireless network design and management firm that was sold in 2005 to Motorola, Inc. He has testified before the U.S. Congress, has served as an international consultant for the ITU, has consulted for more than 30 major telecommunications firms, and works on many national committees pertaining to communications research and technology policy. He is a highly sought-after consultant and technical expert, and serves on the Board of Directors of the Marconi Society. He has authored or co-authored more than 200 technical papers, over 100 U.S. and international patents, and several best-selling technical books.

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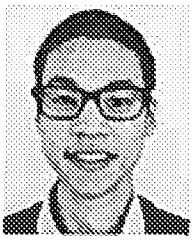
He has previously worked on 28 GHz millimeter-wave propagation measurement campaign, and has a first-author conference publication and co-authored two conference publications. He currently works on his thesis in the biomedical area.



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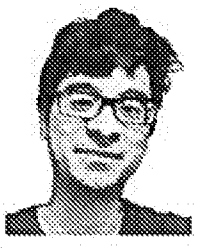

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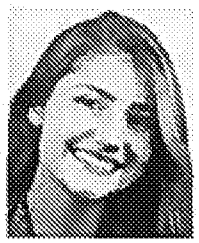

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA	2489

30743 7590 07/29/2016

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EXAMINER
SERAYDARYAN, HELENA H

ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
07/29/2016	PAPER

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.

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	13/966,853	RAPPAPORT, THEODORE S.	
	Examiner	Art Unit	
	HELENA SERAYDARYAN	3648	

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

(1) *HELENA SERAYDARYAN*.

(2) *GREGORY ISSING*.

(3) *MICHAEL WHITHAM*.

(4) *THEODORE RAPPAPORT*.

Date of Interview: *27 July 2016*.

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

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

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

Claim(s) discussed: *1-11*.

Identification of prior art discussed: *Werling*.

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

During the interview Appllicant's proposed amendments to the independent claims were discussed in an effort to overcome the prior art. Specifically, Applicant addressed limitations directed to operation at MMW (e.g. above 10 GHz) and adjusting one or more beams of a steerable antenna as parameters change over time. Applicant also addressed incorporating limitations regarding different signal reception and transmission beams possibilities for the device. The Examiner noted that neither operation at MMW nor use of different transmit and receive beams have been previously addressed or searched and thus would require additional consideration .

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

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

☒ Attachment

/HELENA SERAYDARYAN/ Examiner, Art Unit 3648	/Gregory C. Issing/ Primary Examiner AU 3646

Summary of Record of Interview Requirements

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

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

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

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

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

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

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

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

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

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

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

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

Examiner to Check for Accuracy

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

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30743 7590 05/06/2016

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EXAMINER
SERAYDARYAN, HELENA H

ART UNIT	PAPER NUMBER
3648	

MAIL DATE	DELIVERY MODE
05/06/2016	PAPER

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.

Office Action Summary	Application No. 13/966,853	Applicant(s) RAPPAPORT, THEODORE S.	
	Examiner HELENA SERAYDARYAN	Art Unit 3648	AIA (First Inventor to File) Status No

-- 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 *08/14/2013*.

☐ 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) *1-11* 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) *1-11* 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 *08/14/2013* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *08/14/2013; 07/24/2014*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Information Disclosure Statement

2. The information disclosure statements (IDS) submitted on 08/14/2013 and07/24/2014 have been entered and considered. The submission is in compliance with the provisions of 37 CFR 1.97. Initialed copies of the PTO-1449 by the Examiner are attached.

Drawings

3. The drawings were received on 08/14/2013. These drawings are acceptable.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of pre-AIA 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 –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. **Claims 1-11 are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Werling (US 6456856).**

6. **As per Claim 1**, Werling teaches a method for avoiding radiation of a user or structure by a wireless device having a steerable antenna (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2; Fig. 1, array 12-15; Col. 2, Lines 54-62), comprising the steps of:

detecting, using one or more sensors (Fig. 1, Item 18), one or more parameters of said wireless device or pertaining to said user's physical relationship to said wireless device (Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said steerable antenna (Col. 3, Lines 8-14) and

adjusting one or more beams of said steerable antenna to radiate in one or more directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32).

7. **As per Claim 2**, Werling teaches the method set forth above, wherein said one or more beams are adjusted as said one or more parameters change over time (Col. 3, Lines 15-18, 57-63).

8. **As per Claim 3**, Werling teaches the method set forth above, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to one or more of the proximity of a user or orientation of user with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer;

detecting heat from a human user with at least one heat sensor (Col. 4, Lines 53-57; ambient temperature); and

detecting touch or proximity of a user's skin or clothing with at least one capacitive sensor.

9. **As per Claim 4**, Werling teaches a wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect at least one parameter of said wireless device or pertaining to a user's physical relationship to said wireless device (Fig. 1, Item 18; Col. 3, Lines 1 -14; Col. 4, Lines 53-57; ambient temperature);

one or more processors communicatively coupled to said one or more sensors (Col. 3, Lines 1-14; Fig. 1, control element 17);

a steerable antenna communicatively coupled to said one or more processors (Fig. 1, Items 12-15; Col. 2, Lines 56-59; Col. 3, Lines 45-55); and

a non-transitory computer readable medium comprising executable instructions (Col. 2, Lines 59- 65; Fig. 1, control element 17) that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said at least one parameter (Fig. 1, Item 18; Col. 3, Lines 1 -14; Col. 4, Lines 53-57; ambient temperature);

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said steerable antenna (Col. 3, Lines 8-14); and

adjusting one or more beams of said steerable antenna to radiate in one or more directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32).

10. **As per Claim 5**, Werling teaches the wireless device set forth above, wherein said steerable antenna comprises a plurality of antennas, said plurality of antennas forming an antenna array (Fig. 1, array 12-15; Col. 2, Lines 54-62; Claim 3).

11. **As per Claim 6**, Werling teaches the wireless device set forth above, wherein said one or more sensors includes one or more heat sensors (Fig. 1, Item 18; Col. 3, Lines 1-8).

12. **As per Claim 7**, Werling teaches the wireless device set forth above, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound (Col. 2, Lines 17-25; Col. 3, Lines 1-8; ambient temperature).

13. **As per Claim 8**, Werling teaches a steerable antenna system for avoiding radiation of a user or structure by a wireless device (Col. 1, Line 65 – Col. 2, Line 6; Fig. 2), comprising:

one or more sensors (Fig. 1, Item 18) configured to detect at least one parameter of said wireless device or pertaining to a user's physical relationship to said wireless device Col. 2, Lines 17-25; Col. 3, Lines 1 - 8);

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions (Col. 3, Lines 1-14; Fig. 1, control element 17); and

a steerable antenna (Fig. 1, array 12-15; Col. 2, Lines 54-62; claim 3) communicatively coupled to said computation module, said steerable antenna radiating

one or more beams in one or more directions which are not in said zones or spans of directions (Col. 3, Lines 15-22, 27-32).

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said steerable antenna (Col. 3, Lines 8-14).

14. **As per Claim 9**, Werling teaches the steerable antenna system set forth above, wherein said steerable antenna comprises a plurality of antennas, said plurality of antennas forming an antenna array (Fig. 1, arrays 12-15; Col. 2, Lines 54-62; claim 3).

15. **As per Claim 10**, Werling teaches the steerable antenna device set forth above, wherein said one or more sensors includes one or more heat sensors (Fig. 1, Item 18; Col. 3, Lines 1-8).

16. **As per Claim 11**, Werling teaches the steerable antenna device set forth above, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound (Col. 2, Lines 17-25; Col. 3, Lines 1-8; ambient temperature).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HELENA SERAYDARYAN whose telephone number is (571)270-0706. The examiner can normally be reached on M-Th, 7:30-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tashiana Adams can be reached on (571)270-5228. 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 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.

/HELENA SERAYDARYAN/
Examiner, Art Unit 3648

/GREGORY C. ISSING/
Primary Examiner, Art Unit 3646

Notice of References Cited	Application/Control No. 13/966,853	Applicant(s)/Patent Under Reexamination RAPPAPORT, THEODORE S.	
	Examiner HELENA SERAYDARYAN	Art Unit 3648	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-6,456,856 B1	09-2002	Werling; Thierry B. F.	H01Q1/243	455/129
*	B	US-2008/0242349 A1	10-2008	Rofougaran; Ahmadreza (Reza)	H04M1/72572	455/556.1
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	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.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13966853	RAPPAPORT, THEODORE S.
	Examiner	Art Unit
	HELENA SERAYDARYAN	3648

CPC- SEARCHED		
Symbol	Date	Examiner
H01Q1/245	4/11/2016	H.S.

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
342	368	4/1/2016	H.S.

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search in PALM	4/1/2016	H.S.
Inventor Name Search in EAST	4/1/2016	H.S.
Text Search in EAST	4/11/2016	H.S.
Consulted with Primary G. Issing	4/1/2016	H.S.

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

/HELENA SERAYDARYAN/ Examiner.Art Unit 3648	

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13966853
Filing Date	
First Named Inventor	Theodore S. Rappaport
Art Unit	3648
Examiner Name	/Helena Seraydaryan/
Attorney Docket Number	08610010PA

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4499606		1985-02-12	Rambo	
	2	6693600		2004-02-17	Elliot	
	3	7088299		2006-08-06	Siegler et al.	
	4	3381222		1968-04-30	Gray	
	5	3689928		1972-09-05	Felsenheld	
	6	6140966		2000-10-31	Pankinaho	
	7	6762723		2004-07-13	Nallo et al.	
	8	7132989		2006-11-07	Poilasne	

Receipt date: 08/14/2013	Application Number	13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	
	First Named Inventor	Theodore S. Rappaport
	Art Unit	
	Examiner Name	/Helena Seraydaryan/
	Attorney Docket Number	08610010PA

	9	8421695		2013-04-16	Friman et al.	
	10	8456366		2013-06-04	Vance	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030151556		2003-08-14	Cohen	
	2	20080158081		2008-07-03	Rofougaran	
	3	20013004065		2013-02-14	Keidar	

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /H.S./

Receipt date: 08/14/2013	Application Number	13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	
	First Named Inventor	Theodore S. Rappaport
	Art Unit	
	Examiner Name	/Helena Seraydaryan/
	Attorney Docket Number	08610010PA

	1		☐

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EXAMINER SIGNATURE

Examiner Signature	/Helena Seraydaryan/	Date Considered	04/01/2016

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /H.S./

Receipt date: 08/14/2013	Application Number	13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	
	First Named Inventor	Theodore S. Rappaport
	Art Unit	
	Examiner Name	/Helena Seraydaryan/
	Attorney Docket Number	08610010PA

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael E. Whitham/	Date (YYYY-MM-DD)	2013-08-14
Name/Print	Michael E. Whitham	Registration Number	32635

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

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

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

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

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

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

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

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /HC/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L14	1058	steer$4 with antenna with mobile	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/12 09:08
L15	5	"9529117".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/12 09:34
L16	2	(US-20080242349-$).did. or (US-6456856-$).did.	US-PGPUB; USPAT	AND	ON	2016/04/12 10:53
S1	104	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2016/04/01 13:02
S2	218	((Theodore) near2 (Rappaport)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:02
S3	1	S2 and ((steerable adj antenna) with sensors)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S4	1748	342/368.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/01 13:04
S5	3044	H01Q1/245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S6	2704	H04B1/3838.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:44
S7	4870	H01Q3/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S8	6373	H01Q3/26.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46
S10	23279	H01Q1/243.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:46

S11	196	steer$4 with sensor with phone	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:47
S14	36859	S5 or S6 or S7 or S8 or S10	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S16	775	steer$4 with sensor with (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:49
S17	11	S16 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S18	6	S14 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:50
S19	3	"52780741".FMID.	US-PGPUB; USPAT; FPRS	AND	ON	2016/04/11 16:51
S20	1533	S14 and Lee.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S21	452	S20 and (cellphone or phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S22	77	S20 and (cellphone or phone)S21 and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:52
S23	1	S22 and (steer$4 or redirect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:55
S24	73	S22 and (steer$4 or redirect$4 or direct$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 16:56
S25	1	2014-T60821.NRAN.	DERWENT	AND	ON	2016/04/11 16:57
S26	19336	((steer$4 or redirect$4 or direct or direction or directionality) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:27
S27	41	S14 and S26	US-PGPUB; USPAT; USOCR; FPRS;	AND	ON	2016/04/11 17:27

			EPO; JPO; DERWENT			
S28	25566	((steer$4 or redirect$4 or direct or direction or directionality or pattern) with (sensor or camera) with (user or person)) and (phone or mobile or cellphone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:33
S29	79	S14 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:34
S30	27	H01Q1/245.cpc. and steer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:35
S31	277	H01Q1/245.cpc. and sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	AND	ON	2016/04/11 17:49

4/12/2016 11:00:04 AM
C:\Users\hseraydaryan\Documents\EAST\Workspaces\13966853_Steerable_Antenna_Device_wSensors.wsp

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BIB DATA SHEET

CONFIRMATION NO. 2489

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/966,853	08/14/2013 RULE	342	3648	08610010PA

APPLICANTS

INVENTORS

Theodore S. Rappaport, Riner, VA;

**** CONTINUING DATA ***************************

This application is a CIP of 13/713,804 12/13/2012 PAT 8593358
which is a CON of 12/541,764 08/14/2009 PAT 8350763
which claims benefit of 61/088,829 08/14/2008

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
08/29/2013

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and Acknowledged /HELENA H SERAYDARYAN/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		VA	5	11	3

ADDRESS

WHITHAM, CURTIS & CHRISTOFFERSON & COOK, P.C.
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190
UNITED STATES

TITLE

Steerable Antenna Device

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13966853
Filing Date	2013-08-14
First Named Inventor	Rappaport
Art Unit	2845 3648
Examiner Name	Choi, Jacob Y. /Helena Seraydaryan/
Attorney Docket Number	08610010PA

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7403164	B2	2008-07-22	Sanz et al.	
	2	7187945	B2	2007-03-06	Ranta et al.	
	3	7042417	B2	2006-05-09	Santhoff et al.	
	4	6957081	B2	2008-10-18	Leyh et al.	
	5	6990357	B2	2006-01-24	Ella et al.	
	6	6865376	B2	2005-03-08	Forrester	
	7	6560443	B1	2003-05-06	Vaisanen et al.	
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(Not for submission under 37 CFR 1.99)

Application Number	13966853 13966853 - GAU: 3648
Filing Date	2013-08-14
First Named Inventor	Rappaport
Art Unit	2845 3648
Examiner Name	Choi, Jacob Y. /Helena Seraydaryan/
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20080278405	A1	2008-11-13	Montgomery et al.	

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	1	M. ALKANHAL, ET AL., "A novel dual-band reconfigurable square-ring microstrip antenna", Progress in Electromagnetics Research, 2007, pages 337-349, vol. 70.	☐
	2	M. AZAD, ET AL., "A Miniaturized Hilbert PIFA for Dual-Band Mobile Wireless Applications", IEEE Antennas and Propagation Letters, 2005, pages 59-62, vol.4.	☐
	3	A. SAYEM, ET AL., "Characteristics of a microstrip-FED miniature printed Hilbert slot antenna", Progress in Electromagnetics Research, 2006, pages 1-18, vol.56.	☐
	4	G. ZHAO, ET AL., "Compact ring monopole antenna with double meander lines for 2.4/5 GHz dual-band operation", Progress in Electromagnetics Research, 2007, pages 187-194, vol.72.	☐

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Receipt date: 07/24/2014	Application Number	13966853 13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2013-08-14
	First Named Inventor	Rappaport
	Art Unit	2845 3648
	Examiner Name	Choi, Jacob Y. /Helena Seraydaryan/
	Attorney Docket Number	08610010PA

EXAMINER SIGNATURE			
Examiner Signature	/Helena Seraydaryan/	Date Considered	04/01/2016

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Receipt date: 07/24/2014	Application Number	13966853 13966853 - GAU: 3648
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2013-08-14
	First Named Inventor	Rappaport
	Art Unit	2845 3648
	Examiner Name	Choi, Jacob Y. /Helena Seraydaryan/
	Attorney Docket Number	08610010PA

CERTIFICATION STATEMENT

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OR

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☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael E. Whitham/	Date (YYYY-MM-DD)	2014-07-24
Name/Print	Michael E. Whitham	Registration Number	32635

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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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).

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

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

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /HC/

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13966853	RAPPAPORT, THEODORE S.
	Examiner	**Art Unit**
	HELENA SERAYDARYAN	3648

✓	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	04/12/2016								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								

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First Named Inventor	Rappaport
Art Unit	2845
Examiner Name	Choi, Jacob Y.
Attorney Docket Number	08610010PA

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7403164	B2	2008-07-22	Sanz et al.	
	2	7187945	B2	2007-03-06	Ranta et al.	
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	8	6381471	B1	2002-04-30	Dvorkin	

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	1	20080278405	A1	2008-11-13	Montgomery et al.	
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	1	M. ALKANHAL, ET AL., "A novel dual-band reconfigurable square-ring microstrip antenna", Progress in Electromagnetics Research, 2007, pages 337-349, vol. 70.	☐
	2	M. AZAD, ET AL., "A Miniaturized Hilbert PIFA for Dual-Band Mobile Wireless Applications", IEEE Antennas and Propagation Letters, 2005, pages 59-62, vol.4.	☐
	3	A. SAYEM, ET AL., "Characteristics of a microstrip-FED miniature printed Hilbert slot antenna", Progress in Electromagnetics Research, 2006, pages 1-18, vol.56.	☐
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	Examiner Name	Choi, Jacob Y.
	Attorney Docket Number	08610010PA

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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Signature	/Michael E. Whitham/	Date (YYYY-MM-DD)	2014-07-24
Name/Print	Michael E. Whitham	Registration Number	32635

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EFS ID:	19678923
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham/Ivan Torres
Filer Authorized By:	Michael E. Whitham
Attorney Docket Number:	08610010PA
Receipt Date:	24-JUL-2014
Filing Date:	14-AUG-2013
Time Stamp:	18:33:33
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)	08610010PA_IDS2.pdf	613223 6ad3a002a904bd844f278332208637b83f1c1de1	no	5

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5	Non Patent Literature	08610010PA_ids2_NPL_4.pdf	294500 56407e1a43f8fc4650c6d181fe503f5073b500a4	no	8
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA

CONFIRMATION NO. 2489

30743
WHITHAM, CURTIS & CHRISTOFFERSON & COOK, P.C.
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

PUBLICATION NOTICE

Title: Steerable Antenna Device

Publication No.US-2013-0328723-A1
Publication Date:12/12/2013

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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.

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PATENT APPLICATION FEE DETERMINATION RECORD

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Application or Docket Number: 13/966,853

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	300		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	11 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*	x 210 =	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	730		TOTAL	

APPLICATION AS AMENDED - PART II

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

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

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

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www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/966,853	08/14/2013	2821	730	08610010PA	11	3

CONFIRMATION NO. 2489

30743
WHITHAM, CURTIS & CHRISTOFFERSON & COOK, P.C.
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

FILING RECEIPT

Date Mailed: 09/04/2013

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)

Theodore S. Rappaport, Riner, VA;

Applicant(s)

Theodore S. Rappaport, Riner, VA;

Power of Attorney: The patent practitioners associated with Customer Number 30743

Domestic Priority data as claimed by applicant

This application is a CIP of 13/713,804 12/13/2012
which is a CON of 12/541,764 08/14/2009 PAT 8350763
which claims benefit of 61/088,829 08/14/2008

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 - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 08/29/2013
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/966,853**
Projected Publication Date: 12/12/2013
Non-Publication Request: No
Early Publication Request: No

**** SMALL ENTITY ****

Title

Steerable Antenna Device

Preliminary Class

343

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

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/966,853	08/14/2013	Theodore S. Rappaport	08610010PA

CONFIRMATION NO. 2489

POA ACCEPTANCE LETTER

30743
WHITHAM, CURTIS & CHRISTOFFERSON & COOK, P.C.
11491 SUNSET HILLS ROAD
SUITE 340
RESTON, VA 20190

OC000000063509089

Date Mailed: 09/04/2013

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/14/2013.

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

/gkejela/

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

Utility Patent Application Transmittal

Docket Number
08610010PA

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

First Named Inventor

Name	Theodore S. Rappaport		
Mailing Address			
City		State	
Country		Postal Code	
City of Residence		State of Residence	
Country of Residence		Citizenship	

Title of Invention

STEERABLE ANTENNA DEVICE

Assignee Information*

Name			
Company			
Address			
City		State	
Country		Postal Code	

*Complete this section if applicant wants the patent application publication to include assignee information. Providing this information does not substitute for compliance with any requirement of Part 3 of 37 CFR to have an assignment recorded by the Patent Office.

Application Elements

See MPEP chapter 600 concerning utility patent application contents.

1. [X] **USPTO Filing Fee** (as calculated *infra*)
2. [X] **Applicant claims small entity status**
   See 37 CFR 1.27
3. [X] **Specification**
   Total number of pages 25
   Both the claims and abstract must start on a new page
   (For information on the preferred arrangement, see MPEP 608.01(a))
4. [X] **Drawing(s)** *(35 U.S.C. 113)*
   Total number of sheets 5
5. [X] **Oath or Declaration**
   a. [X] Newly executed (original or copy), or [ ] Unexecuted
   b. [ ] A copy from a prior application (37 CFR 1.63(d))
   (for Continuation or Divisional Application)
   i. [ ] DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) named in the prior application (see 37 CFR 1.63(d) and 1.33(b).)
6. [X] **Application Data Sheet** (37 CFR 1.76)
7. [ ] **CD-ROM or CD-R** in duplicate, large table or Computer Program *(Appendix)*
   [ ] Landscape Table on CD
8. [ ] **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

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Utility Patent Application Transmittal

Docket Number
08610010PA

Accompanying Application Parts

9. ☐ **Assignment**
   a. ☐ Recordation Form Cover Sheet
10. ☐ **37 CFR 3.73(b) Statement** *(when there is an assignee)*
11. ☐ Power of Attorney ☐ No Power of Attorney
12. ☐ **English Translation Document** *(if applicable)*
13. ☒ **Information Disclosure Statement**
    a. ☐ 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 USC 122(b)(2)(B)(i)
18. ☐ **Certificate of Mailing**
    a. ☐ First Class Mail, or
    b. ☐ Express Mail
    Label Number _____
19. ☐ **Other:**

20. If a **CONTINUING APPLICATION**, *check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:*

☐ Continuation ☐ Divisional ☒ Continuation-in-part (CIP) of prior application No. 13/713,804 (XX/YYY,YYY)

Prior application information: *Examiner* Tho Gia Phan *Art Unit:* 2821

Request Not To Publish*

21. ☐ Applicant hereby requests that the attached application not be published under 35 U.S.C. 122(b).

Applicant hereby certifies 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.

***Warning**

This request must be signed in compliance with 37 CFR 1.33(b) and submitted with the application upon filing.

Applicant may rescind this nonpublication request at any time. If applicant rescinds a request that an application not be published under 35 U.S.C. 122(b), the application will be scheduled for publication at eighteen months from the earliest claimed filing date for which a benefit is claimed.

If applicant subsequently files an application directed to the invention disclosed in the attached application in another country, or under a multilateral international agreement, that requires publication of applications eighteen months after filing, the applicant must notify the United States Patent and Trademark Office of such filing within forty-five (45) days after the date of the filing of such foreign or international application. Failure to do so will result in abandonment of this application (35 U.S.C. 122(b)(2)(B)(iii)).

Request To Publish Early

22. ☐ Applicant hereby requests the publication of this patent application earlier than as set forth in 37 CFR 1.211(a) pursuant to 37 CFR 1.219 as provided in 37 CFR 1.215(c).

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Utility Patent Application Transmittal

Docket Number
08610010PA

Fee Calculation

Utility Patent Application Fee

Claims as Filed

For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	11	- 20 =		x 40 =	
Total Indep. Claims	3	- 3 =		x 210 =	
Multiple Dependent Claims (check if applicable) ☐					
☒ E-Filing (small entity must be selected to get Filing Fee discount)				Basic Filing Fee	$70
Number of Specification Pages	25	Number of Drawing Sheets	5		
Total Pages	30			Application Size Fee	$ 0

Pre-Grant Publication Fee

Early publication fee as set forth in 37 CFR 1.18(d) ☐	
Processing fee for publication or republication as set forth in 37 CFR 1.17(i) ☐	

Assignment Recordal Fee

Enter Number of Properties Affected by Recordal x =	

Examination Fee

Examination Fee	$360

Search Fee

Search Fee	$300
TOTAL	$730

Method of Payment

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

Deposit Account Number 50-2041

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

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Amount Grand Total $730

Samsung Ex. 1002, Page 626 of 679

Utility Patent Application Transmittal

Docket Number
08610010PA

Correspondence Address

Customer Number	30743		
-OR-			
Name			
Address			
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Country		Postal Code	
Phone Number			
E-mail Address			

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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: **Michael E. Whitham**

Name	Michael E. Whitham			Registration Number	32,635
Signatory Capacity	Attorney for Applicant(s)	E-mail Address	action@wcc-ip.com		
eSign	/Michael E. Whitham/			Date Signed	08/14/2013

STEERABLE ANTENNA DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part (CIP) of U.S. Patent Application No. 13/713,804, filed December 13, 2012, which is a continuation of U.S. Patent Application No. 12/541,764, filed August 14, 2009, now issued Patent No. 8,350,763, which further claims priority to U.S. Provisional Application Serial No. 61/088,829, filed August 14, 2008. The complete contents of all three references are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to wireless portable devices and particularly to improvements in transmitting and receiving electromagnetic signals at multiple frequency bands.

Background of the Invention

Today's wireless devices, such as laptops and computers that connect wirelessly to the cellphone network or internet must use antennas to transmit and receive wireless energy to and from the device. Today's cellphones and laptops typically require multiple antennas, each antenna designed for resonance or desired performance at a particular frequency band (such as cellular band, say in the 850 – 950 MHz band, the Bluetooth/WiFi band, say in the 2400 – 2490 MHz band, and so on). Computer makers and cellphone makers have difficulty with the mechanical design of their equipment, and spend a great deal of engineering time, research, and cost in manufacture for the bill of materials for the feedlines and connections between transmitter circuits, transceiver circuits, or receiver circuits and the antennas that are mounted to or housed in the wireless device casing. In some cases, antennas must be oriented in the flip up top of a

Samsung Ex. 1002, Page 628 of 679

laptop or placed behind or in the display screen, and tiny coaxial cables run through the case hinges to the motherboard mounted below the keyboard. Similar problems exist with cellphones, and all devices generally must meet or exceed certain federal or wireless carrier-imposed requirements for radiation efficiency for a wide range of device orientations. It is envisioned that as wireless proliferates, cellphones and laptops will require more and more separate radio frequency bands in order to offer connectivity and competitive services. It is not inconceivable to eventually have wireless portable devices requiring 10 or more separate frequency bands, where the term "band" here means a particular wireless standard or service that is distinct from another. For example, standards such as IEEE 802.11a, 802.11b, 802.11g, 802.15a, 802.15.3.c, Cellular telephone (European, Asian, or US spectrum), Bluetooth, WiMax, and PCS all represent different bands, as they generally have different RF frequency band allocations assigned to them. In the future, RFID tags, vehicles, wireless post it notes, equipment, shipping containers, and even clothing may also suffer the issue of having to provide multiple antennas for different RF bands.

Today, there are many passive antennas solutions that have been published in the literature, such as, for example, the broadband planar antenna developed by Professor Chen at The University of Texas. Using Fractal programming (genetic algorithms), it is possible to do computer simulations that eventually create an antenna design that offers resonance for several different frequency bands. Such antennas generally are developed by using field solver programs, where the field solver is set to optimize an antenna structure for a particular antenna performance over a specified range of frequencies (for example, the field solver may be set to find an antenna structure that has a low return loss, S11, of less than -13dB over the range of frequencies of 2.4 – 2.9 GHz and 5.1 – 5.8 GHz, in order to accommodate Bluetooth and WiFi 802.11a, 802.11b, and 802.11g). However, planar antennas, when designed by an optimization program or set of algorithms, without the use of active antenna tuning, may result in a larger antenna than what is feasible for a small package (e.g. a small handset or mobile device).

Recently, there have been some technical advances in active antenna tuning, some of which have been pioneered by Paratek Microwave in Nashua, NH. Using active lumped elements, such as tunable capacitors, it is possible to allow for the active tuning

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of an antenna within a cellphone handset. Using electrically tunable capacitors, Paratek has pioneered a way to allow for active tuning of one or more cellphone antennas, as discussed in US patent 7,369,828.

In US patent 7,369,828 by Shamsaifar (owned by Paratek Microwave), the device can tune two different cellphone antennas for use on one of several bands of interest, where each distinct and separate antenna (one for high band and one for low band) has an active element that may be tuned. As described in U.S. Patent 7,369,829, a cellphone antenna is designed specifically for cellphone bands, since today's cellphones generally provide a small Bluetooth antenna, separate and apart from the cellular antenna. In U.S. Patent 7,369,829, there is described a method of transmitting and receiving RF signals from multiple frequency bands utilizing an electronically tunable multiple band antenna, comprising the steps of: providing a high band antenna with at least one voltage tunable varactor associated therewith, the high band antenna providing a first input to a controller; providing a low band antenna with at least one voltage tunable varactor associated therewith, the low band antenna providing a second input to the controller; and inputting control data to the controller and controlling a first bias voltage for biasing the at least one voltage tunable varactor associated with the high band antenna and a second bias voltage for biasing the at least one voltage tunable varactor associated with the low band antenna. By using a controller, the invention enables an antenna to be tuned.

The controller of the method in U.S. Patent 7,369,828 can use a DC voltage supply to provide the DC voltage needed to bias the voltage tunable varactors. The high band antenna of the method taught in U.S. Patent 7,369,828 can further comprise: a substrate; a patch element on the substrate; at least one voltage tunable varactor associated with the patch element; a DC bias point on the patch element; an RF input on the patch element; a temperature sensor; and a ground plane on one side of the substrate.

The low band antenna of the method taught in U.S. Patent 7,369,828 can further comprise: a substrate; a patch element on the substrate; at least one voltage tunable varactor associated with the patch element; a DC bias point on the patch element; an RF input on the patch element; a temperature sensor; and a ground plane on one side of the substrate.

In a more specific embodiment of a preferred method of U.S. Patent 7,369,829, the multiple band antenna is a quad band antenna and covers the following frequency bands and standards which only involve cellular telephone (cellular and PCS): 824-894 MHz; 880-960 MHz; 1710-1880 MHz; 1850-1990 Hz; GSM850; EGSM; GSM1800; and PCS 1900.

Paratek uses BST as a tunable dielectric material that may be used in a tunable dielectric capacitor. ***Paratek Microwave,*** Inc. has developed and continues to develop tunable dielectric materials that may be utilized in embodiments of the antenna tuners and tunable filters, and the tuners are not necessary limited to using BST material. This family of tunable dielectric materials may be referred to as Parascan by the company.

The term "Parascan" as used herein is a trademarked term indicating a tunable dielectric material developed by Paratek Microwave, the assignee of US patents 7,397,329 and 7,369,828, and the idea of tunable dielectric materials have been described in several patents. Barium strontium titanate (BaTiO3-SrTiO3), also referred to as BSTO, is used for its high dielectric constant (200-6,000) and large change in dielectric constant with applied voltage (25-75 percent with a field of 2 Volts/micron).

Tunable dielectric materials including barium strontium titanate are disclosed in U.S. Pat. No. 5,312,790 to Sengupta, et al. entitled "Ceramic Ferroelectric Material"; U.S. Pat. No. 5,427,988 by Sengupta, et al. entitled "Ceramic Ferroelectric Composite Material-BSTO-MgO"; U.S. Pat. No. 5,486,491 to Sengupta, et al. entitled "Ceramic Ferroelectric Composite Material-BSTO-ZrO2"; U.S. Pat. No. 5,635,434 by Sengupta, et al. entitled "Ceramic Ferroelectric Composite Material-BSTO-Magnesium Based Compound"; U.S. Pat. No. 5,830,591 by Sengupta, et al. entitled "Multilayered Ferroelectric Composite Waveguides"; U.S. Pat. No. 5,846,893 by Sengupta, et al. entitled "Thin Film Ferroelectric Composites and Method of Making"; U.S. Pat. No. 5,766,697 by Sengupta, et al. entitled "Method of Making Thin Film Composites"; U.S. Pat. No. 5,693,429 by Sengupta, et al. entitled "Electronically Graded Multilayer Ferroelectric Composites"; U.S. Pat. No. 5,635,433 by Sengupta entitled "Ceramic Ferroelectric Composite Material BSTO-ZnO"; U.S. Pat. No. 6,074,971 by Chiu et al. entitled "Ceramic Ferroelectric Composite Materials with Enhanced Electronic Properties BSTO Mg Based Compound-Rare Earth Oxide". These patents are incorporated herein

by reference. The materials described in these patents, especially BSTO-MgO composites, show low dielectric loss and high tunability. Tunability is defined as the fractional change in the dielectric constant with applied voltage.

Using the idea of tunable capacitance, and following on the above listed prior art, Paratek Microwave has developed a technology called Adaptive Impedance Matching Models (AIMM) which it currently demonstrates on its website at worldwide web site paratek.com as able to adaptively tune antennas.

Agile Materials, a company founded in 1999 as a spinoff of University of California, Santa Barbara, has also developed tunable wireless components for multi-band systems. Agile has successfully commercialized its proprietary method to harness the unique properties of a thin-film ferroelectric capacitors, which may be tuned over at least an octave of frequency range. Agile employees produced patent 7,202,747, "Self Tuning Variable Impedence Circuit for Impedence Matching of Power amplifiers,", as well a 7,012,483, "Tunable Bridge Circuit", both of which use a BST tunable capacitive material to affect a resonance change in a tuneable circuit.. All of the aforementioned is known from the public prior art of record.

SUMMARY

The current invention uses one or more antennas, at least one of which can be used by multiple transmitters or receivers in different bands, thereby greatly simplifying the antenna structures in a portable wireless device, and greatly reducing the mechanical design complexity, the cost of bill of materials, and the variance in manufacturing of different devices of a particular model.

The current invention exploits the idea of active antenna tuning, but expands it greatly in a non-obvious way by applying the concepts to the situation of where multiple band transmitters, receivers, or transceivers must be used simultaneously in a wireless portable device. In cellphones today, since telephone call need only be made on one band at a time (either on High Band Cellular or Low Band Cellular, or 3G band, but not more than one at a time), US Patent 7,369,829 and other prior art have not contemplated the present invention, which allows a single antenna to be used for simultaneous

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transmission (or reception) for multiple bands. The present invention greatly simplifies the mechanical design and layout of wireless portable devices by allowing multiple transmitter (or receiver) bands to simultaneously use one or more antennas for simultaneous multi-purpose use.

This invention allows an antenna, such as a patch or metal fixture or other type of conductive or non/semi-conductive element or elements mounted on or within a mobile or portable device, to be simultaneously fed and used by multiple transmitters, receivers, or transceivers on different bands. It is understood that the terms portable and mobile may be used interchangeably. The invention has application with all wireless devices whether mobile, portable or fixed. This invention exploits active tuning and matching for each of the feedlines to antennas, or may use a single antenna feedline to match a single or multiple antenna from multiple devices, using tunable technologies developed by Paratek Microwave, Agile, or others, as well as techniques described below, or by using signal processing in the RF or IF domains, as well. The invention also allows a steerable antenna within a wireless device to avoid radiating towards a person or object.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows today's typical cellphone or laptop design, where different transceivers are connected to different antennas.

Figure 2 shows an embodiment of the present invention, where multiple transmitters are fed to a single antenna (it is understood that transmitters could also be transceivers, or receivers).

Figure 3 shows a more detailed embodiment of the present invention, where multiple transmitters may be fed to a single antenna using multiple feedlines and active antenna tuners, controlled by a controller, operates on the RF of each signal. (it is understood that transmitters could also be transceivers, or receivers).

Figure 4 shows another embodiment of the present invention, where multiple transmitters may be fed to a single antenna using a single feedline and a single active antenna tuner which is controlled by a controller.

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Figure 5 shows yet another alternate embodiment of the present invention, where a multiband tuner provides matching from a single multiband transmitter (or transceiver or receiver) feedline (e.g. a single RF source) to a single multi-use multi-band antenna

Figures 6A, B, and C illustrate some of the possible examples and configurations of tuning elements and circuits used within a tuner, with active elements, or in a multiband transceiver.

Figure 7 shows a portable device with multiple antenna elements, where an antenna element is not activated when covered by a person's finger.

Figure 8 shows a portable device with a steerable antenna, where the beams formed by the steerable antenna avoid radiating toward the user of the device.

DETAILED DESCRIPTION

Shown in Figure 1 is an example of how cellphones or laptops or other wireless devices 10 are designed today. In general, different band transceivers (e.g., GSM cellular transceiver 12, Bluetooth transceiver 14, and ultrawideband transceiver 16) are connected to different antennas (e.g., cellular antenna 20, Bluetooth antenna 22, and UWB antenna 24) that must be affixed to, located within the packaging of the device, or included in the printed circuit boards of the device, thereby taking up space, feedline resources (e.g., feedlines 26), increasing the bill of materials, and adding complexity.

Figure 2 illustrates the basic idea of the present invention which can be implemented in fixed or mobile wireless devices 10 such as computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, personal data assistants and navigation assistants. For the purposes of this disclosure, the term "mobile wireless device" may be used interchangeably with "portable wireless device" and "wireless portable device". One potential application of the invention is in the IEEE 802.11ad standard, where very high throughput wireless devices (e.g., 60 GHz carrier transmissions) may use one or more transmitters, receivers or transceivers to simultaneously provide capabilities in the existing 802.11a and 802.11b bands of 2.4 GHz and 5.8 GHz, as well as the 60 GHz spectrum. Instead of requiring different antennas for the different RF bands, the present invention allows for the use of a

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single antenna 28 for multiple bands (or multiple antennas, at least one of which can be used for multiple bands, and at least one of which may be a steerable antenna, where a steerable antenna may steer or direct its energy in particular directions while providing nulls or dead zones in other directions, and may be used on one or more bands).. By providing the ability to use just a single antenna 28, the problem of mounting, locating, and feeding the antenna can be greatly reduced, so long as a desired antenna efficiency can be maintained for all bands of interest.

Figure 3 shows how the antenna efficiency can be maintained. By using individual RF tuners 30, 32, and 34, that may be based on Paratek's or Agile's technology, or any other active tuning method, such as Microelectrical Mechanical Systems (MEMS), or variable mechanical resonator technologies, or other active or passive methods known now or in the future, it becomes possible to provide a good impedance match for each of the transceivers 36, 38 and 40 shown in Figure 3. The key to proper operation is to also, while providing good matching, provide sufficient RF isolation so that the transmitters in other bands do not overload the front end receiver of a band that is receiving. Fortunately, RF filtering and overload protection is improving in commercially available wireless transceivers in various popular bands, so that overload protection may be offered within the wireless transceiver chip itself through the integrated circuitry. Where more isolation is required, the tuner for a particular band is adjusted to offer very high impedance S22 characteristics at the other bands that differ from the dedicated band of the tuner, so that there is little, if any energy returned to the desired transceiver (or transmitter, or receiver) of the particular band of the tuner. In addition, low cost LC circuits may be etched into and/or added on the circuit board during manufacture or otherwise made a part of the tuner circuitry in order to create an RF Trap for the other bands, at much less cost and reduced engineering than having to use separate antennas for each band.

Furthermore, it is possible to use band transceivers that offer different antenna ports for the transmitter and the receiver within a particular band, whereby the present invention is simply extended to where there are two antennas used – one that is used solely for transmission by the multiple bands, and another multiband shared antenna for the receiver that is located a sufficient distance away within the casing, or which uses

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polarization diversity, or uses shielding or distributed antenna ideas within the case in order to reduce the RF overload from the transmitting antenna. The receiving antenna, for instance, might be mounted on the other side of the printed circuit board for the cellphone, or laptop, or RFID tag, or wireless post-it, or might be pitched at right angles in the casing, etc. It is also possible to use buffer amplifiers, tuned amplifiers, as well as tuned trap circuits for particular offending bands, that can act as filters to prevent RF from other multi-user band transmitters from leaking into the receiver portion of a particular band. Also, RF antenna switches, may be made inexpensively in an integrated circuit process in CMOS, GaAs, or other well known semiconductor technologies known now or the future. These capabilities which may be incorporated in the tuner as described below. It should be clear in this disclosure that the term "antenna" is not meant to be limiting to any particular structure, but rather is meant to represent all of the possible ways that a wireless portable device may allow for radiation and reception of electromagnetic energy from particular frequency bands of interest.

Figure 3 also shows a tuner controller 42, preferably digital in nature and which may be part of a computer or microprocessor circuit that also controls one or more of the transceivers (or transmitters or receivers) shown in the figure. The controller 42 provides the proper voltages, or more preferably, the digital control values that are used by the tuner in order to adjust the active elements of the tuner (e.g. the tunable capacitors, inductors, amplifiers, and to toggle switches). The digital decoding circuitry in the tuner is not shown here, but is known to be implemented in a number of ways using standard serial or parallel digital busses that interconnect integrated circuits within cellphones and laptops. Furthermore, the controller receives feedback from the tuner, or from other circuitry (not shown) with respect to VSWR, power, and proper functionality so that the controller may properly adjust, alter, initiate, and end its use of control signals (either voltages or data values sent over a serial data line or a bus) to the tuner. In the case of the tuner receiving digital signals from the controller, it is understood that the tuner would have its own processing that would allow for the digital interpretation of control signals such as to properly determine the necessary analog voltages or other signal adjustments needed to perform impedance tuning through adjustment of the active tunable elements of the tuner, so that it would be possible to sequentially or simultaneously tune one or more

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of the tuners so that multiple bands may simultaneously transmit (or receive, or both) using the single antenna structure shown in the figure. The controller may be part of the overall portable device computing logic or controlling circuitry, or may be integrated within one or more of a particular band or multiband transceiver, transmitter, or receiver. The controller may be distributed within the portable device, and may even be responsive to over the air signaling that is received by one or more of the transceivers. The controller would have awareness of when particular bands were to be transmitting, receiving, or in the idle/off mode, so that it could properly control the active elements, and even provide power on/off/sleep instructions to the circuitry within the tuner. Note that nothing here is meant to be limiting in how the controller might be used, as it is conceivable that it could be included in the circuitry of the tuner, or the tuner and controller ideas contemplated here all could be integrated within a single multiband transceiver chip, such as is shown in Figure 4.

Figure 4 shows an alternate embodiment, where the progress in IC design for wireless multiband, multi-mode circuits is contemplated. Indeed, today it is possible to purchase multi-band transceiver chips for popular wireless standards where different antenna ports are provided for various RF output bands. Figure 4 illustrates the use of a combined multiband transceiver 44 which may include, for example, GSM, Bluetooth, UWB, WiMAX all on one chip—eventually software designed radio may be a part of the chip). The present idea, shown in Figure 4, using a single RF feedline to a single multiband active controller, would provide an advantage to the wireless industry through simplicity and reduced feedlines, reduced size and weight, and more flexibility in locating the antenna. The multiband tuner 46 would require greater complexity than as shown in Figure 3, as it would require the ability to simultaneously pass desired RF signals at proper low (generally 50 ohms to 600 ohms) impedance for each of the bands that are being used, while providing very high impedance to other bands. The tuner is adjusted by the controller in order to indicate when a particular transmitter on a particular band is in the transmit mode or in the receive mode, or, alternatively, the tuner could simply offer matching capabilities to a transmitter to the antenna without consideration for the receiver (for the case where the receiver would be connected to a different antenna). The circuitry of the tuner is described in more detail below, and can exploit

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buffer amplifiers or tuned RF amplifiers at various RF frequencies to provide isolation, as well as antenna switching, all contained within the tuner, making it possible to create a low cost, high performance antenna tuner chip for the present application. An optional RF switch allows separate transmitter path and receiver path tuning for each of the bands at use. This concept may be included within a single band tuner element for the present invention.

Figure 5 illustrates a more detailed example of the active and passive circuitry of the present invention. To provide a single feedline to a single antenna, the tuner 46 requires controller circuitry that provides instructions as to how the particular active devices may be adjusted. In this case, the term active indicates that RF tuning is possible, such as in the case of tunable capacitors or tunable inductors. Figure 5 shows an example, not in any way meant to be limiting to the type of impedance matching circuits 48 contemplated here, where the capacitors of each of three parallel band tuners are able to be tuned. Tuning methods for capacitors are well known, such as taught in the prior art patents by Paratek, and by researchers throughout the world. Similarly, it is possible to tune inductances, as well. Furthermore, shown in Figure 5, it is noted that RF amplifiers, that may be used to either offer matching impedance at the input (say 50 ohms) and particular desired impedance at the output feedline to the antenna, is shown. It should be clear that RF amplifiers, as shown in Figures 5 and 6, may either be strict buffer amplifiers with a very high output impedance, or alternatively, may be active devices that have a controlled impedance that is adjusted in tandem with the tuned circuit elements shown in the figures. Figure 5 represents an example of how multiband transmitted signals may be applied to a single multiband tuner. The input signals are split and routed to each of the respective tuner circuits, and may use a Wilkinson or simple ohmic splitter, which may implemented either on a printed circuit board substrate or within an integrated circuit. It is clear to one skilled in the art that tuner circuits and feedlines may be implemented in a myriad of ways depending on the particular physical structure of the circuitry. For example, coplanar waveguides or microstrip lines may be used in integrated circuits or circuit boards, and splitters, combiners, couplers, mixers, and switches may be fabricated to realize the invention using well understood techniques such as taught in D. Pozar's books Microwave Engineering, copyright 2004, and Microwave

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and RF Design of Wireless Systems, copyright 2000 which are hereby incorporated by reference, and as presented at various IEEE conferences on antennas, microwave theories, and circuits.

While techniques for building both active and passive circuits are taught at various conferences, the use of such technology for the present invention has not been heretofore contemplated. It is well understood that a wide range of active and passive components, either lumped or distributed, may be combined with various transmission line and active and passive signal coupling techniques to implement the invention.

Figures 6A, B, and C illustrate some of the possible configurations of tuner elements for use in a multiband transceiver. It should be understood that these are representative, and other combinations of lumped or distributed circuits are possible, where the proper choice would depend on the type and structure of single antenna to be used, the electrical specifications and impedance matching/antenna port/isolation capabilities of the transmitter, receiver, or transceiver chips being used in the portable device, as well as cost, bill of materials, and the type of mounting to be used for the tuner circuitry. That is, an integrated circuit tuner might be more likely to pick adjustable capacitors over adjustable inductors in some instances.

Note in Figures 6A, B, and C that there are optional RF switches, that may be implemented in integrated circuit form within the tuner circuitry, that can be controlled by the controller to position properly for either transmit or receive operation. The transmitter configuration would exploit the left side of each of the depicted tuners, with a path providing matching to the single antenna structure, where the right side of each depicted tuner would be used for matching provided on the receive path. The switch would be controlled by the controller, or by some other means, such as from a master controller of the wireless device, the transceiver chip, or some other logic that instructs the particular transmitter in the particular band to transmit. Alternatively, the switches could be controlled by RF sensing, whereby the presence of sufficient level of RF from the transmitter (transceiver) chip causes the switches at the top and the bottom of the depictions to throw properly.

The active (tuned) elements shown in Figures 6A, B, and C, suggest that one or more tuned elements may be used in a tuner as disclosed here. For example, one method

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would only use tunable capacitors, which are available from Paratek Microwave. Other embodiments would use both tunable capacitors and tunable inductors, and still others may use a combination of tunable and fixed elements in order to provide antenna tuning of a particular band to a single antenna while providing sufficient RF isolation/rejection of unwanted bands.

For simplicity, the controller signal in the circuitry shown in Figures 6A, B, and C is omitted, but it should be clear that such signaling capability exists. Other features have also been omitted, such as temperature sensors to determine proper electrical characteristics and calibration of the tuned elements, feedback circuitry (to sense proper VSWR, impedence, or acceptable power transfer, sufficient isolation), but these concepts are well understood by those skilled in the art.

It should also be clear that optimization algorithms that determine the values of multiband tuners so as to properly determine each of the active element positions could be performed by the controller as depicted in this invention disclosure. The optimization could use pre-set or memorized settings from recent or long term histories of proper tuning values, or could determine, on start up of the wireless device, appropriate values for the settings of each tuner elements. Such computation techniques, to determine a matrix of various values in a multidimensional problem, are well known and are varied. The use of memory to remember preset values for various use cases, and to store new or recent or past settings of tuner elements, in order to allow the invention to be used in a power efficient and reliable manner is contemplated here, although memory is not shown in the drawings. These techniques are well understood in the art.

In addition to the active tuned elements shown in Figures 6A, B, and C, it is possible to implement the invention using other frequency selective approaches, such as reasonably high-q passive circuits (with or without amplification), or using metamaterials or transmission line implementations which may be embedded within one or more semiconductor layers or substrates, or implemented in lumped element form, or through active and/or passive circuitry to provide the ability to provide either receiver or transmitter antenna tuning on multiple bands, as described above. Metamaterials are one way to create frequency selective surfaces and can provide good isolation, as described in the paper coauthored by L. Ragan, A. Hassibi, T. S. Rappaport, and C. L. Christianson,

entitled "Novel On-Chip Antenna Structures and Frequency Selective Surface (FSS) Approaches for Millimeter Wave Devices," IEEE 66th Vehicular Technology Conference (VTC), Baltimore, MD, Oct. 1 -3, 2007, pp. 2051-2055, and as described in US patent publication 20080238801 by Lawrence Ragan, both of which are fully incorporated here by reference. Such frequency selective structures and implementations, depending upon the particular implementation, may require amplifiers or may be of sufficiently low loss to obviate the need for amplifiers directly at the antenna tuner junction. The controller would cause various switches, devices, or series or parallel (or both) combinations of connections, or would otherwise support voltages or currents to be established in order to implement or select the desired tunability for these various possible implementations, it being understood that the controller could be designed to work in concert with various semiconductor properties, or with embedded, distributed or lumped circuitry within the RF stage or antenna interconnect stage, in order to affect the ability to use a single antenna on multiple bands.

As wireless devices begin to evolve to millimeter wave (mmWave) carrier frequencies above 10 GHz, say at 28 or 38 GHz, and even to frequencies in the 70 to 500 GHz range, and even to Terahertz frequencies, the need to integrate the tuning and interconnection of a single antenna to RF circuitry will become even greater. System on a chip (Soc) implementations of the invention described here will be highly desirable so that a single integrated circuit, with an embedded antenna on the integrated circuit (chip) or package or on the case or circuit board of a consumer device (such as a PC, cellphone, television, vehicle, etc.) may be used for several different frequency bands, or for different portions of a massively wideband spectrum allocation. For example, 60 GHz devices may well work from 58 to 65 GHz, and it will be desirable to implement the current invention across different portions of that band (e.g. the same antenna may need to be tuned for the 58 - 60 GHz portion of the band for one particular application or instance, and the 62-64 GHz portion of the band for a different application or instance, or may also be used to tune to the 77 GHz band or 5.1 - 5.8 GHz band for operations, as well.). Ultrawideband repeaters, such as described in US patent application 10/919,515, now issued Patent No. 7,676,194 to Rappaport, which is fully incorporated here by reference, could make use of this. It is understood that the controller may selectively

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switch, exit, or cause voltages or currents or switches to be activated in any particular implementation, and that the single antenna may itself be designed to have certain desirable properties or preferential frequency responses at certain different bands, but which are further improved and made to more efficiently transfer power (e.g. reduce the Voltage Standing Wave Ratio, increase efficiency, tune for improved SNR, decrease power or current drain, or improve some other power transfer metric, all of which are examples of matching the antenna to the other circuitry including without limitation the transmitters, receivers, and transceivers) between the antenna and the transmitter and/or receiver through the disclosed invention.

Using the concepts of adaptive or steerable antennas of multiple elements, wireless communication systems and devices in the millimeter wave (mmWave) bands (for example, above 10 GHz in frequency, where directional antennas may be fabricated using antenna elements much smaller than used in today's 2 GHz cellphones) will be able to exploit the steerable properties of such antennas for improved performance and safety of the user.

In future mmWave communication systems, portable devices and/or fixed infrastructure, such as base stations, and/or "access points" or repeaters, or other infrastructure devices will use directional, steerable antennas for advantage. It is useful to steer radiation energy of a portable or fixed device away from a person's head, or body, or building or obstruction of some kind. This is desirable for at least two reasons. First, portable wireless devices should radiate away from a body of a person (or structure) because a body may often attenuate or interfere with an intended radiation signal of such a device. – It is often advantageous to radiate energy away from a person or structure such that that a path between the portable device and access point is clear of local obstructions. The second desirable reason is that it is generally desirable to radiate energy away from a person's head for safety or health considerations (for example, see: http://hps.org/hpspublications/articles/rfradiation.html regarding present day portable radio systems). By having a steerable antenna avoid radiating into a person or structure, safety precautions may be taken while enabling a more predictable signal strength.

In this invention, a smartphone or cellphone/computing device (herein called a "portable wireless device" or "wireless portable device", both terms being

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interchangeable) uses one or more internal sensors to sense parameters indicative, for example, of how a person is holding the smartphone or cellphone/computing device, and adjusts the transmission beam pattern to ensure that the primary energy radiated by the portable wireless device is radiated away from the person using the portable wireless device.

Sensing of the parameters of the portable wireless device which may be used to ensure energy is radiated from the portable wireless device, e.g., away from the user, may be accomplished in many ways using one or parameter sensors 29, e.g. Figure 2, which are built in, added on, or are otherwise associated with the portable wireless device. The choice of sensor 29 and location can vary widely and may include, e.g., without limitation, cameras, heat sensors, gyroscopes, light detectors, capacitive detectors (including capacitive elements of a capacitive touch interface of a portable wireless device), microphones, and ultrasound sensors or transducers.

One method is to use a sensor such as a built in camera, used by a portable wireless device (e.g. smartphone or cellphone/computing device) to sense the presence of one or more persons. Having information as to the presence and relative location of a user or a user's body, and/or other surroundings, an antenna system of the portable wireless device can steer away from the detected user and/or other surroundings a primary beam or beams formed by the portable wireless device to avoid radiating the user.

Pattern recognition, facial recognition, or the use of the camera to sense hair, skin, body parts (such as eyes or ears, or heads, or arms), or clothing may be used to steer a beam or beams away from a user. The geometry of the portable wireless device, including the camera or cameras in the device, their locations and orientation on the device itself, and the physical orientation of the antenna may be used in determination of a direction to steer a beam or beams. Patterns for adaptive antennas may be controlled using a wide range of electrical switching, phasing, or selecting techniques known in the art and described elsewhere in this specification to enable pattern adjustments in two and three dimensions. Since a human being moves at a much slower rate than adaptive antennas can beamform or steer beams, antenna beam patterns may be adjusted in real time (at least as fast, and actually much faster, than as a person moves) to maintain a primary beam or beams radiating away from a user during continued use of the portable

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wireless device. Note that multiple cameras on the device may be used to determine approximate distances of a user from the device (as can other methods and systems described below), which may be used to then determine fields of view or zones or spans of directions where energy should not be radiated by a steerable beam of the device.

By using simple geometry calculations, accounting for the camera's field of view (used to sense the human user and/or the user's body parts or clothing, etc.) and the orientation of the antenna elements in a portable wireless device, a zone or span of directions can be computed by the device (using a "beamformer" or "beamsteering" or "beam selection" approach, which may be implemented in software within the device, e.g. a computation module, or on a specialized processor or generalized processor such as processor 27 in Figure 2, along with antenna and RF front end hardware to actuate the desired radiation pattern from antennas in the device, where computer algorithms are used to select proper hardware settings for desired beam patterns) to know where not to transmit energy, and the beamforming algorithms (which may include beam or antenna element selection, adaptive beamforming, beam selection ,multibeam combining, mimo, phasing, etc.) may be adjusted to ensure that a primary energy is radiated away from the zone or span of directions.

In addition to camera sensors, other parameter sensors such as gyroscopes, light detectors, heat detectors, or capacitance detectors may be used to sense how or where a person is holding a device, moving a device, and may give indications as to where the device is oriented, so that the beamforming or beamsteering algorithms or approaches may, for example, radiate energy away from a human user. A gyroscope may be used, for example, to determine when the phone is being moved and signal the device to begin computing new orientations that would be applied to the beamformer, so that new zones of avoidance may be computed, such that an antenna beam or beams may be pointing away from the user as the device is moved.

Light detectors may be used to determine intensity of light to which a wireless portable device is exposed. When a wireless portable device is pressed up to a person's head, for example, the device may sense the difference between the head, and the hand, which may not completely cover the device. This difference, through preset or learned calibration routines, allows the wireless portable device to determine an orientation of

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the device relative the user's body, and resulting computation by the device involving estimation of the user's location may be fed to or used by the beamformer to allow the beamforming operation to compute, and recompute (as the device is moved, or in a periodic or non periodic fashion during transmission) primary beam directions that would avoid zones where the user is estimated to be.

One or more heat detectors may be used to determine how a human is holding a wireless portable device, how hands are positioned on the device, by sensing around a case of the device. Such heat detectors may be used explicitly for detecting thermal radiation to which an exterior of the portable wireless device is exposed, and not for detection of thermal conditions inside the device, such as monitoring of circuitry temperature and overheating prevention. Heat detectors may also determine approximate distance of a human user's body from a device, by sensing a difference between ambient temperature and temperatures on different sides of the device. Using this approach, the device may determine, either alone or with other sensor inputs (e.g. sensor fusion, such as with cameras, or other sensors) where the user is located relative the device, and in particular the device's antennas. Information from one or more heat sensors and one or more other sensor inputs may be used computationally to determine special orientations of the user, and then the beamforming operation can use the computational outputs to allow the antenna beam or beams to be directed such as to radiate away from the user.

Similarly, one or more capacitive devices may be used to sense touch and/or proximity of a user's skin to a portable wireless device, and either alone or with sensor fusion, the portable wireless device can determine how to orient the one or more beams of the device to avoid radiating in the direction of the user.

Sensors may also include audio sensors or microphones, ultrasound transducers, or ultrasound range finders or sensors, working alone or in concert with other sensors (i.e. sensor fusion), or with multiple types of the same sensor, to provide stereoscopic or differential measurements to determine distance ranges between a portable wireless device to parts of a human body, or the presence of fingers or hands on the case or display of the portable wireless device to determine if certain antennas should even be used (e.g to avoid radiating when a finger or palm or head is directly over one or more antennas).

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Note that beamforming operations may also be used to simultaneously find the best or sufficient beam pointing directions to ensure a link between the transmitter and receiver, while still avoiding radiation of energy toward a human user. It should be noted that for receiving signals, the same beam arrays used for transmitting might be used to point in a different direction (for example, on receive, the beam array may wish to point at a human user to pick up reflections off of the human body). In future mmWave wireless systems, time division duplexing may be likely, since the transmitter-receiver distances will likely shrink to a few hundred meters, allowing antenna arrays to be used partially for transmit and partially for receive, in a time division duplexed fashion, thereby allowing a device to provide different beam patterns on transmit than on receive. It is understood that as future mmWave wireless standard evolve, the beamforming computations need to be made within a time frame between successive time division transmissions. Thus a portable wireless device would need to be able to use sensory information to determine spatial zones of avoidance of the beamforming process, so that the computations and recomputations (as the device is moved) in a periodic or non periodic fashion between transmission slots (as indicated by the wireless standards created for mmWave wireless systems), or at least at a rate much less than the movement of humans, so as to ensure that the primary beam directions would avoid the zones where the human would be estimated to be by the wireless portable device.

Figure 7 shows an example of how sensors 70 may be used with a wireless portable device (e.g. phone or tablet 71) to determine the proximity of, for example, a hand and fingers 73 of a person 74 as the device is being held. Multiple embedded antenna elements 75 are usable to provide a steerable antenna beam. Sensors 70 detect one or more parameters which cause detection of the user's fingers 73 gripping a top left portion of the tablet 71. For example, a heat sensor 70B in an edge of the tablet or capacitive elements integral with display 77 detect the heat from and contact of fingers 73 with the tablet 71. Accordingly, antenna element 75B (shown in dashed lines as being under the user's fingers) which is covered by a human finger is not activated and accordingly does not radiate outward from the face of the tablet. The configuration shown in Figure 7 is simply an example. It should be understood that the number and configuration of sensors 70 and antenna elements 75 may vary from one device to

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another, and sensors and antenna elements may be combined with one another, as with sensor antenna/combination 75C, and/or with other circuitry or hardware elements of a portable wireless device 71.

Figure 8 shows a person 74 holding a wireless portable device (e.g. a tablet 71). Sensors 70, which may be integral with, affixed to, or otherwise configured with tablet 71, collect data concerning the tablet's environment and state. The proximity, distance, and direction of a surrounding, such as person 74 and parts of his or her body, in three dimensional space relative the device can be estimated or determined, and the radiated antenna patterns/beams 80 of the device are steered or otherwise directed away from person 74 or any other detected person or structure by modulation and control of the radiation pattern of antenna elements 75. Antenna element 75B (shown dashed as being under the user's hand) is detected as being covered by fingers 73 and is deactivated, preferably until no obstruction by a person or part of a person or structure is detected. As a result, the user's fingers 73, as well as the user's body (i.e. torso, head, etc), are not radiated by energy from the antenna elements.

The above systems and methods for steering the beams away from a user, parts of a user's body, or one or more objects, may be implemented in a single band, or multiple bands, and may be used with a wide variety of devices, with one or more sensors, multiple screens, and for use in wireless communication systems where antenna beams may be formed by multiple antenna elements, preferably at mmWave frequencies at or above 10 GHz. "Avoidance zones", to ensure primary radiation away from a human user, may be one or more directions, or zones or angles that are computed by a device.

It should be clear that other sensors, not yet developed, could also be used to allow a wireless portable device to avoid radiating a human user, and such sensors could be used to follow the movements of the user to ensure the device could implement beamforming or beamsteering that continue to avoid radiating energy in the direction of the user or parts of the user's body. Also, all of the systems and methods described above may also be applied to fixed wireless devices and infrastructure used in wireless systems, as well, where repeaters or access points or base stations and the like would be deployed in or around dwellings, malls, or locations where humans are or move near. Similarly, to allow for rapid deployment of fixed infrastructure, the above approaches may be used to

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allow fixed infrastructure to automatically steer beams in a manner to avoid buildings, structures, or objects that could otherwise interfere with a more desired or optimal beam pattern.

It should be evident that the invention contemplated here, while described as a single antenna, may itself be implemented with other antennas or antenna elements or sub elements to form an antenna array, including for use in a MiMO system or beam switchable array, and that the disclosed invention with single antenna which may have one or more elements or antennas and which may be implemented in a lumped or distributed or passive or active or hybrid manner, and may be used in conjunction with other antennas in various switching, phasing, or active or passive combining techniques to form a larger or distributed antenna structure that also works over multiple frequencies. The invention extends to components such as the tuner and/or controller for implementing the invention. For example, tuners or sets of tuners which are connectable or coupled to multiple transmitters, receivers, or transceivers for allowing the simultaneous transmission or reception at multiple frequency bands or the ability to use a single physical structure (e.g., an antenna) for transmission and reception of many different bands, or controllers or other circuitry for accomplishing the same form a part of this invention.

CLAIMS

I claim:

1. A method for avoiding radiation of a user or structure by a wireless device having a steerable antenna, comprising the steps of:

detecting, using one or more sensors, one or more parameters of said wireless device or pertaining to said user's physical relationship to said wireless device;

determining, using said one or more parameters, zones or spans of directions corresponding with one or more directions of said user or structure relative to said steerable antenna; and

adjusting one or more beams of said steerable antenna to radiate in one or more directions which are not in said zones or spans of directions.

2. The method of claim 1, wherein said one or more beams are adjusted as said one or more parameters change over time.

3. The method of claim 1, wherein said detecting step comprises one or more of:

capturing one or more images with at least one camera;

detecting ambient light or blockage thereof with at least one light sensor;

detecting motion of said wireless device with at least one gyroscope;

detecting one or more of audio or ultrasonic signals relating to one or more of the proximity of a user or orientation of user with one or more of a microphone, ultrasonic sensor, or ultrasonic transducer;

detecting heat from a human user with at least one heat sensor; and

detecting touch or proximity of a user's skin or clothing with at least one capacitive sensor.

4. A wireless device for avoiding radiation of a user or structure, comprising:

one or more sensors configured to detect at least one parameter of said wireless device or pertaining to a user's physical relationship to said wireless device;

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one or more processors communicatively coupled to said one or more sensors;

a steerable antenna communicatively coupled to said one or more processors; and

a non-transitory computer readable medium comprising executable instructions that when executed by said one or more processors cause said one or more processors to perform the steps of:

receiving signals from said one or more sensors pertaining to said at least one parameter;

using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said steerable antenna; and

adjusting one or more beams of said steerable antenna to radiate in one or more directions which are not in said zones or spans of directions.

5. The wireless device of claim 4, wherein said steerable antenna comprises a plurality of antennas, said plurality of antennas forming an antenna array.

6. The wireless device of claim 4, wherein said one or more sensors includes one or more cameras, heat sensors, gyroscopes, light or motion detectors, capacitive detectors, microphones, and ultrasound sensors or transducers.

7. The wireless device of claim 4, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

8. A steerable antenna system for avoiding radiation of a user or structure by a wireless device, comprising:

one or more sensors configured to detect at least one parameter of said wireless device or pertaining to a user's physical relationship to said wireless device;

a computation module communicatively coupled to said one or more sensors configured to determine zones or spans of directions; and

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a steerable antenna communicatively coupled to said computation module, said steerable antenna radiating one or more beams in one or more directions which are not in said zones or spans of directions,

wherein said zones or spans of directions correspond with one or more directions of said user or structure relative to said steerable antenna.

9. The steerable antenna system of claim 8, wherein said steerable antenna comprises a plurality of antennas, said plurality of antennas forming an antenna array.

10. The steerable antenna device of claim 8, wherein said one or more sensors includes one or more cameras, heat sensors, gyroscopes, light or motion detectors, capacitive detectors, microphones, and ultrasound transducers.

11. The steerable antenna device of claim 8, wherein said one or more parameters are selected from the group consisting of light, temperature, motion, orientation, video, capacitance, ultrasound, and sound.

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ABSTRACT OF THE DISCLOSURE

Wireless devices, and particularly mobile devices such as cellphones, PDAs, computers, navigation devices, etc., as well as other devices which transmit or receive data or other signals at multiple frequency bands utilize at least one antenna to transmit and receive and a plurality of different bands (e.g., GSM cellular communication band; Bluetooth short range communication band; ultrawideband (UWB) communications, etc.). These wireless devices can simultaneously transmit or receive at a plurality of different bands, or simultaneously transmit and receive at different bands. The wireless devices have the ability to use a single physical structure (e.g., an antenna) for transmission and reception of many different bands. The antenna can be either actively tuned or passively tuned using one or more elements. The antenna may comprise a plurality of antenna elements or antennas, and at least one antenna may be a steerable antenna.

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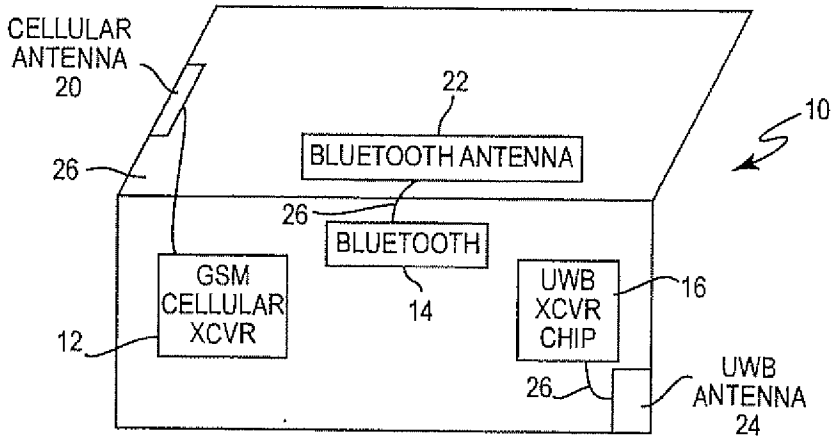

Figure 1

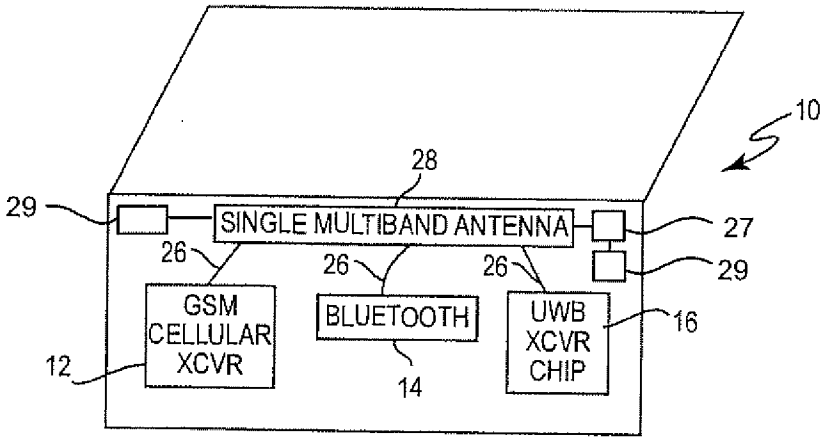

Figure 2

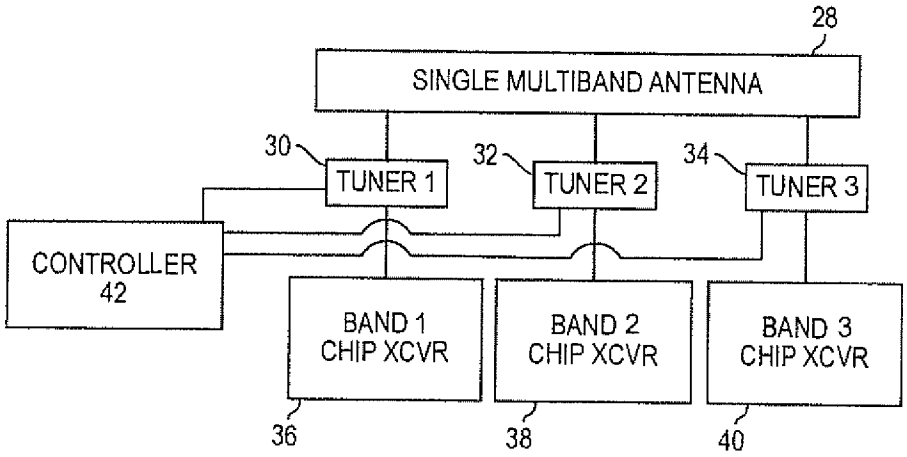

Figure 3

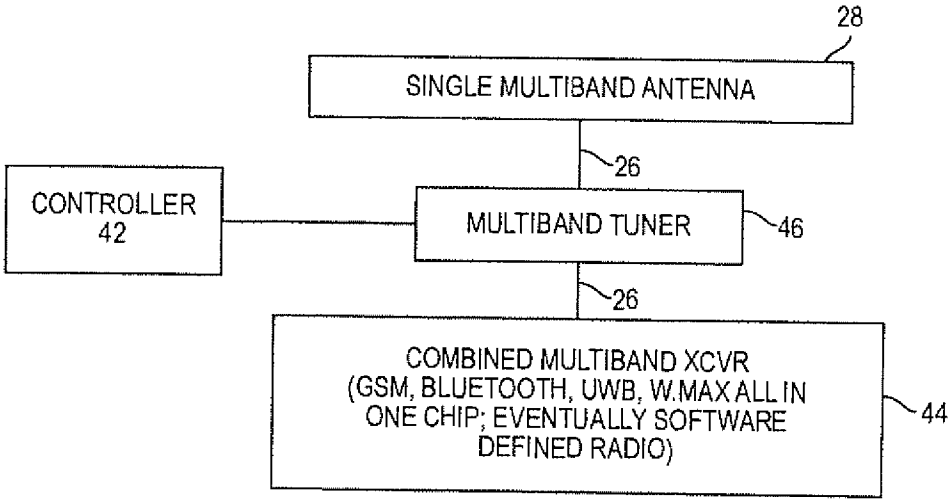

Figure 4

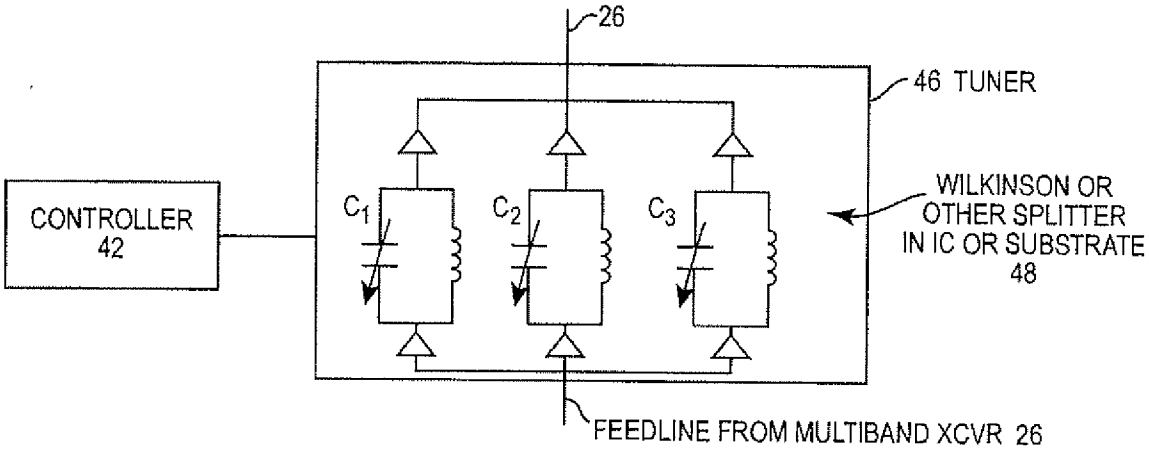

Figure 5

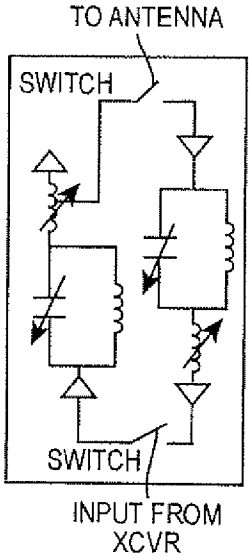

Figure 6A

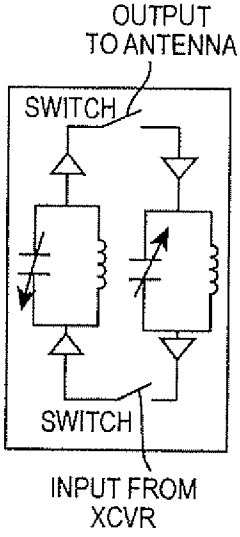

Figure 6B

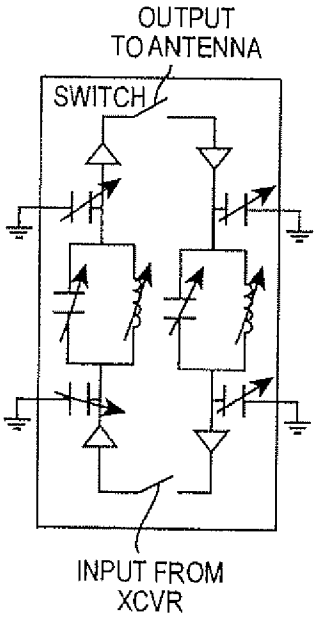

Figure 6C

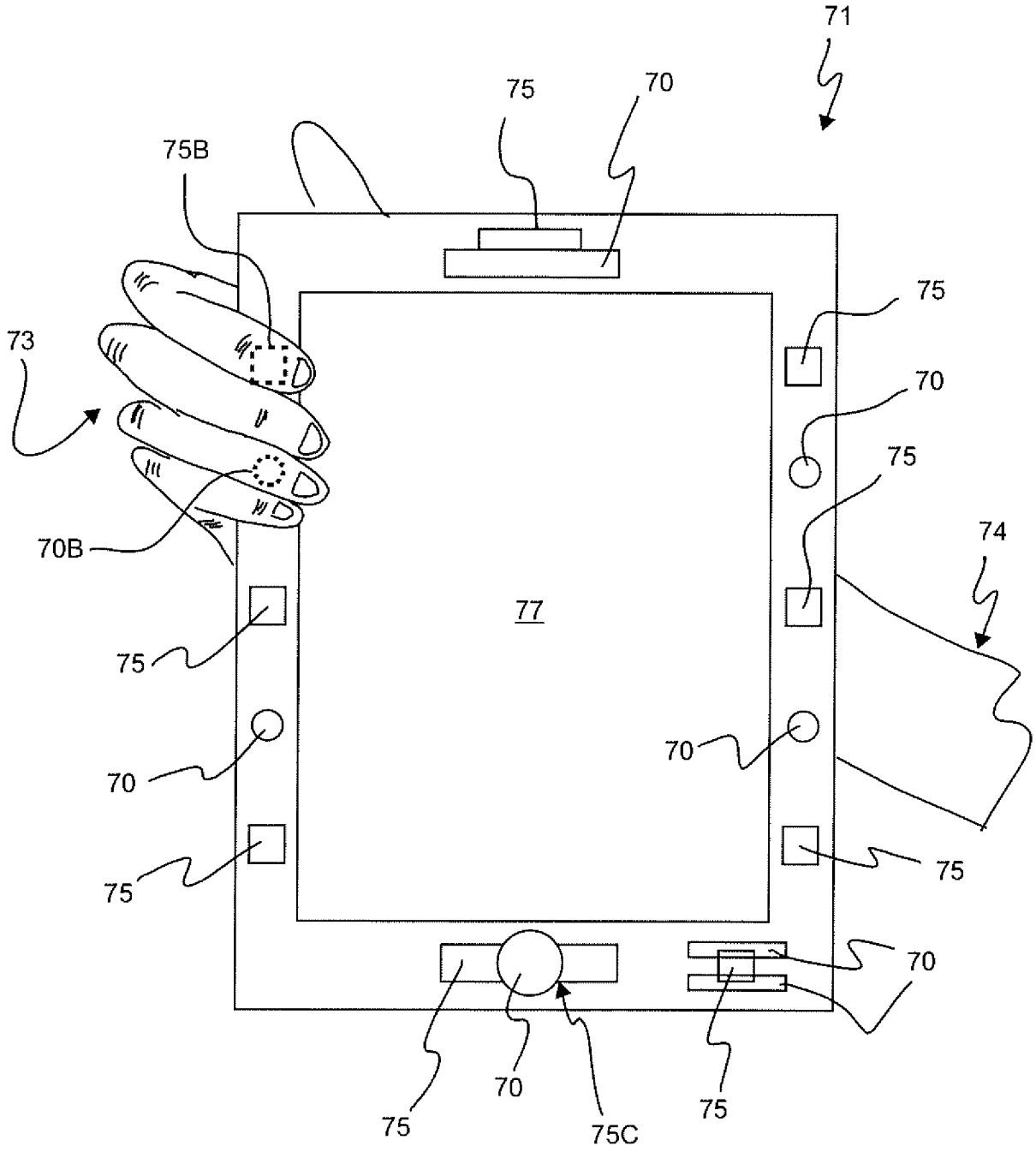

Figure 7

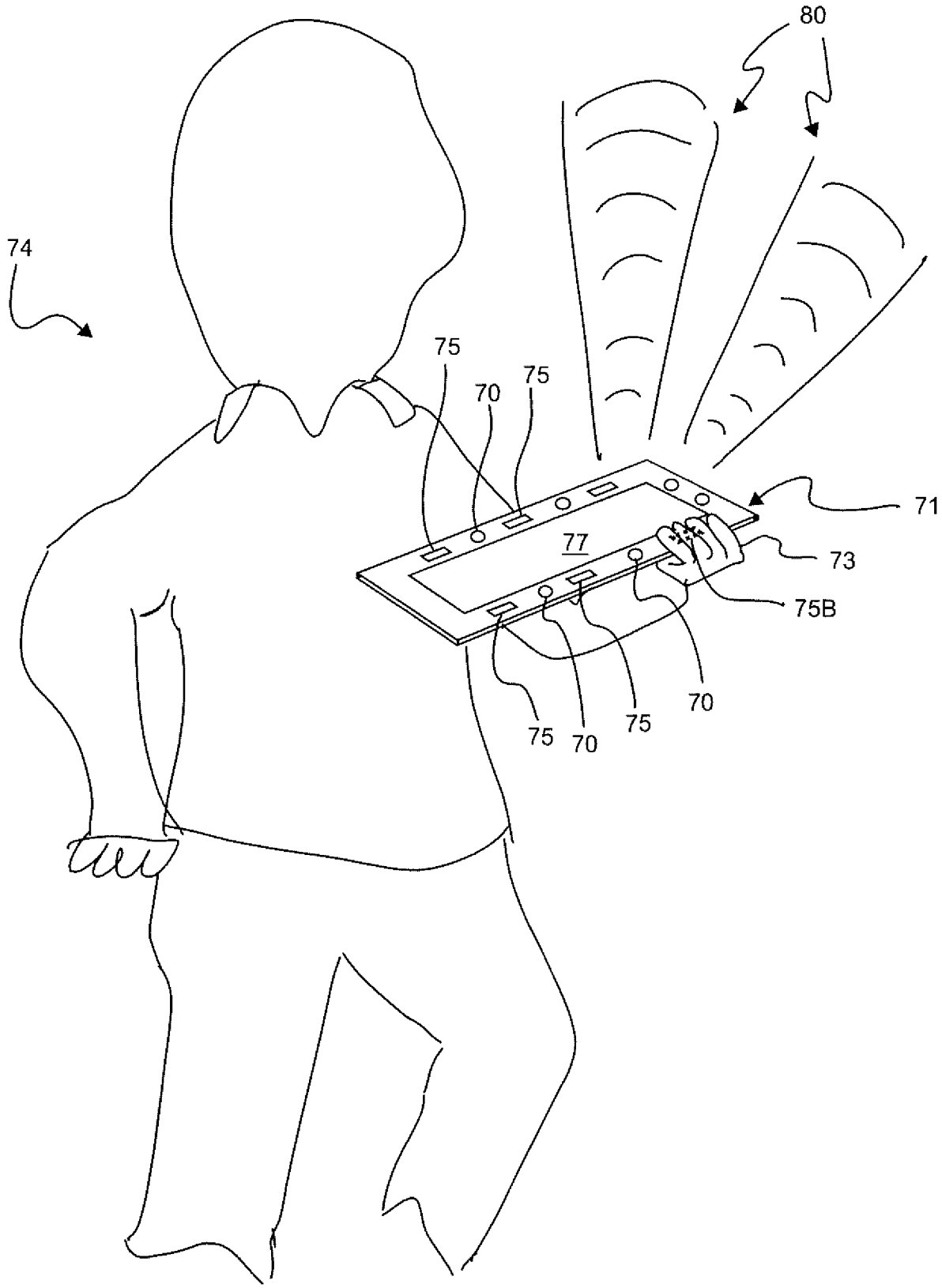

Figure 8

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

Title of Invention	Steerable Antenna Device

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.

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LEGAL NAME OF INVENTOR

Inventor: Theodore S. Rappaport Date (Optional): Aug 14, 2013

Signature: _____

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Application Number	
Filing Date	
First Named Inventor	Theodore S. Rappaport
Art Unit	
Examiner Name	
Attorney Docket Number	08610010PA

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	4	3381222		1968-04-30	Gray	
	5	3689928		1972-09-05	Felsenheld	
	6	6140966		2000-10-31	Pankinaho	
	7	6762723		2004-07-13	Nallo et al.	
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	First Named Inventor	Theodore S. Rappaport
	Art Unit	
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	9	8421695		2013-04-16	Friman et al.	
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	Examiner Name	
	Attorney Docket Number	08610010PA

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OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael E. Whitham/	Date (YYYY-MM-DD)	2013-08-14
Name/Print	Michael E. Whitham	Registration Number	32635

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Title of Invention:	STEERABLE ANTENNA DEVICE
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Filer:	Michael E. Whitham/Linda Handler
Attorney Docket Number:	08610010PA

Filed as Small Entity

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Utility filing Fee (Electronic filing)	4011	1	70	70
Utility Search Fee	2111	1	300	300
Utility Examination Fee	2311	1	360	360
Pages:				
Claims:				
Miscellaneous-Filing:				
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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
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Miscellaneous:				
			Total in USD ($)	**730**

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EFS ID:	16590287
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	STEERABLE ANTENNA DEVICE
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham/Linda Handler
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Attorney Docket Number:	08610010PA
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Payment was successfully received in RAM	$730
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Warnings:					
Information:					
2		08610010PA_Application_08-14-13.pdf	2611853 7e4cd4542c4c2b8443e53a4a8616ee752398d86f	yes	35

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal of New Application	1	4
	Specification	5	25
	Claims	26	28
	Abstract	29	29
	Drawings-only black and white line drawings	30	34
	Oath or Declaration filed	35	35

Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	08610010PA_IDS.pdf	612908 aaa631a73673367587cfb6734d941138787ea354	no	5
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32869 d5fc86330842dc49dd777af05a7ffc0c061ee6c8	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	4365210		

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	08610010PA
	Application Number	
Title of Invention	Steerable Antenna Device	

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

Secrecy Order 37 CFR 5.2

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

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Theodore	S.	Rappaport	

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

City	Riner	State/Province	VA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	2515 Camp Carysbrook Road		
Address 2			
City	Riner	State/Province	VA
Postal Code	24149	Country i	US

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

Correspondence Information:

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

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

Customer Number	30743		
Email Address	action@wcc-ip.com	Add Email	Remove Email

Application Information:

Title of the Invention	Steerable Antenna Device		
Attorney Docket Number	08610010PA	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	5	Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	08610010PA
	Application Number	
Title of Invention	Steerable Antenna Device	

Publication Information:

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

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

Representative Information:

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

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	30743		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(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.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation in part of	13713804	2012-12-13

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13713804	Continuation of	12541764	2009-08-14	8350763	2013-01-08

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
12541764	non provisional of	61088829	2008-08-14

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

Foreign Priority Information:

PTO/AIA/14 (03-13)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	08610010PA
	Application Number	
Title of Invention	Steerable Antenna Device	

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(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) [i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country [i]	Filing Date (YYYY-MM-DD)	Access Code [i] (if applicable)

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

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

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

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	08610010PA
	Application Number	
Title of Invention	Steerable Antenna Device	

If 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 World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

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

Applicant 1 Remove

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

Clear

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

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

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	08610010PA
	Application Number	
Title of Invention	Steerable Antenna Device	

Mailing Address Information:			
Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

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

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute 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.

Remove

If the Assignee is an Organization check here. ☐

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

Mailing Address Information:			
Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

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

PTO/AIA/14 (03-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	08610010PA
	Application Number	
Title of Invention	Steerable Antenna Device	

Signature:

Remove

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

Signature	/Michael E. Whitham/			Date (YYYY-MM-DD)	2013-08-14
First Name	Michael	Last Name	Whitham	Registration Number	32635

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

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

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

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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

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

Application Number	13/966,853
Filing Date	2013-08-14
First Named Inventor	Theodore S. Rappaport
Title	STEERABLE ANTENNA DEVICE
Art Unit	
Examiner Name	
Attorney Docket Number	08610010PA

SIGNATURE of Applicant or Patent Practitioner

Signature	/Michael E. Whitham/	Date (Optional)	2013-08-14
Name	Michael E. Whitham	Registration Number	32,635
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 1 forms are submitted.

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

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

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

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POWER OF ATTORNEY BY APPLICANT

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

Application Number	Filing Date

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

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 30743

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 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		Date (Optional)	
Name	Theodore S. Rappaport		
Title			

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

☑ Total of 1 forms are submitted.

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

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

Electronic Acknowledgement Receipt

EFS ID:	16590563
Application Number:	13966853
International Application Number:	
Confirmation Number:	2489
Title of Invention:	Steerable Antenna Device
First Named Inventor/Applicant Name:	Theodore S. Rappaport
Customer Number:	30743
Filer:	Michael E. Whitham/Linda Handler
Filer Authorized By:	Michael E. Whitham
Attorney Docket Number:	08610010PA
Receipt Date:	14-AUG-2013
Filing Date:	
Time Stamp:	16:14:17
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	Power of Attorney	08610010PA_POA_08-14-13.pdf	226868 1142ac0edf84bf715006d4fad7f79c421b1829c3	no	2

Warnings:	
Information:	

Total Files Size (in bytes):	226868

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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