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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/689,763	10/22/2003	Jerry D. Burchfiel	USTAP030

CONFIRMATION NO. 6023

POA ACCEPTANCE LETTER

92045
The Caldwell Firm, LLC
PO Box 59655
Dept. SVIPGP
Dallas, TX 75229

OC00000097786367

Date Mailed: 03/05/2018

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/23/2018.

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

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

/tmwilliams/

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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/689,763	10/22/2003	Jerry D. Burchfiel	BBNT-P01-238

CONFIRMATION NO. 6023

POWER OF ATTORNEY NOTICE

28120
ROPES & GRAY LLP
IPRM Docketing - Floor 43
PRUDENTIAL TOWER
800 BOYLSTON STREET
BOSTON, MA 02199-3600

OC000000097786366

Date Mailed: 03/05/2018

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/23/2018.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71.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

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

/tmwilliams/

PTO/SB/81A (12-08)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT - POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Patent Number	7,483,711
Issue Date	01-27-2009
First Named Inventor	Jerry D. Burchfiel
Title	SPECTRUM-ADAPTIVE NETWORKING
Attorney Docket No.	USTAP030

I hereby revoke all previous powers of attorney given in the above-identified patent.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the Customer Number identified in the box at right as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

92045

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

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

☒ The address associated with the above-identified Customer Number.

OR

☐ The address associated with the Customer Number identified in the box at right:

OR

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

I am the:

☐ Inventor, having ownership of the patent.

OR

☒ Patent owner.

Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on _____.

SIGNATURE of Inventor or Patent Owner

Signature	/Andrew Gordon/	Date	2/23/2018
Name	Andrew Gordon	Telephone	
Title and Company	Manager, Usta Technology, LLC		

NOTE: Signatures of all the inventors or patent owners of the entire interest or their representative(s) are required. If more than one signature is required, submit multiple forms, check the box below, and identify the total number of forms submitted in the blank below.

☐ A total of _____ forms are submitted.

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.

PTO/SB/96 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Usta Technology, LLC

Application No./Patent No.: 7,483,711 Filed/Issue Date: 01-27-2009

Titled:

Usta Technology, LLC , a Limited Liability Company

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

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;

2. ☐ an assignee of less than the entire right, title, and interest in (The extent (by percentage) of its ownership interest is _____ %); or

3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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

OR

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

1. From: BURCHFIEL, JERRY D. To: BBNT SOLUTIONS LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 014638 , Frame 0084 , or for which a copy thereof is attached.

2. From: BBNT SOLUTIONS LLC To: BBN TECHNOLOGIES CORP.

The document was recorded in the United States Patent and Trademark Office at
Reel 017274 , Frame 0318 , or for which a copy thereof is attached.

3. From: BBN TECHNOLOGIES CORP. To: RAYTHEON BBN TECHNOLOGIES CORP.

The document was recorded in the United States Patent and Trademark Office at
Reel 024456 , Frame 0537 , or for which a copy thereof is attached.

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

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

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

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

/Andrew Gordon/ 2/23/2018

Signature Date

Andrew Gordon Manager

Printed or Typed Name Title

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

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
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PTO/SB/96 (07-09)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Usta Technology, LLC

Application No./Patent No.: 7,483,711 Filed/Issue Date: 01-27-2009

Titled:

Usta Technology, LLC , a Limited Liability Company

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

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;

2. ☐ an assignee of less than the entire right, title, and interest in (The extent (by percentage) of its ownership interest is _____ %); or

3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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

OR

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

1. From: RAYTHEON BBN TECHNOLOGIES CORP. To: MIRAI VENTURES LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 042347 , Frame 0371 , or for which a copy thereof is attached.

2. From: MIRAI VENTURES LLC To: USTA TECHNOLOGY LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 044933 , Frame 0544 , or for which a copy thereof is attached.

3. From: _____ To: _____

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

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

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

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

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

/Andrew Gordon/ 2/23/2018

Signature Date

Andrew Gordon Manager

Printed or Typed Name Title

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

Privacy Act Statement

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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 Acknowledgement Receipt

EFS ID:	31878405
Application Number:	10689763
International Application Number:	
Confirmation Number:	6023
Title of Invention:	SPECTRUM-ADAPTIVE NETWORKING
First Named Inventor/Applicant Name:	Jerry D. Burchfiel
Customer Number:	28120
Filer:	Patrick Edgar Caldwell
Filer Authorized By:	
Attorney Docket Number:	BBNT-P01-238
Receipt Date:	23-FEB-2018
Filing Date:	22-OCT-2003
Time Stamp:	22:30:53
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	USTAP030_POA.pdf	494328 087faaa098fa79769717628bd2e5ad02dfa373a2	no	2

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	USTAP030_373b.pdf	428749 31709789d2961261c3d694607f794d10cce25b45	no	2
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73	USTAP030_373b2.pdf	427569 8ad53cb423fb6a12fc03d9b072f2c0c1311fcbd4	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	1350646	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/689,763	01/27/2009	7483711	BBNT-P01-238	6023

28120 7590 01/07/2009

ROPES & GRAY LLP
PATENT DOCKETING 39/41
ONE INTERNATIONAL PLACE
BOSTON, MA 02110-2624

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 1019 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 Customer Service Center of the Office of Patent Publication at (571)-272-4200.

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

Jerry D. Burchfiel, Waltham, MA;

PART B -FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571) 273-2885

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

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

ROPES & GRAY LLP
One International Place
Boston, Massachusetts 02110

12/22/2008 WASFAW2 00000014 181945 10689763

01 FC:1501 1510.00 DA
02 FC:1504 300.00 DA

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

Pamela A. Harrison	(Depositor's name)
Pamela Harrison	(Signature)
December 19, 2008	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/689,763	October 22, 2003	Jerry D. Burchfiel	BBNT-P01-238	6023

TITLE OF INVENTION: SPECTRUM-ADAPTIVE NETWORKING

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
Patent	no	$1,510.00	$300.00	$1,810.00	December 22, 2008

EXAMINER	ART UNIT	CLASS-SUBCLASS
T. A. Tran	2618	

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- [ ] Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- [ ] "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

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

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

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

(A) NAME OF ASSIGNEE: BBN Technologies Corp

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Cambridge, Massachusetts

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

4a. The following fee(s) are enclosed:
- [x] Issue Fee
- [x] Publication Fee (No small entity discount permitted)
- [ ] Advance Order -# of Copies _____

4b. Payment of Fee(s):
- [ ] A check in the amount of the fee(s) is enclosed.
- [ ] Payment by credit card. Form PTO-2038 is attached.
- [x] The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number 18-1945

5. **Change in Entity Status** (from status indicated above)
- [ ] a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- [ ] b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature Regina Sam Date December 19, 2008

Typed or printed name Regina Sam Registration No. L0381

FAX TRANSMISSION

DATE: December 19, 2008

PTO IDENTIFIER: **Application Number** 10/689,763
Patent Number
Inventor: Jerry D. Burchfiel

MESSAGE TO: US Patent and Trademark Office
FAX NUMBER: (571) 273-2885

FROM: ROPES & GRAY LLP
Regina Sam
PHONE: (617) 951-7814
Attorney Dkt. #: BBNT-P01-238

PAGES (Including Cover Sheet): 2

CONTENTS:
Issue Fee Transmittal (1 page)
Charge $1,810.00 to deposit account 18-1945

ROPES & GRAY LLP
One International Place, Boston, Massachusetts 02110
Telephone: (617) 951-7000 **Facsimile:** (617) 951-7050

PAGE 1/2 * RCVD AT 12/19/2008 6:20:51 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/30 * DNIS:2732885 * CSID:617 951 7050 * DURATION (mm-ss):01-04

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
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NOTICE OF ALLOWANCE AND FEE(S) DUE

28120 7590 09/22/2008

ROPES & GRAY LLP
PATENT DOCKETING 39/41
ONE INTERNATIONAL PLACE
BOSTON, MA 02110-2624

EXAMINER	
TRAN, TUAN A	
ART UNIT	PAPER NUMBER
2618	

DATE MAILED: 09/22/2008

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/689,763	10/22/2003	Jerry D. Burchfiel	BBNT-P01-238	6023

TITLE OF INVENTION: SPECTRUM-ADAPTIVE NETWORKING

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1440	$300	$0	$1740	12/22/2008

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 SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

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

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

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

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

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

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

28120 7590 09/22/2008

ROPES & GRAY LLP
PATENT DOCKETING 39/41
ONE INTERNATIONAL PLACE
BOSTON, MA 02110-2624

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/689,763	10/22/2003	Jerry D. Burchfiel	BBNT-P01-238	6023

TITLE OF INVENTION: SPECTRUM-ADAPTIVE NETWORKING

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1440	$300	$0	$1740	12/22/2008

EXAMINER	ART UNIT	CLASS-SUBCLASS
TRAN, TUAN A	2618	455-067100

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

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

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

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

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

1 _____

2 _____

3 _____

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

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

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

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

4a. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

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

❑ A check is enclosed.

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

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

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

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/689,763	10/22/2003	Jerry D. Burchfiel	BBNT-P01-238	6023

28120 7590 09/22/2008

ROPES & GRAY LLP
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BOSTON, MA 02110-2624

EXAMINER	
TRAN, TUAN A	
ART UNIT	PAPER NUMBER
2618	

DATE MAILED: 09/22/2008

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

The Patent Term Adjustment to date is 1019 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 1019 day(s).

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 Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Notice of Allowability	Application No.	Applicant(s)	
	10/689,763	BURCHFIEL, JERRY D.	
	Examiner	Art Unit	
	TUAN A. TRAN	2618	

-- 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 *02/26/2008*.

2. ☒ The allowed claim(s) is/are *1-16 and 19-23 renumbered 1-21*.

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

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ 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. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/Tuan A Tran/
Primary Examiner, Art Unit 2618

DETAILED ACTION

EXAMINER'S AMENDMENT

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

The application has been amended as follows:

IN THE CLAIMS:

Claim 1: the phrase "to produce a power differentials for thee each frequency" has been changed to "to produce a power differential for the each frequency"

Claim 8: the phrase "in the plurality of power" has been changed to "in the plurality of power differentials"

Allowable Subject Matter

1. Claims 1-16 and 19-23 are allowed.

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

The reasons for allowance have been indicated in the Office Action mailed on 02/26/2008.

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

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to TUAN A. TRAN whose telephone number is (571)272-7858. The examiner can normally be reached on Mon-Fri, 10:00AM-6:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Anderson can be reached on (571) 272-4177. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Tuan A Tran/
Primary Examiner, Art Unit 2618

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10689763	BURCHFIEL, JERRY D.
	Examiner	**Art Unit**
	TUAN A TRAN	2618

ORIGINAL		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
455	522	H 0 4 B 7 / 00 (2006.01.01)	
CROSS REFERENCE(S)		H 0 4 Q 7 / 20 (2006.01.01)	

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
455	68	69	70	63.1	114.2
455	127.1	452.1	452.2		

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

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1		17		33		49		65		81		97		
2	2		18		34		50		66		82				
4	3	17	19		35		51		67		83				
5	4	18	20		36		52		68		84				
3	5	19	21		37		53		69		85				
6	6	20	22		38		54		70		86				
7	7	21	23		39		55		71		87				
8	8		24		40		56		72		88				
9	9		25		41		57		73		89				
10	10		26		42		58		74		90				
11	11		27		43		59		75		91				
12	12		28		44		60		76		92				
13	13		29		45		61		77		93				
14	14		30		46		62		78		94				
15	15		31		47		63		79		95				
16	16		32		48		64		80		96				

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	21	
/TUAN A TRAN/ Primary Examiner.Art Unit 2618	09/15/2008	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	14

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10689763	BURCHFIEL, JERRY D.
	Examiner	Art Unit
	TUAN A TRAN	2618

✓	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	09/15/2008								
1	1	=								
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10689763	BURCHFIEL, JERRY D.
	Examiner	Art Unit
	TUAN A TRAN	2618

✓	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	09/15/2008								
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10689763	BURCHFIEL, JERRY D.
	Examiner	Art Unit
	TUAN A TRAN	2618

✓	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	09/15/2008								
	73	-								
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10689763	BURCHFIEL, JERRY D.
	Examiner	Art Unit
	TUAN A TRAN	2618

SEARCHED

Class	Subclass	Date	Examiner
455	450-451, 452.1-2, 67.11-67.16, 68-70, 522, 127.1-127.5, 63.1, 114.2, 114.3, 296, 226.1-226.4	9/11/08	TT

SEARCH NOTES

Search Notes	Date	Examiner
EAST (USPAT, USPGPUB, USOCR, FPRS, JPO, EPO, DERWENT) updating search	9/11/08	TT

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
	Interference text search	9/11/08	TT

AMENDMENT TRANSMITTAL LETTER

Docket No. BBNT-P01-238

Application No.	Filing Date	Examiner	Art Unit
10/689,763	October 22, 2003	T. A. Tran	2618

Applicant(s): Jerry D. Burchfiel

Invention: SPECTRUM-ADAPTIVE NETWORKING

TO THE COMMISSIONER FOR PATENTS

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

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

CLAIMS AS AMENDED

	Claims Remaining After Amendment	Highest Number Previously Paid	Number Extra Claims Present	Rate	
Total Claims	21	- 97 =	0	x 0.00	0.00
Independent Claims	2	- 8 =	0	x 0.00	0.00
Multiple Dependent Claims (check if applicable)	☐				
Other fee (please specify):					
TOTAL ADDITIONAL FEE FOR THIS AMENDMENT:					0.00

☒ Large Entity ☐ Small Entity

☒ No additional fee is required for this amendment.

☐ Please charge Deposit Account No. 18-1945 in the amount of $ 0.00 .
A duplicate copy of this sheet is enclosed.

☐ A check in the amount of $ _____ to cover the filing fee is enclosed.

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

☒ The Director is hereby authorized to charge and credit Deposit Account No. 18-1945 as described below.

☒ Credit any overpayment.

☒ Charge any additional filing or application processing fees required under 37 CFR 1.16 and 1.17.

Dated: May 27, 2008

Edward A. Gordon
Attorney/Agent Reg. No.: 54,130

ROPES & GRAY LLP
One International Place
Boston, Massachusetts 02110
(617) 951-7066

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: 5-27-08 Signature: Mary Murphy (Mary Murphy)

Docket No.: BBNT-P01-238
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Jerry D. Burchfiel

Application No.: 10/689,763 Confirmation No.: 6023

Filed: October 22, 2003 Art Unit: 2618

For: SPECTRUM-ADAPTIVE NETWORKING Examiner: Tuan A. Tran

AMENDMENT IN RESPONSE TO NON-FINAL OFFICE ACTION

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

Dear Sir:

INTRODUCTORY COMMENTS

In response to the Office Action dated February 26, 2008, please amend the above-identified U.S. patent application as follows:

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

Remarks/Arguments begin on page 6 of this paper.

AMENDMENTS TO THE CLAIMS

1. (Original) A method for managing interference in a radio communications network, comprising the steps of:

receiving an aggregated radio signal at a first node in the radio communications network on a plurality of frequencies;

determining a power level for the aggregated radio signal for each frequency in the plurality frequencies;

subtracting the power level for each the frequency from a power limit to produce a power differentials for thee each frequency; and

instructing a second node in the radio communications network to avoid using a transmission frequency corresponding to a non-positive power differential in the plurality of power differentials to transmit to the first node.

2. (Original) The method of claim 1, further comprising the steps of: receiving a transmission from the second node in the radio communications network; and discarding any portion of the transmission carried on the transmission frequency.

3. (Original) The method of claim 1, wherein the step of determining a power level is carried out by:

acquiring a plurality of instantaneous power level measurements for each the frequency; and

calculating an average power level based on the plurality of instantaneous power level measurements.

4. (Original) The method of claim 1, wherein the step of determining a power level is carried out by:

acquiring a plurality of instantaneous power level measurements for the each frequency; and

calculating a median power level based on the plurality of instantaneous power level measurements.

5. (Original) The method of claim 2, wherein the discarding step comprises applying a filter to the transmission.

6. (Original) The method of claim 1, further comprising the step of: sending to the second node a request to adjust a transmission power level on a frequency corresponding to a positive power differential in the plurality of power differentials.

7. (Original) The method of claim 1, further comprising the step of: instructing a plurality of other nodes in the radio communications network to avoid using the transmission frequency to transmit information to the first node.

8. (Original) The method of claim 7, further comprising the steps of:

receiving a transmission from one of the plurality of other nodes; and

discarding any portion of the second transmission carried on a frequency corresponding to a non-positive power differential in the plurality of power.

9. (Original) The method of claim 8, further comprising the step of: sending to the one of the plurality of other nodes a request to adjust a transmit power level on a frequency corresponding to a positive power differential in the plurality of power differentials.

10. (Original) The method of claim 1, further comprising the steps of:

determining an updated power level for the aggregated radio signal for each frequency in the plurality frequencies;

subtracting the updated power level for each the frequency from the power limit to produce a plurality of updated power differentials; and

instructing the second node to avoid transmitting to the first node on a frequency corresponding to a non-positive updated power differential in the plurality of updated power differentials.

11. (Original) The method of claim 1, further comprising the steps of:

generating an optimal waveform profile based on the plurality of power differentials; and

reporting the optimal waveform profile to the second node.

12. (Original) The method of claim 11, wherein the reporting step is carried out using a common network configuration channel.

13. (Original) The method of claim 11, further comprising the step of compressing the optimal waveform profile prior to performing the reporting step.

14. (Original) The method of claim 11, wherein the optimal waveform profile specifies a waveform pattern.

15. (Original) The method of claim 14, wherein the waveform pattern defines a transmission signal having a power spectral density that varies over time.

16. (Original) The method of claim 14, further comprising the steps of:

generating a second optimal waveform profile based on the plurality of power differentials; and

reporting the second optimal waveform profile to a third node in the radio communications network; wherein the second optimal waveform profile specifies a second waveform pattern that is orthogonal to the waveform pattern.

17. (Cancelled)

18. (Cancelled)

19. (Original) The method of claim 1, wherein the plurality of frequencies comprises all of the frequencies in a radio frequency band.

20. (Original) The method of claim 1, further comprising the steps of: associating a unique pattern with the second node; and determining whether the transmission contains the unique pattern.

21. (Original) A method for managing interference in a radio communications network, comprising the steps of:

receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node;

filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies; and

transmitting the transmission signal to the second node.

22. (Original) The method of claim 21, further comprising the steps of:

receiving an optimal waveform profile from the second node, the optimal waveform profile being based on a plurality of power measurements for the plurality of frequencies and a power limit; and

conforming the transmission signal to the optimal waveform profile prior to performing the transmitting step.

23. (Original) The method of claim 22, further comprising the step of decompressing the optimal waveform profile prior to performing the conforming step.

24-97. (Cancelled)

REMARKS

Claims 1-97 are pending in this application, of which claims 26-97 are withdrawn. In the non-final Office Action, the Examiner rejects claims 17, 18, 24, and 25 under 35 U.S.C. § 112, second paragraph as being indefinite but indicates that these claims are allowable if rewritten to overcome the indefiniteness, and allows claims 1-16 and 19-23.

While Applicant traverses this rejection, to move prosecution forward, Applicant cancels claims 17, 18, and 24-97 without prejudice or disclaimer of the subject matter thereof. Thus, only original allowed claims 1-16 and 19-23 remain pending.

Because only allowed claims remain, Applicant respectfully requests that the Examiner issue a notice of allowance on the pending claims.

Applicant believes no fee is due with this response. However, if any other fees are due in connection with the filing of this Response, please charge our Deposit Account No. 18-1945, under Order No. BBNT-P01-238 from which the undersigned is authorized to draw.

Dated: May 27, 2008

Respectfully submitted,

By _____

Edward A. Gordon, Esq.
Registration No.: 54,130
ROPES & GRAY LLP
One International Place
Boston, Massachusetts 02110-2624
(617) 951-7000
(617) 951-7050 (Fax)
Attorneys/Agents For Applicant

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
10/689,763	10/22/2003	

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☐		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			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 $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	05/29/2008	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 21	Minus	** 97	= 0	X $ =		OR	X $50=	0
	Independent (37 CFR 1.16(h))	* 2	Minus	***8	= 0	X $ =		OR	X $210=	0
	☐ 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	0

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/JACQULYN L. WILLIAMS/

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.
10/689,763	10/22/2003	Jerry D. Burchfiel	BBNT-P01-238	6023

28120 7590 02/26/2008

ROPES & GRAY LLP
PATENT DOCKETING 39/41
ONE INTERNATIONAL PLACE
BOSTON, MA 02110-2624

EXAMINER	
TRAN, TUAN A	

ART UNIT	PAPER NUMBER
2618	

MAIL DATE	DELIVERY MODE
02/26/2008	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.	Applicant(s)	
	10/689,763	BURCHFIEL, JERRY D.	
	Examiner	Art Unit	
	Tuan A. Tran	2618	

-- 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 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *19 November 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ 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

4)☒ Claim(s) *1-97* is/are pending in the application.

4a) Of the above claim(s) *26-97* is/are withdrawn from consideration.

5)☒ Claim(s) *1-16 and 19-23* is/are allowed.

6)☒ Claim(s) *17,18,24 and 25* is/are rejected.

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

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

Application Papers

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

10)☐ 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).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> 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 17-18 and 24-25 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The terms "a rule-making body" or "an industry standard" in claims 17-18 and 24-25 is a relative term which renders the claim indefinite. The term "a rule-making body" or "an industry standard" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention.

Allowable Subject Matter

Claims 1-16 and 19-23 are allowed.

The following is a statement of reasons for the indication of allowable subject matter:

None of cited prior arts of record discloses a method for managing interference in a radio communication network, comprising the steps of: receiving at a first node in the radio communication network an instruction transmitted from a second node in the radio communication network to avoid using a plurality of frequencies to transmit to the second node, wherein the instruction is generated as specified in claim 1; filtering a transmission signal to remove power from the transmission signal at each frequency in

the plurality of frequencies; and transmitting the transmission signal to the second node as specified in claim 21.

Claim17-18 and 24-25 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

USPAT (6,850,739/6,438,358/6,587,673/6,807,399/6,567,648/6,600,911).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tuan A. Tran whose telephone number is (571) 272-7858. The examiner can normally be reached on Mon-Fri, 10:00AM-6:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Anderson can be reached on (571) 272-4177. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Tuan Tran
AU 2618

PTO/SB/08a/b (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	10/689763
Filing Date	October 22, 2003
First Named Inventor	Jerry D. Burchfiel
Art Unit	2681
Examiner Name	Not Yet Assigned
Attorney Docket Number	02-4099 (BBNT-P01-238)

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/TT/	AA	US-2002/0022484	02-21-2002	Dickey, Sergey L.	
/TT/	AB	US-2002/0022495	02-21-2002	Choi et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. **CITE NO.: Those patent(s) or publication(s) which are marked with an double asterisk (**) next to the Cite No. are not supplied because they were previously cited by or submitted to the Office in a prior application relied upon in this application for an earlier filing date under 35 U.S.C. 120. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature	/Tuan Tran/	Date Considered	02/19/2008

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PTO/SB/08a/b (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449A/B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	Not Yet Assigned
Filing Date	October 22, 2003
First Named Inventor	Jerry D. Burchfiel
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	02-4099

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
/TT/	CA	Notice of Proposed Rulemaking in Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure "U-NII) devices in the 5 GHz band Before the Federal Communications Commission, Doc. No. 03-122 RM - 10371, FCC 03-110 1-28 (June 4, 2003) .	
/TT/	CB	Li PING et al., Low-Rate Turbo-Hadamard Codes1, 1-38, (unpublished manuscript, on file with the Department of Electronic Engineering, City University of Hong Kong).	
/TT/	CC	Spectrum Policy Task Force Report, Federal Communications Commission, ET Doc. No. 02-135 (November 2002).	

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature	/Tuan Tran/	Date Considered	02/19/2008

Notice of References Cited	Application/Control No. 10/689,763	Applicant(s)/Patent Under Reexamination BURCHFIEL, JERRY D.	
	Examiner Tuan A. Tran	Art Unit 2618	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,850,739	02-2005	Higuchi, Kazutoshi	455/84
*	B	US-6,438,358	08-2002	Higuchi, Kazutoshi	455/84
*	C	US-6,587,673	07-2003	Higuchi, Kazutoshi	455/84
*	D	US-6,807,399	10-2004	Shim, Jae Hoon	455/24
*	E	US-6,600,911	07-2003	Morishige et al.	455/307
*	F	US-6,567,648	05-2003	Ahn et al.	455/83
	G	US-			
	H	US-			
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	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	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
10/689,763	BURCHFIEL, JERRY D.
Examiner	**Art Unit**
Tuan A. Tran	2618

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim		Date
Final	Original	
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Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination
	10/689,763	BURCHFIEL, JERRY D.
	Examiner	Art Unit
	Tuan A. Tran	2618

SEARCHED			
Class	Subclass	Date	Examiner
455	450-451	2/17/08	
455	452.1-2		
455	67.11-16		
455	68-70		
455	522		
455	127.1-5		

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
EAST (USPAT, USPGPUB, USOCR, JPO, DERWENT)	2/14/08	

Docket No.: BBNT-P01-238
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Jerry D. Burchfiel

Application No.: 10/689763 Confirmation No.: 6023

Filed: October 22, 2003 Art Unit: 2618

For: SPECTRUM-ADAPTIVE NETWORKING Examiner: Tuan A. Tran

RESPONSE TO RESTRICTION REQUIREMENT

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

Dear Sir:

In response to the restriction requirement set forth in the Office Action dated October 10, 2007 requiring election of a single disclosed invention, Applicant hereby elects claims 1-25, corresponding to the Examiner's invention Group I, without traverse for continued examination. The time period for response has been extended to December 10, 2007, by the accompanying petition for a one-month extension of time.

The Examiner has required election, pursuant to 35 U.S.C. § 121, of one of the following inventions:

Group I, including claims 1-25 and allegedly drawn to a method for managing interference in a radio communication network, classified in class 455, subclass 69;

Group II, including claims 26-31 and allegedly drawn to a method of managing interference in a communication network, classified in class 455, subclass 450;

Group III, including claims 32-42 and allegedly drawn to a radio communication device, classified in class 455, subclass 226.1;

Group IV, including claims 43-82 and allegedly drawn to a method of managing co-sire interference in a wireless network, classified in class 455, subclass 63.1;

Group V, including claims 83-86 and allegedly drawn to a wireless network, classified in class 455, subclass 41.2;

Group VI, including claims 87-90 and allegedly drawn to a radio communication device, classified in class 455, subclass 561; and

Group VII, including claims 91-97 and allegedly drawn to a wireless communication network, classified in class 455, subclass 445.

(See Restriction Requirement, pp. 2-3). The Examiner has stated that invention Groups I-VII are related as subcombinations that are distinct from each other.

Applicants believe no fee is due with this response other than as reflected on the attached Petition for Extension of Time. However, if there are any other fees due in connection with the filing of this Response, please charge our Deposit Account No. 18-1945, under Order No. BBNT-P01-238 from which the undersigned is authorized to draw.

Dated: November 15, 2007

Respectfully submitted,

By _____
Edward A. Gordon, Esq.
Registration No.: 54,130
ROPES & GRAY LLP
One International Place
Boston, Massachusetts 02110-2624
(617) 951-7000
(617) 951-7050 (Fax)
Attorneys/Agents For Applicant

PTO/SB/22 (10-07)
Approved for use through 10/31/2007. 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 if displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a) FY 2006 (Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).)	Docket Number (Optional) BBNT-P01-238
Application Number 10/689,763	Filed October 22, 2003
For SPECTRUM-ADAPTIVE NETWORKING	
Art Unit 2618	Examiner T. A. Tran

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	
[x]	One month (37 CFR 1.17(a)(1))	$120	$60	$ 120.00
[ ]	Two months (37 CFR 1.17(a)(2))	$460	$230	$
[ ]	Three months (37 CFR 1.17(a)(3))	$1050	$525	$
[ ]	Four months (37 CFR 1.17(a)(4))	$1640	$820	$
[ ]	Five months (37 CFR 1.17(a)(5))	$2230	$1115	$

[ ] Applicant claims small entity status. See 37 CFR 1.27.

[ ] A check in the amount of the fee is enclosed.

[ ] Payment by credit card. Form PTO-2038 is attached.

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

[x] The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 18-1945 . I have enclosed a duplicate copy of this sheet.

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/inventor.

[ ] assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

[x] attorney or agent of record. Registration Number 54,130

[ ] attorney or agent under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 _____

Signature	November 15, 2007 Date
Edward A. Gordon Typed or printed name	(617) 951-7066 Telephone Number

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

[x] Total of 1 forms are submitted.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: 11/15/07 Signature: Joanne Ryan (Joanne Ryan)

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.
10/689,763	10/22/2003	Jerry D. Burchfiel	BBNT-P01-238	6023

28120 7590 10/10/2007

ROPES & GRAY LLP
PATENT DOCKETING 39/41
ONE INTERNATIONAL PLACE
BOSTON, MA 02110-2624

EXAMINER	
TRAN, TUAN A	

ART UNIT	PAPER NUMBER
2618	

MAIL DATE	DELIVERY MODE
10/10/2007	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.	Applicant(s)	
	10/689,763	BURCHFIEL, JERRY D.	
	Examiner	Art Unit	
	Tuan A. Tran	2618	

-- 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 1 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *22 October 2003*.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ 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

4)☒ Claim(s) *1-97* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

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

8)☒ Claim(s) *1-97* are subject to restriction and/or election requirement.

Application Papers

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

10)☐ 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).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-25, drawn to a method for managing interference in a radio communication network comprising the step of instructing, by a first node, a second node in the network to avoid using transmission frequency corresponding to a non-positive power differential in a plurality of power differentials to transmit to the first node, classified in class 455, subclass 69.

II. Claims 26-31, drawn to a method of managing interference in a communication network comprising the steps of: dividing a multiplicity of nodes into a plurality of node clusters; assigning a unique receiving frequency to each node in at least one of the node cluster; and assigning a unique transmission frequency to each antenna in the set of antennas attached to a first node in the at least one node cluster, classified in class 455, subclass 450.

III. Claims 32-42, drawn to a radio communication device comprising a receiver and a receiver, coupled to the receiver, configured to detect in the aggregated radio signal a transmission signal addressed to the radio communication device and to discard any portion of the transmission signal carried on a frequency corresponding to an unacceptable

transmission frequency in the set of unacceptable transmission frequency, classified in class 455, subclass 226.1.

IV. Claims 43-82, drawn to a method of managing co-sire interference in a wireless network comprising the step of identifying a subset of nodes within a multiplicity of nodes, wherein each node in the subset is capable of transmitting data to each other node in the subset in accordance with a connectivity threshold and using a power setting that falls within a low power range, classified in class 455, subclass 63.1.

V. Claims 83-86, drawn to a wireless network comprising the step of select a node in a cluster to act a long-range transmission manager, wherein the long-range transmission manager is configured to permit only one member of the cluster at a time to transmit using any power setting that falls outside the low power range, classified in class 455, subclass 41.2.

VI. Claims 87-90, drawn to a radio communication device comprising a MAC controller configured to receive a plurality of request from a multiplicity of other radio communication devices to transmit a power that falls within a high power range, classified in class 455, subclass 561.

VII. Claims 91-97, drawn to a wireless communication network comprising a multiplicity of nodes and configured to transmit a data stream along a route from a source node to a destination node in the network according to a routing protocol, classified in class 455, subclass 445.

2. The inventions are distinct, each from the other because of the following reasons:

3. Inventions [I] to [VII] are related as subcombinations disclosed as usable together in a single combination. The subcombinations are distinct from each other if they are shown to be separately usable. In the instant case, invention [I] has separate utility such as the step of instructing, by a first node, a second node in the network to avoid using transmission frequency corresponding to a non-positive power differential in a plurality of power differentials to transmit to the first node or invention [II] has separate utility such as dividing a multiplicity of nodes into a plurality of node clusters; assigning a unique receiving frequency to each node in at least one of the node cluster; and assigning a unique transmission frequency to each antenna in the set of antennas attached to a first node in the at least one node cluster or each of the invention [III] to invention [VII] has separate utility as specified above. See MPEP § 806.05(d).

4. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art because of their recognized divergent subject matter, restriction for examination purposes as indicated is proper.

5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at

least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

6. Applicant is advised that the response to this requirement to be complete must include an election of the invention to be examined even through the requirement be traversed.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tuan A. Tran whose telephone number is (571) 272-7858. The examiner can normally be reached on Mon-Fri, 10:00AM-6:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Anderson can be reached on (571) 272-4177. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Tuan Tran
AU 2618

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

Bib Data Sheet

CONFIRMATION NO. 6023

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/689,763	10/22/2003 RULE	455	2618	BBNT-P01-238

APPLICANTS
Jerry D. Burchfiel, Waltham, MA;

**** CONTINUING DATA **************************
This appln claims benefit of 60/420,930 10/24/2002 Yes

**** FOREIGN APPLICATIONS *********************
None

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 01/30/2004

Foreign Priority claimed	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☒ no	MA	19	97	9
35 USC 119 (a-d) conditions met ☐ yes ☐ no ☐ Met after Allowance				
Verified and Acknowledged Examiner's Signature Initials				

ADDRESS
28120

TITLE
Spectrum-adaptive networking

FILING FEE RECEIVED		
2672	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
10/689,763	BURCHFIEL, JERRY D.
Examiner	**Art Unit**
Tuan A. Tran	2618

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim		Date
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IFW

Docket No.: BBNT-P01-238
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Jerry D. Burchfiel

Application No.: 10/689763 Group Art Unit: 2681

Filed: October 22, 2003 Examiner: Not Yet Assigned

For: SPECTRUM-ADAPTIVE NETWORKING

CHANGE OF ATTORNEY DOCKET NUMBER

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

Dear Sir:

Please note that the Attorney Docket Number has been changed from 02-4099 to **BBNT-P01-238**. Please reference **BBNT-P01-238** on all future correspondence.

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 18-1945, under Order No. BBNT-P01-238 from which the undersigned is authorized to draw.

Dated: 3/17/05

Respectfully submitted,

By _____
Corey Scott
Registration No.: 56,245
ROPES & GRAY LLP
One International Place
Boston, Massachusetts 02110-2624

(617) 951-7000
(617) 951-7050 (Fax)
Attorneys/Agents For Applicant

9656220-1

IFW

Docket No.: (BBNT-P01-238) 02-4099
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Burchfiel, Jerry D.

Application No.: 10/689763

Filed: 10/22/2003 Art Unit:

For: Spectrum-adaptive networking Examiner:

NEW POWER OF ATTORNEY

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

Dear Sir:

Pursuant to the attached "Power of Attorney to Prosecute Applications Before the USPTO", signed by an individual having signature authority for the Assignee (BBNT Solutions LLC) of the above-referenced application, Assignee has granted the following attorneys and agents:

All practitioners at Customer Number 28120

power of attorney to prosecute the above-referenced application before the USPTO.

Dated: September 14, 2004

Respectfully submitted,

By _____
Edward A. Gordon
Registration No.: 54,130
ROPES & GRAY LLP
One International Place
Boston, Massachusetts 02110-2624
(617) 951-7000
(617) 951-7050 (Fax)
Attorneys/Agents For Applicant

PTO/SB/80 (10-03)
Approved for use through 11/30/2004. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby appoint:

[X] Practitioners associated with the Customer Number: 28120

OR

[ ] Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Assignee Name and Address:
BBNT SOLUTIONS LLC
10 Moulton Street
Cambridge, MA 02138

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Name	Mark J. Sherman		
Signature	Mark J. Sherman	Date	May 18, 2004
Title	Vice President Contracts	Telephone	(617) 873-3000

CHANGE OF CORRESPONDENCE ADDRESS Application		
Address to: Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450	**Application Number**	10/689763
	Filing Date	10/22/2003
	First Named Inventor	Burchfiel, Jerry D.
	Art Unit	N/A
	Examiner Name	
	Attorney Docket No.	BBNT-P01-238

Please change the Correspondence Address for the above-identified application to:

[X] Customer Number: 28120

OR

[ ] **Firm *or* Individual Name**	Edward J. Kelly ROPES & GRAY LLP				
Address	One International Place				
City	Boston	State	MA	Zip	02110-2624
Country	US				
Telephone	(617) 951-7000	Fax	(617) 951-7050		

This form cannot be used to change the data associated with a Customer Number. To change the data associated with an existing Customer Number use "Request for Customer Number Data Change" (PTO/SB/124).

I am the:

[ ] Applicant/Inventor

[ ] Assignee of record of the entire interest.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

[X] Attorney or Agent of record. Registration Number 54,130

[ ] Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number _____

Typed or Printed Name	Edward A. Gordon		
Signature			
Date	September 14, 2004	Telephone	(617) 951-7066

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[ ] *Total of 1 forms are submitted.

I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as First Class Mail, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below.

Dated: September 14, 2004 Signature: Joanne Ryan (Joanne Ryan)

Docket No.: (BBNT-P01-238) 02-4099
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Burchfiel, Jerry D.

Application No.: 10/689763

Filed: 10/22/2003

For: Spectrum-adaptive networking

CHANGE OF ATTORNEY DOCKET NUMBER

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

Dear Sir:

Please note that the Attorney Docket Number has been changed from 02-4099 to **BBNT-P01-238**. Please reference **BBNT-P01-238** on all future correspondence.

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 18-1945, under Order No. BBNT-P01-238 from which the undersigned is authorized to draw.

Dated: September 14, 2004

Respectfully submitted,

By _____
Edward A. Gordon
Registration No.: 54,130
ROPES & GRAY LLP
One International Place
Boston, Massachusetts 02110-2624
(617) 951-7000
(617) 951-7050 (Fax)
Attorneys/Agents For Applicant

PTO/SB/21 (02-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/689763
Filing Date	October 22, 2003
First Named Inventor	Jerry D. Burchfiel
Art Unit	2681
Examiner Name	Not Yet Assigned
Total Number of Pages in This Submission: 9	Attorney Docket Number: 02-4099 (BBNT-P01-238)

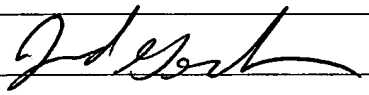
ENCLOSURES (*Check all that apply*)

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [x] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] After Allowance communication to Technology Center (TC)
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [ ] Other Enclosure(s) (please Identify below):

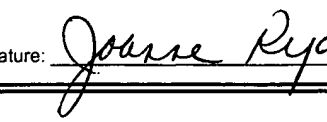
Remarks

Form PTO/SB/08; copy of International Search Report; return receipt postcard

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual name	ROPES & GRAY LLP Edward A. Gordon - 54,130
Signature	
Date	June 11, 2004

I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below.

Dated: 6/11/04 Signature:  (Joanne Ryan)

Docket No.: 02-4099 (BBNT-P01-238) (PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Jerry D. Burchfiel

Application No.: 10/689763 Confirmation No.: 6023

Filed: October 22, 2003 Art Unit: 2681

For: SPECTRUM-ADAPTIVE NETWORKING Examiner: Not Yet Assigned

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

In accordance with 37 CFR 1.97, Applicant(s) hereby make of record the following additional documents. A PTO Form SB/08 accompany this statement.

Applicant(s) have become aware of the following documents, cited in an International Search Report issued May 18, 2004, during the prosecution of international application no. PCT/US03/33338, which corresponds to the above referenced application, and in accordance with 37 CFR 1.97(c) and (e)(1) or (b)(3), hereby submit(s) these documents for the Examiner's consideration. These documents are cited on the enclosed PTO Form SB/08, and a copy of the International Search Report is enclosed as well.

This statement is not to be interpreted as a representation that the cited documents are material, that an exhaustive search has been conducted, or that no other relevant information exists. Nor shall the citation of any document herein be construed *per se* as a representation that such document is prior art. Moreover, Applicant(s) understand(s) the Examiner will make an independent evaluation of the cited documents.

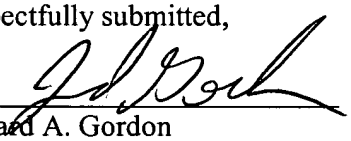
The undersigned hereby certifies that each item contained in this Supplemental Information Disclosure Statement was cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Supplemental Information Disclosure Statement. Furthermore, in accordance with 37 CFR 1.704(d), Applicant(s) note(s) that to our knowledge this communication was not received by any individual designated in 1.156(c) more than thirty days prior to the filing of this statement.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 18-1945, under Order No. BBNT-P01-238.

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 18-1945, under Order No. BBNT-P01-238 from which the undersigned is authorized to draw.

Dated: June 11, 2004

Respectfully submitted,

By 

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Attorneys/Agents For Applicant

PTO/SB/08a/b (08-03)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449A/B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	10/689763
Filing Date	October 22, 2003
First Named Inventor	Jerry D. Burchfiel
Art Unit	2681
Examiner Name	Not Yet Assigned
Attorney Docket Number	02-4099 (BBNT-P01-238)

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA	US-2002/0022484	02-21-2002	Dickey, Sergey L.	
	AB	US-2002/0022495	02-21-2002	Choi et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. **CITE NO.: Those patent(s) or publication(s) which are marked with an double asterisk (**) next to the Cite No. are not supplied because they were previously cited by or submitted to the Office in a prior application relied upon in this application for an earlier filing date under 35 U.S.C. 120. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature		Date Considered	

PTO/SB/05 (08-03)
Approved for use through 07/31/2006. OMB 0651-0032
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	02-4099
First Inventor	Jerry D. Burchfiel
Title	SPECTRUM-ADAPTIVE NETWORKING
Express Mail Label No.	

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: MS Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

1. [X] Fee Transmittal Form (e.g., PTO/SB/17) *(Submit an original, and a duplicate for fee processing)*
2. [ ] Applicant claims small entity status. See 37 CFR 1.27.
3. [X] Specification [*Total Pages* 67]
   (preferred arrangement set forth below)
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [X] Drawing(s) *(35 U.S.C. 113)* [*Total Sheets* 19]
5. Oath or Declaration [*Total Sheets* 2]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [X] Application Data Sheet. See 37 CFR 1.76
7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program *(Appendix)*
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   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

ACCOMPANYING APPLICATION PARTS

9. [X] Assignment Papers (cover sheet & document(s))
10. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney
11. [ ] English Translation Document *(if applicable)*
12. [X] Information Disclosure Statement (IDS)/PTO-1449 [X] Copies of IDS Citations
13. [ ] Preliminary Amendment
14. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. [ ] Other:

18. 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.: _____

Prior application information: Examiner _____ *Art Unit:* _____

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

19. CORRESPONDENCE ADDRESS

[X] Customer Number: 32127 *OR* [ ] Correspondence address below

Name	Leonard C. Suchyta c/o Christian Anderson				
Address	Verizon Corporate Services Group Inc. 600 Hidden Ridge, HQE03H01				
City	Irving	*State*	Texas	*Zip Code*	75038
Country	USA	*Telephone*	(781) 466-2220	*Fax*	

Name (Print/Type)	Andrea G. Reister	*Registration No. (Attorney/Agent)*	36,253
Signature	Andrea G. Reister	*Date*	October 22, 2003

22582 U.S. PTO 10689763 102203

Use in lieu of PTO/SB/17 (08-03)
(Form updated to reflect FY 2004 fees effective 10/1/03)

FEE TRANSMITTAL for FY 2004

Effective 10/01/2003, Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 2,626.00

Complete if Known	
Application Number	Not Yet Assigned
Filing Date	October 22, 2003
First Named Inventor	Jerry D. Burchfiel
Examiner Name	Not Yet Assigned
Art Unit	N/A
Attorney Docket No.	02-4099

METHOD OF PAYMENT *(check all that apply)*

☒ Check ☐ Credit Card ☐ Money Order ☐ Other ☐ None

☐ Deposit Account:

Deposit Account Number: 50-0740

Deposit Account Name: Covington & Burling

The Director is authorized to: *(check all that apply)*

☐ Charge fee(s) indicated below ☒ Credit any overpayments

☐ Charge any additional fee(s) during the pendency of this application

☐ Charge fee(s) indicated below, **except for the filing fee** to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	770.00
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	

SUBTOTAL (1) ($) 770.00

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee from below		Fee Paid
Total Claims	97	-20** =	77	x	18.00	=	1,386.00
Independent Claims	8	-3** =	5	x	86.00	=	430.00
Multiple Dependent						=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 1,816.00

***or number previously paid, if greater; For Reissues, see above*

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge – late filing fee or oath	
1052	50	2052	25	Surcharge – late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive – unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	40.00
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee (specify)					

*Reduced by Basic Filing Fee Paid **SUBTOTAL (3)** ($) 40.00

SUBMITTED BY (Complete *(if applicable)*)

Name (Print/Type)	Andrea G. Reister	Registration No. (Attorney/Agent)	36,253	Telephone	(202) 662-6000
Signature	Andrea G. Reister			Date	October 22, 2003

Docket No.: 02-4099
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Jerry D. Burchfiel

Application No.: Not Yet Assigned

Group Art Unit: N/A

Filed: October 22, 2003

Examiner: Not Yet Assigned

For: SPECTRUM-ADAPTIVE NETWORKING

TRANSMITTAL LETTER

MS Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Enclosed are the following items for filing in connection with the above-referenced Patent Application:

1. Fee Transmittal;
2. Utility Patent Application Transmittal;
3. Application Data Sheet;
4. Utility application comprising: 51 pages of description; 15 pages of claims (97 claims); a one page abstract; and 19 sheets of drawings (Figs. 1-19);
5. Declaration and Power of Attorney for Patent Application;
6. Recordation Form Cover Sheet;
7. Assignment to BBNT Solutions LLC;

8. Information Disclosure Statement;

9. Form PTO/SB/08a/b;

10. Three cited documents;

11. Check No. 319314 for $2,626.00 to cover:
    $770.00 basic filing fee;
    $1,816.00 additional claims fee;
    $40.00 assignment recordation fee; and

12. Two return receipt postcards.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 50-0740, under Order No. 02-4099. A duplicate copy of this paper is enclosed.

It is not believed that extensions of time or fees for net addition of claims are required beyond those that may otherwise be provided for in documents accompanying this paper. However, if additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required therefor (including fees for net addition of claims) are hereby authorized to be charged to our Deposit Account No. 50-0740.

Dated: October 22, 2003

Respectfully submitted,

By _____

Andrea G. Reister
Registration No.: 36,253
COVINGTON & BURLING
1201 Pennsylvania Avenue, N.W.
Washington, DC 20004-2401
(202) 662-6000
Attorney for Applicant

SPECTRUM ADAPTIVE NETWORKING

BACKGROUND OF THE INVENTION

RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. § 119 to provisional Application No. 60/420,930, filed October 24, 2002, the entirety of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to radio frequency spectrum management systems, and, more particularly, to systems and methods for recovering and/or sharing radio frequency spectrum in radio frequency bands already populated by legacy users (such as cell phone users) and high-priority users (such as public safety, military and government entities) without exposing those legacy and high-priority users to harmful interference.

DESCRIPTION OF THE RELATED ART

[0003] Wireless communications network bandwidth continues to shrink at an alarming rate. Increasing demand for spectrum-based services and devices is putting a strain on long-standing and out-moded spectrum allocation and use policies. Managing interference levels among the rapidly increasing number of users has become extremely difficult because of the greater density, mobility and variability of "next generation" (XG) radio frequency emitters.

[0004] Current spectrum management policy seeks to assign locally unoccupied portions of the RF spectrum to XG users. The Federal Communications Commission ("FCC") Spectrum Management Policy Task Force has recommended adoption of a policy of "Interference Protection," which defines an acceptable level of interference to primary users from secondary users in terms of this interference temperature. Under the recommended policy, secondary users

of a band are required to accept interference from primary users, and must cause no "harmful" interference to the primary users. Thus, the policy permits secondary (e.g., unlicensed) users to radiate only enough power in an area of interest to raise the interference temperature in the band to a specified threshold T_0 for the band, service, and locality. The receivers of the primary (e.g., licensed) users are then expected to tolerate this specified level of interference. This proposed arrangement, if it is widely adopted, will create an opportunity to "underlay" existing primary applications with low-power, low-impact opportunistic applications that operate below the threshold.

[0005] While the Spectrum Policy Task Force Report recommends a new set of rules for spectrum use that in turn will provide a sound framework for using the available spectrum more efficiently, the report does not address many important and heretofore unanswered questions about how to build and configure networks and devices that comply with the new set of rules. Accordingly, what is needed are tools, devices and applications XG users can build, configure and deploy in order to take advantage of the proposed spectrum policies.

SUMMARY OF THE INVENTION

[0006] The present invention provides key enabling technology to implement the FCC's new flexible spectrum use policy. The invention addresses both individual spectrum management devices and provides an integrated system concept for dynamic, adaptive, radio frequency spectrum assignment and use. The result is far greater spectrum efficiency, providing megabit/sec rate communications networks that can extend far beyond the capabilities of existing wireless networking systems and devices. The invention provides a way to underlay new

services on existing bandwidth allocations with minimal or no interference to, and from, existing legacy users, while providing up to 30 times greater throughput than the current systems.

[0007] To accomplish these goals, a node of a network communications system configured to operate in accordance with the present invention is configured to:

- Continuously carry out real-time sensing and characterization of the local spectrum usage by (potentially interfering) narrowband and wideband emitters;
- Dynamically and autonomously adapt (on a time scale of milliseconds) to the local spectrum environment by selecting and controlling the waveforms (power spectral density (PSD) and Media Access Control (MAC) protocols) that its network neighbors use when transmitting to this node;
- Automatically carry out a closed loop power control algorithm with each neighbor to throttle back on unnecessarily high power levels, thereby enhancing Low Probability of Detection (LPD);
- Apply transmission security ("TRANSEC") parameters to the spread spectrum modulation process in order to enhance Low Probability of Intercept (LPI); and
- Carry out packet forwarding (routing) in a way that balances aggregate network throughput against average end-to-end delay. (This results in real time traffic, e.g., voice, being sent with higher power, minimizing latency due to channel access delays at multiple hops, and bulk traffic being sent with lower power, minimizing network self-interference, maximizing spatial reuse of frequencies and enhancing LPI/LPD).

[0008] As described in detail below, the present invention also provides a highly advanced networking communications architecture for implementing the policies recommended by the FCC Task Force. The design of the architecture combines dynamic spectrum management techniques with matching adaptive networking and full exploitation of multiple transceivers per communications node. The invention also provides the flexibility and scalability, and may be easily adapted for use with other forward-looking wireless communications systems and technologies.

[0009] The present invention solves the "spectrum crisis" currently plaguing commercial, military, government and private users by providing a way to underlay spectrum-efficient megabit rate networking onto bands allocated for other purposes. The invention can thus be used, for example, to underlay military networking below any narrowband-channelized spectrum where individual channels have less than 100% duty cycle, such as in commercial cellular, without interfering with existing legacy users of these bands. Initial use of existing frequency allocations ensures that the invention may be implemented domestically without displacing or upsetting existing users. In overseas locations and in wartime, however, the invention is not restricted to these particular bands, and the flexible hardware and software made possible by the invention will also operate in other frequencies without hardware modification.

[0010] In general, the present invention provides a method for managing interference in a radio communications network, comprising the steps of: (1) receiving an aggregated radio signal at a first node in the radio communications network on a plurality of frequencies; (2) determining a power level for the aggregated radio signal for each frequency in the plurality frequencies; (3) subtracting the power level at each frequency from a power limit to produce a power differential for each frequency; and (4) instructing other nodes in the radio communications network to avoid

using a transmission frequency corresponding to a non-positive power differential in the plurality of power differentials to transmit to the first node. A government agency, such as the FCC, an industry standards group, or other rule-making body may specify the power limit.

[0011] In preferred embodiments, the method further comprises the steps of: (5) receiving a transmission from a second node in the radio communications network; and (6) discarding any portion of the transmission carried on the transmission frequency the second node was instructed to avoid. Typically, although not necessarily, the discarding step is accomplished by applying an optimal matched filter to the transmission, said optimal matched filter being keyed to the instruction sent to the second node. By discarding a portion of the received transmission in this manner (the process is called receiver excision), interference produced by other emitters (e.g., legacy primary users) in the wireless environment is filtered out of the transmission.

[0012] The power level may be determined by acquiring a plurality of instantaneous power level measurements for each frequency and calculating an average power level based on the plurality of instantaneous power level measurements. This creates a "model" power level, of sorts, that may reflect a more accurate measure of the power levels present at the plurality of frequencies over a given period of time. Alternatively, the model power level also may be determined by calculating a median power level based on the plurality of instantaneous power level measurements.

[0013] In preferred embodiments, the method also includes closed loop power control. Each receiver sends to other nodes in the network a request to adjust (or limit) its transmission power level on frequencies corresponding to positive power differentials so that the receiver receives transmissions from all of its neighbors at the same power level. This feedback from each

receiver in the network minimizes the transmit power on reliable links, maximizes the ability to achieve spatial separation among transmissions on the same frequency, and thereby minimizes network self-interference. Closed loop power control functionality also improves low probability of intercept (LPI) and low probability of detection (LPD), and minimizes battery drain for mobile and/or portable transmitting nodes.

[0014] In preferred embodiments of the invention, the aggregated signal is continuously monitored and the measured power level is continuously updated to account for the fact that some or all of the nodes may be mobile, and therefore constantly moving around, and new emitters (causing increased levels of interference) may come on line. Accordingly, each receiver in the network is preferably configured to provide constant, or at least fairly constant, updated instructions to its neighbors setting forth the optimal transmission parameters to use to transmit data to that receiver.

[0015] The optimal transmission parameters sent out to neighboring nodes by a receiver node may be embodied in an optimal waveform profile, which itself may contain information and instructions beyond power spectral density values. Such profile might also contain, for example, a schedule of optimal times to transmit information to the receiving node.

[0016] In some embodiments, it may be advantageous, desirable or necessary to compress the optimal waveform profile prior to transmitting it to a neighboring node. It may also be advantageous to specify a particular waveform pattern so that the receiving node will be able to determine from which node the waveform came.

[0017] In another aspect of the invention, another method for managing interference in a radio communications network, is provided, comprising the steps of: (1) receiving at a first node in the

radio communications network an instruction transmitted from a second node to avoid using a plurality of frequencies to transmit to the second node; (2) filtering a transmission signal to remove power at frequencies that should be avoided; and (3) transmitting the filtered transmission signal to the second node. As before, the instruction may be embodied in or combined with an optimal waveform profile from the second node, the optimal waveform profile being based on a plurality of power measurements for a plurality of frequencies, as measured from the second node, and the power limit. In this aspect of the invention, the method may also include the step of decompressing the optimal waveform profile prior to generating a transmission signal conforming to the profile.

[0018] In still another aspect, the invention provides a method of managing interference in a radio communications network having a multiplicity of nodes, each node in the multiplicity having attached thereto a set of antennas oriented to face directions relative to other antennas attached to the node. This method comprises the steps of: (1) dividing the multiplicity of nodes into a plurality of node clusters; (2) assigning a unique receiving frequency to each node in a node cluster; and (3) assigning a unique transmission frequency to each antenna in the set of antennas attached to a first node in the node cluster; wherein the unique transmission frequency assigned to each antenna is equivalent to the unique receiving frequency assigned to a neighboring node in the node cluster.

[0019] In this aspect, the invention may further comprise transmitting outgoing messages from the first node to the neighboring nodes using unique receiving frequencies assigned to the neighboring nodes. The first node is also capable of transmitting the outgoing message to the neighboring node and receiving an incoming message from another neighboring node simultaneously.

[0020] In yet another aspect of the present invention, there is provided a radio communications device, comprising a receiver configured to receive an aggregated radio signal existing at the radio communications device, a spectrum analyzer, coupled to the receiver, configured to produce a series of power readings for the aggregated radio signal for each frequency in a plurality of frequencies, a waveform profile generator configured to produce a waveform profile based on the series of power readings and a power limit, and a filter, coupled to the receiver, configured to detect in the aggregate radio signal a transmission signal addressed to the radio communications device, and to discard any portion of the transmission signal carried on a frequency corresponding to an unacceptable transmission frequency. The waveform profile defines the set of unacceptable transmission frequencies. A radio communications device operating in accordance with this aspect of the invention may also include a signal data processor configured to generate a model power level (e.g, an average or median power level) for the aggregated radio signal for each frequency in the plurality frequencies based on the series of power readings. The radio communications device typically would also include a transmitter configured to transmit the waveform profile to a second radio communications device or to multiple radio communication devices in the network.

[0021] Preferably, the radio communications device in this embodiment of the invention also includes a correlator, or a plurality of correlators, coupled to the filter, configured to determine whether the detected transmission signal contains a pattern uniquely associated with one or more other radio communications devices in the network. Each pattern in a multiplicity of patterns is orthogonal to each other pattern so that the correlators may be used to identify discrete patterns being carried by a single frequency or group of frequencies. The radio communications device

may further include a media access controller ("MAC controller") configured to toggle the radio communications device back and forth between a transmit mode and a receive mode.

[0022] In still another aspect of the invention, there is provided a method for managing co-site interference in a wireless network, comprising the steps of: (1) identifying a subset of nodes within a multiplicity of nodes, each node in the subset being capable of transmitting data to each other node in the subset in accordance with a defined connectivity threshold and using a power setting that falls within a low power range; (2) defining a collection of transmission frequencies to be used by nodes of the subset only when transmitting to a node outside of the subset; and (3) permitting only one node of the subset at a time to transmit using any transmission frequency within the collection. In this embodiment, access to certain frequencies for data transmissions are serially allocated to the members of the subset so that only one node may use those frequencies at a time. Since nodes in a mobile network may be moving continuously, the method may further include the step of updating the subset of nodes in short (i.e., low power) range of each other according to a schedule, at regular intervals, when it is determined that a significant amount of node movement has occurred, or upon a determination that some combination of any one or all of the foregoing situations has occurred.

[0023] In preferred embodiments, the step of identifying a subset of nodes in short range of each other is carried out using a K-Means vector quantization algorithm. The step of serially allocating permission to use the long-range links is carried out using a point coordination function.

[0024] In this embodiment, all nodes in the subset are configured to receive transmissions on the any transmission frequency in the collection while no node in the subset is transmitting on that

transmission frequency. Preferably, a unique spread-spectrum code is associated with the subset of nodes, so that transmissions from the subset may be identified as such.

[0025] To better manage interference, another layer of clustering may be implemented, which involves identifying a second subset of nodes within the multiplicity of nodes, wherein each node in the second subset is capable of transmitting data to each other node in the second subset in accordance with the defined connectivity threshold using a power setting that falls within a medium power range. A second collection of transmission frequencies is generated, this collection to be used by the nodes of the second subset to transmit using a power setting that falls outside the medium power range. Here again, only one node of the second subset at a time is allowed to transmit using any transmission frequency within the second collection.

[0026] Also provided is a method for managing congestion at an elevated node in a wireless network, comprising the steps of: (1) identifying a subset of nodes within a multiplicity of nodes, each node in the subset being capable of transmitting data to each other node in the subset in accordance with a defined connectivity threshold and using a power setting that falls within a low power range; (2) defining a collection of transmission frequencies to be used by nodes of the subset only when transmitting to the elevated node; and (3) permitting only one node of the subset at a time to transmit to the elevated node using any transmission frequency within the collection. This process manages the network communications in such way as to avoid high fan-in congestion. In this embodiment, nodes of the subset are serially allocated permission to use certain frequencies to transmit to the elevated node. All nodes in the subset are configured to receive transmissions on the any transmission frequency in the collection while no node in the subset is transmitting on the transmission frequency.

[0027] A wireless network configured to operate in accordance with the present invention comprises a plurality of short-range links, a multiplicity of nodes configured to automatically identify a cluster of nodes within the multiplicity capable of transmitting data to each other node in the cluster via the plurality of short-range links using a power setting that falls within a low power range. The multiplicity of nodes is also configured to self-select a node in the cluster to act as a long-range transmission manager, which permits only one member of the cluster at a time to transmit using any power setting that falls outside the low power range.

[0028] A radio communications device in accordance with this embodiment may comprise a transmitter configured to send data to any other media access controller in the multiplicity using a power setting that falls within a low power range, and a media access controller configured to receive a plurality of requests from the multiplicity of other radio communications devices to transmit using a power setting that falls within a high-power range. Here again, the media access controller is configured to grant only one request in the plurality of requests at a time. The radio communications device may be further configured to receive any transmission having a power level that falls within the high-power range while no radio communications device in the multiplicity of other radio communications devices is transmitting using the power level. Preferably, the radio communications device also includes a correlator, or multiple correlators, configured to determine whether the transmission contains a pattern associated with a particular radio communications device in the multiplicity of radio communication devices.

[0029] Finally, a method of managing real-time data traffic in a wireless communications network is provided. The network has a multiplicity of nodes and is configured to transmit a data stream along a route from a source node in the network to a destination node in the network according to a routing protocol. This method comprises the steps of receiving at an intermediate

node in the route a data packet from the data stream and a request to transmit the data packet to the next node in the route and determining whether the next node is operating in a receiving mode. If the next node is operating in the receiving mode, the data packet is transmitted to the next node. However, if the next node is not operating in the receiving mode, then the data packet is forwarded to any other node in the multiplicity of nodes that is both in the receiving mode and nearer to the destination node than the intermediate node.

[0030] Aspects of the present invention may be implemented using software radio technology, which provides flexibility to make dynamic adaptive use of spectrum under rapidly changing interference conditions. Software radios also support advanced adaptive Media Access Control (MAC) protocols. Vanu, Inc. (www.vanu.com) of Cambridge, Massachusetts, for example, makes software radios suitable for using as a transceiver in a network configured to operate in accordance with the present invention.

[0031] Software radio technology also enables implementing embodiments of the present invention using COTS (commercial-off-the-shelf) processor-based radios that will improve over time, incorporating new signaling protocols as they become available, and incorporating ever more efficient components in terms of size, weight, and power. Software radios may be built around Intel Pentium 4 processors, for example, which currently operate at clock speeds of about 3.2 GHz, are projected to operate at clock rates beyond 10 GHz by 2005. Because the software used in a software radio is portable, networks and networking devices designed according to embodiments of the present invention can be upgraded over time to feature the latest and fastest COTS processors. In addition, the invention can easily be configured to use RF-to-digital front-end technology, which can provide all the necessary analog functions on a compact card. Rapid technology improvements in this area make these front ends quite affordable, so there is no

impediment to operating each network node with multiple independent transceivers. This rapid evolution in transceiver technology is evident, for example, in today's two-chip CMOS implementations of IEEE 802.11a 54 Mb/s OFDM transceivers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The foregoing summary, as well as the following detailed description, will be best understood in conjunction with the attached drawings, which are incorporated in and constitute part of the specification. The drawings illustrate preferred embodiments of the invention, and, together with the description, serve to explain the principles of the present invention.

[0033] FIG. 1 depicts a high-level block diagram illustrating an arrangement of some of the physical components in a transceiver configured to operate according to an embodiment of the present invention.

[0034] FIG. 2 shows a reference model defining the characteristics of a channel between a transmitter and a receiver configured to operate in accordance with principles of the present invention.

[0035] FIG. 3 graphically illustrates a method of calculating the power spectral density (PSD) of an optimal waveform according to embodiments of the invention.

[0036] FIGs. 4 through 11 contain plots and graphs illustrating the results of spectrum measuring experiments supporting the need for and the benefits of the present invention.

[0037] FIG. 12 depicts a model illustrating an integrated system concept according to an embodiment of the present invention.

[0038] FIG. 13 illustrates one approach, in accordance with the principles of the present invention, to mitigating intersymbol interference.

[0039] FIG. 14 shows a high-level block diagram of a network node 1400 (such as a software radio, a router, etc.) configured to operate according to embodiments of the present invention.

[0040] FIG. 15 contains a high-level flow diagram illustrating the steps performed in an embodiment of the present invention in order to process signals and manage interference received at a node, such as the node shown in FIG. 14.

[0041] FIGS. 16, 17 and 18 show the results of simulation experiments for coloring (assigning different frequencies) a random layout of fifty nodes in a network.

[0042] FIG. 19 shows a high-level flow diagram illustrating the steps that may be performed by a processor configured to assign receive frequencies to a multiplicity of nodes, in accordance with the present invention, to ensure that there are no adjacent nodes that use the same receive frequency.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0043] Reference will now be made in detail to preferred embodiments of the invention, examples of which are illustrated in the drawings. Notably, the present invention may be implemented using software, hardware, or any combination thereof, as would be apparent to those of ordinary skill in the art. Therefore, the figures and examples below are not meant to limit the scope of the present invention or its embodiments or equivalents.

[0044] The invention provides dramatic improvements in assured wireless communications by dynamic redistribution of allocated spectrum and advanced Media Access Control (MAC)

protocols. FIG. 1 shows an architecture that can be used to achieve these improvements according to an embodiment of the present invention. FIG. 1 shows the various functions of the architecture as they are arranged in their appropriate protocol layers. What follows is a description of each layer of the design.

GENERAL ARCHITECTURE DESCRIPTION

[0045] The invention provides a system for using local, metropolitan, and wide-area network (LAN, MAN, and WAN) bands for high-speed (megabit-rate) networking and seamless interoperability with current systems. Taking advantage of military L-Band, UHF and VHF allocations (cross-banding within a single network), for example, as shown in Table 1 below, different links are created for these different purposes.

Band	Use	Per-Hop Range	Path Loss	Data Rate	Analogy
Mil – 3: 1710 – 1850 MHz	W-LANs (Squad)	0.2 Km	60 – 90 dB	~10 Mb/s	Star Trek "Comm Badge"
Mil –UHF: 225 – 400 MHz	W-CANs (Company)	5 Km	90 – 120 dB	~ 2 Mb/s	Star Trek "Communicator"
Mil –VHF: 30 – 88 MHz	W-MANs (Bde)	30 Km	120-150 dB	~0.5 Mb/s	30 times faster than SINCGARS

[0046] This approach, namely providing a range of different link types, all integrated into a single network with automatic cross-banding in nodes with multiple independent transceivers, provides all the benefits needed for successful megabit-rate wireless networking.

[0047] Path loss (PL) is the ratio of the signal power coming down the receive feedline from an isotropic receive antenna, to the signal power going up the transmit feedline to an isotropic transmit antenna. In the example of 90 dB path loss, every Watt transmitted turns into a

nanoWatt received. Assuming the use of isotropic antennas (gain = 1 = 0 dB), the path loss (PL) that can be tolerated on a link (link budget) is the ratio of the available transmit power, to the receiver sensitivity (required receiver power). The Mil-VHF band provides much better propagation (longer range) for modest power, as the effective area of an omni-directional antenna may be represented by the equation $\lambda^2/4\,\pi$, where λ is the wavelength. This results in almost a 30 dB improvement in path loss (P.L.), for 30 times the line of sight (LOS) range compared to the Mil-3 band. Diffraction around wavelength-sized obstacles (e.g., 10 meter hills or buildings) can make an even greater difference beyond LOS.

[0048] In contrast, the Mil-3 band provides much higher available bandwidth, permitting far higher data rates over short ranges. In fact, the short range here results in both high spatial reuse of the frequency allocation, and a low power, LPI/LPD signal with wide spectrum spreading. Having an unobtrusive signal eliminates the need to contest spectrum "ownership".

[0049] The Mil-UHF band is intermediate between these two in both range and available bandwidth, satisfying the need for medium range links.

[0050] As shown in FIG. 1, an architecture structured according to an embodiment of the present invention compromises both physical layer 104 and media access control (MAC) layer 102 components. At the physical layer 104 the functional components of the architecture may include components for radio frequency modulation 110, interference temperature measurements 120, narrow-band receive-transmit R-T excision 130, variable-gain spread spectrum 140 and closed loop link power control 155. The MAC layer 102 comprises components for implementing co-site clustering and serialized access to long-range links and elevated nodes 162,

opportunistic forwarding 164 and multiple correlators 166 for detecting specific waveform patterns. Each of these components are described in more detail below.

CO-SITE CLUSTERING AND MULTIPLE CORRELATORS

[0051] A significant problem encountered when using the spectrum for wireless communication is co-site interference, which occurs when transmissions to distant nodes overwhelm reception by local nodes. The present invention addresses the co-site interference problem by using multiple independent transceivers of different frequencies (bands) to establish short links (e.g., 60 - 90 dB PL), medium links (e.g., 90 - 120 dB PL), and long links (e.g., 120 - 150 dB PL), as shown in Table 1 above.

[0052] Co-site clustering and serialized access component 162 comprises MAC protocols that automatically define W-LAN groups (good internal connectivity with short-range links), in which use of any medium-range link is serialized. W-MAN groups (nodes with good internal connectivity using medium-range links) are defined, in which use of any long-range link is serialized.

[0053] A K-Means vector quantization algorithm may be used to define co-site clusters and dynamically update them. Within each cluster (e.g., squad W-LAN), a point coordination function (PCF) is used to serialize access to a medium-range link. Each cluster alternates between receiving over multiple medium-range links, and transmitting over one medium-range link. Using multiple correlators 166 and a different spread spectrum code for each W-LAN permits simultaneous use of medium-range links by different squads without interference.

[0054] In a preferred embodiment, a number of nodes have elevated antennas to provide long-range links for "Small World" latency reduction and low-latency quality of service (QoS) traffic.

As described below, a specialized MAC protocol to handle the very high fan-in usually associated with using elevated nodes may be used to avoid congestion at the elevated node.

[0055] For extremely low delay traffic, packets are forwarded to any node in the direction of the destination (lower hop count) that is not currently transmitting (like a soccer player passing to an open teammate downfield). Although this violates the customary practice of strict protocol layering, by using instantaneous information from the MAC layer to guide network forwarding decisions, it eliminates the dominant end-to-end latency effect of channel access delay at each hop. Opportunistic forwarding component 164 carries out this function. The opportunistic forwarding component 164 carries out forwarding of packets based on their indicated (differential services, or diffserv) quality of service. Bulk traffic is forwarded via low-power multi-hop routing, to maximize spatial reuse of frequencies and enhance LPI/LPD. Real-time voice traffic traverses the network in fewer hops at higher power in order to minimize end-to-end latency.

CLOSED LOOP LINK POWER CONTROL

[0056] Closed loop link power control component 155 provides feedback from each receiver to a neighboring transmitter to minimize transmit power for a reliable link. This maximizes spatial reuse of frequencies, minimizes network self-interference, improves LPI/LPD, and minimizes battery drain for portable nodes.

[0057] This may be accomplished by keeping transmit power density low (e.g., < 50 mW/MHz or 1 W per 20 MHz) in any frequency or time interval, subject to topology control to maintain a connected network. This also enhances spectrum compatibility with other friendly narrowband and wideband (NB and WB) systems. This limit on power density also helps achieve LPI by

thwarting linear (spectrum analyzer) interceptors. Wideband waveforms may be used to achieve the desired ranges.

VARIABLE-GAIN SPREAD SPECTRUM

[0058] Variable gain spread spectrum component 140 controls the processing gain (spectrum spreading factor) associated with a node in the network. In preferred embodiments, different levels of security may be implemented by varying the processing gain (PG). In the military battle context, for example, very high PG (e.g., 30 dB) may be used during covert insertion and special operations; medium PG (e.g., 20 dB, higher data rate) may be used for entry and positioning of major forces; and modest PG (e.g., 10 dB, highest data rates) be used during actual battles. Flexible software radio technology enables the use of variable PG.

[0059] Multiple receive correlators 166 in the MAC layer 102 may be used to receive simultaneously from multiple neighbors. Spread spectrum signaling increases bandwidth by a factor of the PG. Using multiple correlators recoups spectrum efficiency by a factor of the number of neighbors, up to the square root of the PG.

NARROWBAND R & T EXCISION

[0060] Narrow band R-T Excision component 130 controls the process for using zero power at certain frequencies during transmission and ignoring information (power) existing at those frequencies on the receiving end. In preferred embodiments, orthogonal frequency division multiplexing (OFDM) waveforms with 25 KHz channels that support transmit and receive narrow band excision may be used to eliminate interference with legacy systems. The OFDM signal (which is the sum of many complex exponentials, each with an independent phase) approximates a Gaussian envelope featureless waveform for LPI/LPD. R&T excision may be

adjusted on a very dynamic basis (milliseconds) to underlay spectrum allocated for a legacy channelized narrow band system.

[0061] In preferred embodiments, short-term power spectrum measurements (<<1 sec) may be taken at the receiver, and narrow band (25 KHz) excision of spectral spikes are used to minimize interference produced by legacy systems. Matching narrow band excision of the same spikes at neighboring transmitters eliminates interference experienced by narrow band legacy systems.

INTERFERENCE TEMPERATURE MEASUREMENTS

[0062] Interference temperature measurements component 120 monitors aggregate signals present at the receiver in the wireless network. In preferred embodiments, each receiver does its own spectral analysis of local interference, assigns its own receive frequencies automatically, and reports them to its neighbors over a common, low data rate, configuration channel. Selecting low-interference frequency ranges minimizes transmit power requirements and avoids congested spectrum.

RADIO FREQUENCY (RF)-TO-BASEBAND, USING MULTIPLE TRANSCEIVERS

[0063] As described in more detail below, a wireless networking architecture according to the present invention may also include radio frequency modulation component 110 in order to increase throughput capacity and provide more secure transmissions. For example, and as described in more detail below, multiple transceivers may be used at each node to support simultaneous operation in multiple bands, simultaneous spectral analysis and communications, and other functions. Wide-sense stationary waveforms may also be used to thwart 2nd order cyclo-stationary interceptors. Zero mean, equal power, uncorrelated I and Q signals conceal the carrier frequency. Nyquist filtered symbols may also be used conceal the symbol clock.

[0064] In multi-antenna nodes, a separate time division duplex (TDD) transceiver may be assigned to each directional antenna. This provides far more throughput than a single-transceiver architecture that switches one transceiver among multiple antennas.

[0065] And finally, a distinct receive frequency may be assigned to each node for multiple, non-interfering transmissions in a network having a multiplicity of nodes.

[0066] A more detailed discussion of the characteristics of each node in a wireless network configured to operate according to a preferred embodiment of the present invention will now be provided. Each node in the preferred embodiment is configured to perform the following three receiver-centric activities.

1. Each node continuously carries out real-time sensing and characterization of the local spectrum at the receiver of each node due to (potentially interfering) narrowband and wideband emitters. For example, this analysis could use a 2K complex FFT every 100 usec to achieve 10 KHz resolution over a 20 MHz bandwidth of interest. These measurements will be different at each network node, since each node has a different interference environment. Any other information about the types of transmissions occurring in band with potential for sharing should be gathered at this time. The underlying principle here is that different "applications" can tolerate differing degrees of interference (i.e. A TV broadcast may not tolerate much interference but a wireless packet switched network may tolerate a small percentage of packet loss).

2. Based on the characterization performed as described above, each node further determines a waveform with optimal Power Spectral Density (PSD) to be used by neighboring nodes to transmit to this node. This process consists of "inverting" the various spectral spaces of opportunity into a realizable waveform that will approach the optimal performance predicted by pure water filling (to be described in detail below).

3. Each node reports its optimal receive waveform (an economical parametric characterization of the optimal PSD) to each of its (e.g., handful of) network neighbors for the neighbor's use in talking to this node, preferably along with an optimal transmit schedule and an expiration time after which the information should be considered stale. The waveform reporting function may be performed in conjunction with executing other functions provided by an optional XG transceiver application programming interface (API). Such APIs typically include extensions of the Future Combat Systems Communications primitives. These primitives currently support the receiving node's power control feedback loop with each of its neighbors. The feedback loop ensures that the XG signal arrives at this node's receiver with the same power from every neighbor, minimizing problems of near-far receiver masking).

[0067] This architecture is called receiver-centric, because it focuses largely on eliminating interference, which only occurs in the nonlinear circuits of a receiver, not at a transmitter. Each receiver is responsible for minimizing its own interference by designing a minimal-interference waveform, and directing all its neighbors to use this waveform to transmit to it. Different receivers will design different waveforms, depending on their local interference.

[0068] In preferred embodiments, the present invention may be characterized as having two different temporal metabolisms. At a low level, the local noise interference may be estimated on a msec-by-msec time scale, making very short term predictions that the next msec will resemble the previous one. On a longer time scale of tens or hundreds of msec, time-varying models of the interference may be developed based on recognition of the type of application (e.g., video stream) causing the interference. On this time scale, a temporal model may be used to predict which short term waveform should be used at which time.

METHODS FOR TIME-FREQUENCY WATER FILLING

[0069] A description of the methods used to derive an optimal power spectrum density for static (short term) waveform generation based on short term (e.g., 1 msec) spectral measurements will now be provided. This method permits each transceiver to determine, based on measurements in its receiver, the power spectrum density its neighboring transceivers should use to transmit to it to maximize its detected signal to noise ratio (SNR) under the constraint of limited transmit power. In the embodiment described below, we assume that the interference spectrum over the next msec (or multiple msec) will be the same as it was in a previous measurement. It should be apparent to those skilled in the art, however, that when the measured spectrum changes significantly, the node must notify its neighbors of the updated optimal waveform.

OPTIMAL STATIONARY (SHORT TERM) WAVEFORM SELECTION

[0070] The water-filling approach has long been known as the optimal way to minimize the mean squared error of a channel with colored background noise. This optimality is based on minimizing the mean squared error between the signal at the detector and the originated signal (maximizing the received SNR), subject to the constraint that the transmitted signal has a limited total power S.

[0071] FIG. 2 shows a reference model defining the characteristics of a channel 210 between a transmitter 205 and a receiver 215. In FIG. 2, $P_s(f)$ is the signal power spectrum density (Watts/Hz) at the source. $H(f)$ represents the value of a band selection filter, which is equal to 1 inside the system's desired band of operations, and 0 outside the desired band of operations. Thus, band selection filter $H(f)$ rejects undesired out-of-band signals. $G(f)$ represents the value of the optimal matched filter. When optimal match filter $G(f)$ is applied to the input signal spectrum (which includes noise) at the detector, the filtered signal has the maximum signal to

noise ratio. T is the time interval (sec) for signaling one symbol. A T of 1 usec means a signaling rate of 1 Msamples/sec. $P_n(f)$ is the noise power spectrum density (Watts/Hz) arriving at the receiver along with the desired signal. The optimal PSD results from the "water filling" approach, where the sum of the interference level (weighted by the band selection filter) and the additional received signal power from neighbors is not more than a constant (the water level).

[0072] In a static world, the following optimal water filling would occur:

- At frequencies where local interference exceeds the water level, no power should be transmitted. This automatic transmit excision minimizes the interference from XG signaling to legacy users.
- At these same frequencies, the optimal matched filter in the receiver has zero gain. This automatic receive excision minimizes the interference from legacy users to XG users.
- As a result, the XG network is an underlay network service that meets the requirements for secondary use of the band, namely, accepting any interference from existing users and agreeing to cause no harmful interference.

[0073] In actuality, there are many reasons why this cannot happen in a real system. For example, there is always power leakage in the spectra because signals have finite bandwidth. The question is, how much is allowable, and whether the signal contained in that leakage is missed when it is reconstructed erroneously.

[0074] FIG. 3 graphically illustrates a method of calculating the power spectral density (PSD) of an optimal waveform according to embodiments of the invention. As can be seen in FIG. 3, the PSD (represented by the variable $P_s(f)$ in FIG. 3) is equal to the interference limit B minus the

measured noise floor $P_N(f)$ within the band of interest. The optimality of the waveform is based on minimizing the mean squared error between the signal at the detector and the originated signal, subject to the constraint that the transmitted signal has a limited total power S. Receive excision suffers from finite front-end dynamic range, limiting how large the peaks in FIG. 3 can be before they swamp the front end of the receiver. In this case, the spectrum cannot be inverted in one fell swoop, and may need to be passed through selective analog filtering before digitization.

CHARACTERIZING BACKGROUND INTERFERENCE

[0075] Techniques for defining the stationary waveform best tailored to the short-term noise/interference spectrum received at a node will now be described. These techniques may be used, in embodiments of the invention, to maximize the received SNR subject to limited transmit power. Noise in a specified bandwidth, W, appears as a bivariant Gaussian signal in the in-phase (I) and Quadrature-phase (Q) channels, both measured in RMS Volts across the impedance of the measuring device, typically R = 50 ohms. The total power measured in this bandwidth is then $P = (I^2 + Q^2)/R$, with a Gaussian probability density function (PDF) for both I and Q. A change of independent variable to measured power P shows that it has an exponential PDF equal to $1 / P_0 \exp(-P / P_0)$, with mean = standard deviation = P_0 and median $P_0 \ln 2 \sim .693\ P_0$.

[0076] Noise appears when coupling the measuring device to a resistive load or an antenna operating in a thermal environment with absolute temperature T Kelvins. The noise power resulting from thermal excitation is k T W, where k is Boltzmann's constant $1.38 * 10^{-23}$ Watts/Hertz/Kelvin. This results from Einstein's equipartition of energy theorem, where each mode of a system in thermal equilibrium receives an excitation of kT/2 joules. However, any

measuring device has implementation defects characterized by a noise figure F, which is the ratio of its actual measured noise power referred to the input of the device, to the ideal value of k T W for the thermal noise above. Here the reference value of T is conventionally taken as 290 K (room temperature), and F is normally a few dB for low noise amplifiers. The net equivalent input noise is thus k T F W.

[0077] Attaching antennas to a node also brings in signals from intentional radiators. When there are large numbers of uncorrelated faint signals (e.g., from many distant radiators) in the bandwidth being measured, the Central Limit Theorem (CLT) says that the resulting summed signal again approaches a bivariant Gaussian. Therefore, this particular background interference can also be characterized as thermal noise in a still hotter environment, namely a higher value of T. The FCC Spectrum Policy Task Force defines this equivalent as the interference temperature T_i.

TODAY'S SPECTRUM: NARROWBAND (NB) INTERFERERS

[0078] In addition to the noise signals described above, an antenna on a node will pick up strong signals from other (friendly and hostile) users. Many of these signals are narrowband (e.g., 25 KHz channels allocated for voice and low rate data in the UHF band), and may be non-Gaussian, since data signals often have constant envelopes for efficient power amplification. They can appear and disappear on time scales corresponding to users activating push-to-talk switches (i.e., a time scale of seconds). In the case of frequency hopping radios, the dwell time in a particular 25 KHz channel may only be on the order of milliseconds, while a cellular phone call can last minutes. In any case, these narrow band signals appear on a spectrum analyzer as narrow

"fingers" sticking up above the noise floor in the band of interest (which is normally MHz to tens of MHz wide).

[0079] The spectrum analyzer measures the power in each of a large number of adjacent frequency bins over a short time. The shortest time interval for independent measurements corresponds to calculation of a discrete Fourier transform (DFT), where the measurement interval is the reciprocal of the frequency bin resolution (e.g., 100 μsec measurements for 10 KHz resolution). The measurements described and plotted below were made using a Rhode & Schwartz lab quality spectrum analyzer, exporting digital data to EXCEL and MATLAB for analysis and plotting.

PROBABILITY DISTRIBUTION AND STATISTICAL ANALYSIS FOR "NOISE FLOOR" ESTIMATION

[0080] Experiments were conducted to carry out statistical characterization of the "noise floor" in a band of interest. The initial calibration experiments used a room temperature resistor (290 K) feeding a lab-quality Rhode & Schwartz Model FSEM spectrum analyzer examining a 5 MHz span centered on 450 MHz with 10 KHz resolution. (The spectrum analyzer was preceded by a 24 dB (5 dB N.F.) wide band preamp). The noise power measured in adjacent bins was uncorrelated.

[0081] FIG. 4 shows typical sample data plotted as a histogram (relative frequency of noise power occurrence ~ PDF, versus power) resulting from 500 independent power samples.

[0082] FIG. 5 shows the results of ten identical but independent measurement runs with histogram plotted on a log scale, as a function of the power measured. The straight line of log probability versus measured power demonstrates the predicted exponential probability density function $1 / P_0 \exp(- P / P_0)$, with $P_0 = 0.198$ fW (-127 dBm). This measured power is 7 dB

above k T W (-134 dBm), so the experimental setup has a 7 dB noise figure. The plot shows that the statistical fluctuation in the measurements is far greater at higher power levels, where the small number of samples results in relatively greater sampling fluctuations.

[0083] In order to estimate the "noise floor", i.e., the interference temperature, N power samples were averaged for each frequency bin in order to get a stable, unbiased estimate of average power. The PDF for this sample mean is the N-fold convolution of the exponential PDF scaled by a factor of N, namely:

$$\Pr ob(P) = \frac{N^N}{(N-1)!}\frac{P^{N-1}}{P_o^N}\exp(-NP/P_o) \qquad \text{(Equation 1)}$$

with mean P_0 (as expected) and mode (most probable power) of P_0 (N-1) / N. For N = 10, the median is 0.95 P_0. The standard deviation is P_0 / sqrt(N). The sqrt(N) factor in this denominator can substantially reduce the variations (statistical fluctuations) in our estimate of the mean power in the noise floor. If the spectrum analyzer does a DFT every 100 μsec (10 KHz resolution), averaging ten samples per bin would take 1 msec to develop this estimate of mean power in all bins.

[0084] FIG. 6 shows a comparison of a histogram derived by averaging the results of the 10 experiments of FIG. 5 (relative frequency of occurrence of a given mean power in a bin), compared with the theoretical PDF of Equation 1 above. The agreement between the two histograms is excellent, showing that a 10-sample power estimate in each bin provides a good characterization of the noise floor P_0.

[0085] As described above, some frequency bins will reflect strong narrowband signals by measuring relatively large power. The goal is to determine which bins contain only noise power

corresponding to the measured noise floor (interference temperature), and which contain strong signals. The XG signal PSD will then fill up each noise-only bin to a "water filling" temperature below the FCC-specified maximum interference temperature, and transmit zero in bins where strong signals already exceed the water level. However, since all measures are probabilistic, any decision must be characterized by its confidence level, as described below.

[0086] The null hypothesis is that there is only noise in bin M. If the power measurement for this bin is statistically significant (e.g., 0.01), then the null hypothesis for this bin is rejected, and the conclusion is that there is a strong signal present. Such a large mean power measurement would happen only in one run out of 100 if only random noise is present. This permits rejection of the null hypothesis with a fair degree of confidence. The significance level is the area under the tail of the PDF of the sample mean. Bins with a sample mean that exceeds the corresponding significance threshold are judged likely (e.g., with the corresponding 99% confidence) to contain a strong signal, and a system according to the present invention transmits no power in those bins. This provides transmit excision at the transmitter to minimize interference to narrow band users, and receive excision in the receiver's matched filter to minimize narrow band interference to wide band users. The remaining bins are judged likely to contain only noise, and the system transmits power in those bins up to water filling temperature, below the FCC-specified maximum permissible interference temperature.

[0087] Since the sample mean is the sum of N independent identically distributed variables, its distribution approaches Gaussian (CLT). The 99% probability distribution threshold is P_0 (1 + 2.33 / sqrt(N)).

[0088] FIG. 7 shows a spectrum analysis of received signals when strong narrow band signals are present. The plot in FIG. 7 was made in linear power rather than dB in order to focus on the structure of the noise floor, and to provide an absolute reference of zero Watts. The strong signals reach far off the top of the plot (one signal is 50 dB above the noise floor). It is the noise floor, however, that we want to investigate.

[0089] FIG. 8 shows a histogram of received power corresponding to FIG. 7. The histogram (422 samples) shows the typical power distribution "bump" due to the noise floor. Histogram samples far to the right in FIG. 8 correspond to strong signals. If FIG. 8 contained all of the samples for the received power in FIG. 7, one could observe another 78 samples (not shown in FIG. 8) located many chart widths far off to the right of the chart shown in FIG. 8 representing the strong signals. However, these strong signals are not of particular interest because it is the noise floor that is being measured. Matching the low-power histogram bump with a theoretical curve corresponding to average noise power P_0 permits us to estimate the underlying noise floor P_0, in spite of the presence of strong signals. This will also determine the threshold at 99% confidence (at P_0 (1 + 2.33 / sqrt(N)) to separate the bins containing the narrow band signals from those containing only noise. The waveform synthesized as a result of this measurement will have support over disjoint frequencies, namely those judged to contain only noise.

[0090] Table 2 below shows measured results in characterizing a 5 MHz wide noise floor centered at 450 MHz at different times of the day (10 AM, 3 PM and 6 PM). The table shows average power per 10 KHz bin.

Source	290 K Resistor	Inside lab antenna	Window antenna @ 10 AM	Window antenna @ 3 PM	Window antenna @ 6 PM
P_O=Avg.Pwr.	$2.0 * 10^{-16}$ W	$3.5 * 10^{-16}$ W	$3.5 * 10^{-16}$ W	$6 * 10^{-16}$ W	$7 * 10^{-16}$ W

Table 2: Noise floor measured as a function of time of day.

[0091] FIGs 9 and 10 show the spectrum at 10 AM and 6 PM respectively. The later spectrum obviously has many more high power narrowband signals, and the effects of some of their "skirts" (unintended radiation at nearby frequencies) can be seen in the elevated noise floor. At other frequencies, the noise floor is elevated for unknown reasons, perhaps because of large numbers of additional faint signals.

[0092] Analysis of a single "noise only" bin in the time domain showed no discernible features. Each scan has nonrepeating wiggles (like Gaussian noise), and successive values (at 100 used sampling interval for the 10 KHz analysis bandwidth) are uncorrelated.

[0093] The results of these tests provide a strong indication that the elevated (and varying) noise floor is the sum of a large number of weak narrowband signals (or a smaller number of wideband signals) from unknown sources outside the building, and some skirts from strong signals.

[0094] The results were at 450 MHz, where the noise floor was flat over the 5 MHz analysis range. Examination of an equal bandwidth at center frequencies of 300 MHz and 39 MHz again showed a flat noise floor, although the noise floor was further elevated by a few dB.

[0095] The experiments described above with reference to FIGs. 4-10 illustrate only one approach for characterizing the "noise floor" for water-filling spectrum uses, based on statistical analysis of power measurements as a function of frequency and time, and based on hypothesis testing. After reading the above discussion it should be apparent to those skilled in the art that

numerous other approaches may be used without departing from the scope of the present invention. Such experiments form the basis for algorithms, such as the one described below with reference to FIG. 15, which may be used in tranceivers configured to operate in accordance with embodiments of the present invention.

ALTERNATIVE ANALYSIS TOOL: MEDIAN FILTERS

[0096] Instead of using the sample mean as a power estimate for each bin, a sample median (nonlinear filter) may be used instead. A median filter outputs the 50% percentile value (the median) from a vector of N samples. These filters are often used in image processing to eliminate "outlier" samples due to impulsive noise, while preserving sharp edges.

[0097] FIG. 11 demonstrates the use of the median power across a band at a particular time as a normalizing factor for the power measured in each bin. Here, for each sample spectrum, a trial median was generated across the entire band. A number of the bins reflected very strong signals (far above the band median), so bins with power more than 2.5 times the median were discarded when calculating the final band median. For the 10 AM, 3 PM, and 6 PM data, discarding these bins eliminated 71, 82, and 97 of the 500 frequency bins, respectively. After rejecting consideration of these very strong signals, the band median power in remaining bands was recalculated to characterize the noise floor by normalizing bin power with the band median power.

[0098] The theory curve gives the theoretical probability density function obtained from integrating Equation 1. The quite similar resistor curve shows the results of measured noise from a resistor source. The other three curves (10 AM, 3 PM, and 6 PM) show increasing deviations from the theoretical curve and the resistor (noise only) curve. The vertical dotted line shows the

99th percentile value (P = 1.6 * Pmedian) for the theoretical curve. If this value is applied as the threshold to determine whether only noise is present in a bin or a signal is present, we will reject 1% of the bins in the noise-only case. Therefore, 99% of the noise only bins in the band will be targeted for reuse.

[0099] Using the same threshold algorithm at 10 AM, we would reject about 4% of the surviving 429 bins as containing signal. At 3 PM, we would eliminate use of 6% of the surviving 418 bins, and at 6 PM we would eliminate 15% of the surviving 413 bins for spectrum use. The overall result is that respectively 82%, 79%, and 70% of the band is still available for reuse at these times.

[0100] By using the above-described method, each receiver in a network operating in accordance with the present invention may characterize the noise floor of a band in terms of a median power across it, and normalize all bin powers in terms of this measured band median. Establishing a threshold (e.g., the 99th percentile for theoretical or measured "pure" noise) for signal presence determines the spectrum waveform for all neighbors to use to transmit to this node.

REPRESENTING THE WAVEFORM PSD (QUANTIFIED BITS)

[0101] The procedure above will mark a subset of the (hundreds to a few thousand) frequency bins as available for water-filled transmissions. Since each strong signal typically covers a number of contiguous bins, run length coding is a compact and efficient representation of this subset. If we have, for example, 12 strong signals appearing in a 4096-bin spectrum analysis, this representation might appear as 12 pairs of 12-bit integers (18 bytes total). The first number of each pair is the number of contiguous available frequency bins, and the second is the

number of following contiguous unavailable bins. This representation of the desired PSD is sufficiently compact that it can easily be added to the power control feedback loop to each neighbor node in the network, specifying both the neighbor's desired transmit power and its desired PSD.

TOMORROW'S SPECTRUM: INTERFERENCE TEMPERATURE WITH ADDED WB INTERFERERS

[0102] Once the FCC begins to succeed in its quest for more flexible and dynamic spectrum use, more wideband adaptive (XG-like) emitters will appear. They will use wideband signals to provide good spectrum compatibility among independent users, and high data rates in spite of limited transmit PSD. The resulting interference temperature will be the result of a number of uncorrelated low power wideband signals, again summing in the limit to a bivariant Gaussian signal. In this case, it isn't possible to identify individual emitters, just their composite power effect. The same statistical estimation techniques described above may be used to estimate the interference power in each bin, and send enough power in each bin to "fill it up" to the water-filling temperature below the FCC's maximum permissible interference temperature.

[0103] When the FCC's spectrum management revolution is complete and everyone is using XG technology, we can expect to see white Gaussian "noise" at all frequencies everywhere, equal to the FCC's permissible interference temperature in each band.

REPRESENTING THE XG WAVEFORM PSD (QUANTIFIED BITS)

[0104] A compact representation of the XG PSD for this case would again be a sequence of pairs of integers. The first number specifies the permissible power to be transmitted, and the second the number of contiguous bins to which the value applies. For six different measured noise floors in a band, 18 bytes can represent the desired XG PSD in the power-and-spectrum-

control feedback loop messages to neighbors. When strong narrowband signals are also present, the permissible power will be zero for that interval of bins.

TRADE STUDIES FOR DESIGN OF THE SHORT-TERM WAVEFORM

[0105] FIG. 12 depicts a model illustrating an integrated system concept according to an embodiment of the present invention. As shown in FIG. 12, the present invention uses water-filling (represented by the component designated 1201) for each node to create its optimal short-term receiving waveform for use by all of its neighbors to communicate with it. The resulting spectrum is nonuniform and covers disjoint frequencies. As a result, the time domain version of this waveform (a basic symbol on the channel) will be far more complicated than the sin(t)/t pulse generated by a brick wall frequency domain specification. In the following, a number of techniques for achieving very desirable waveform characteristics are presented. These techniques, which will be described in more detail below, include using: Intersymbol Interference Mitigation (component 1202); Spread Spectrum Transmissions (component 1203); Multiple Correlators (component 1204); and Wide Sense Stationary (WSS) Baseband Signals and Modulation (component 1205). When used in conjunction with operating nodes in a Power-Limited Regime (component 1206), these techniques provide a comprehensive spectrum reuse system that is far more efficient than any of the existing or proposed systems.

INTERSYMBOL INTERFERENCE MITIGATION

[0106] The power spectrum derived from the statistical noise floor characterization described above is a crenelated structure with fragmented frequency support. The first challenge was to transmit a sequence of basic symbols with this power spectrum (modulated to carry user data) in a way that intersymbol interference is tolerable. Obviously, spacing the symbols far apart in time will reduce the intersymbol interference, at the cost of greatly reducing the data rate.

[0107] An alternative approach is shown in FIG. 13. Here, the desired waveform is specified as a contiguous vector of complex Fourier coefficients *X(f)*, with constant amplitude and some phase structure. *X(f)* is the set of the coefficients to be transmitted over the channel, expressed as the complex value of each frequency bin of a complex waveform (as would result from a fast Fourier transform (FFT)). This frequency vector is then expanded to a wider bandwidth that has zeroes in the ranges where the spectrum estimator has judged that interfering signals are present. This wider band frequency vector is then inverse-FFT'ed into a time waveform for transmission across the channel. The symbol rate on the channel is higher, corresponding to the expanded bandwidth of this vector. *Y(t)* is the signal sent over the channel, which has the wider bandwidth. The undesired frequencies have been removed from *y(t)* by the transmit excision.

[0108] On the receive side (toward the right-most side of FIG. 13), the receiver does a matching FFT, "squeezes out" the undesirable frequencies (accomplishing receive excision), and then multiplies the frequency vector by the characteristic matched filter (with phases opposite to the original signal in each frequency bin) to produce the signal to be detected at the original symbol rate. The core structure (IFFT, channel, FFT) corresponds to OFDM modulation recently commercialized in IEEE 802.11a and 802.11g wireless LANs. Of course, the remaining structure (a spectrum shaping appliqué) is unique to XG. A Nyquist shaper (satisfying the Nyquist criterion for zero intersymbol interference) algorithm permits finite length symbols with no intersymbol interference, in spite of the use of noncontiguous spectrum. Thus, *X(f)* on the receiver side is a reconstruction of the original set of frequency coefficients with the same name at the sender. The user symbol rate matches the bandwidth of this frequency domain specification *X(f)*.

CDMA W/ MULTIPLE CORRELATORS – WHITE SIGNALS

[0109] Some throughput may be lost due to spreading (processing gain). By using multiple code division multiple access (CDMA) correlators at each receiver to permit multiple neighbors to send to the node at the same time, some of the throughput lost to spreading can be recovered. Examples of multi-correlator systems that exchange information with multiple nodes simultaneously include GPS (receiving from up to 12 satellites) and IS-95 CDMA downlink (sending to up to 64 cell phones). The present invention uses multiple waveforms (e.g., with differing phase structure) that all have the optimal PSD and have a small, tolerable level of mutual interference. For typical mobile ad hoc networks, nodes usually have 4 to 6 neighbors, so that is a reasonable estimate of the number of correlators needed, and thus the throughput factor that can be recovered from the spreading loss.

[0110] To achieve high performance CDMA, the present invention uses white waveforms (those having constant power spectrum density at the detector) with pseudorandom phase structure. A waveform of this type can be used to provide a signal that approximates a Gaussian envelope to improve LPI/LPD, while providing orthogonal CDMA for minimal interference among multiple simultaneous transmissions to the destination node.

[0111] Unlike the CDMA cell towers, the present invention uses small, light transceivers with small antenna structures, so the transceivers will only be able to operate in wideband half duplex, not full duplex, mode. This means that each node will alternate between a state of receiving from N neighbors simultaneously, and a state of transmitting either to one neighbor, or to N neighbors simultaneously when this doesn't require an impractical dynamic range. This requires MAC protocol that is quite different from conventional carrier sense multiple access/collision detect (CSMA/CD) protocols, such as IEEE 802.11, which uses RTS/CTS exchanges. The basic rule in the multi-correlator architecture of the present invention is to

transmit traffic to any neighbors that aren't currently transmitting. This approach provides another opportunity to use "Opportunistic Forwarding", as described above. For extremely low delay traffic, packets are forwarded to any node in the direction of the destination (lower hop count) that is not currently transmitting (like a soccer player looking for an open team mate downfield). This violates the customary practice of strict protocol layering, by using instantaneous information from the MAC layer to guide network forwarding decisions. It minimizes the dominant end-to-end latency effect of channel access delay at each hop, providing far lower network latency for critical real time traffic.

[0112] The invention also uses orthogonal CDMA waveforms, as well as that of the multi-correlator MAC protocol, described above, to achieve optimal performance.

LPI/LPD: WIDE SENSE STATIONARY BASEBAND SIGNAL AND MODULATION

[0113] The present invention generates a waveform with the optimal PSD that enhances LPI/LPD capability. In some applications, it is important to generate a wide sense stationary (WSS) water-filling waveform that minimizes features susceptible to intercept by a second order cyclo-stationary interceptor. Wide sense stationarity requires that all second order statistics of the signal are constant functions of time, meaning that the expected value of the signal (mean) is constant (chosen to be zero), and the expected variance (mean power) and the autocorrelation function are also constant functions of time. Specialized filtering and linear modulation architecture may be used to eliminate any spectral redundancy (nonlinear constant envelope and continuous phase modulations are easily susceptible to second order cyclostationary intercept). This symbol generation and modulation structure involves Nyquist filtering of the symbols (limiting symbol frequencies to 1/(2T), where T is the symbol period on the channel), to produce

constant mean power signaling, and to prevent exposure of the symbol clock by a magnitude-square operation.

[0114] In addition, the symbols are modulated onto a carrier using uncorrelated I and Q channels with equal mean power to prevent exposure of the doubled carrier frequency by a squaring operator. Making I and Q uncorrelated may be accomplished either by sending uncorrelated data on each channel, or by making Q the Hilbert transform of I, resulting in single sideband modulation of the carrier. Hilbert transforms are described in A. Papoulis, Probability, Random Variables, and Stochastic Processes, McGraw Hill 1991, which is incorporated herein by reference in its entirety.

USE OF POWER LIMITED SIGNALS FOR SPECTRUM COMPATIBILITY AND LPI/LPD: (DATA RATE << BANDWIDTH, EB ~ NO)

[0115] In preferred embodiments of the present invention, network links are operated in the power limited regime (transmitting far less than one bps per Hz), rather than the conventional bandwidth limited regime (with more than one bps per Hz), which requires high SNR (e.g. >10dB for 10-5 BER with QPSK). At the cost of lower data rates, this capability, along with closed loop power control on each link, will permit an entire network to operate in LPI/LPD mode. Using wide bandwidths and low power also greatly enhances the spectrum compatibility among multiple XG users and legacy users.

[0116] Preferably, the optimal water-filling waveforms produced by the above-described methods are used in a spread spectrum mode, where the user bit rate is roughly an order of magnitude less than the basic symbol rate. Spectrum spreading improves LPI/LPD and interference performance by a factor of the processing gain, at the cost of a reduced user data rate. The recently introduced Turbo-Hadamard codes, which provide very low rate (e.g. rate 1/8 or 1/16) forward error correction (FEC) coding, may be used to address this problem. A rate of

1/8 or 1/16 means that one user bit turns into 8 or 16 bits with forward error correction on the channel. These codes have been demonstrated to operate with 10-5 BER down to Eb/No ratios below 0 dB at the detector, which is close to the ultimate Shannon bound of Eb/No = -1.6 dB. With this approach, spectrum spreading and FEC are combined into a single operation. Operation at such low Eb/No ratios provides LPI/LPD and excellent spectrum compatibility with other users. The spread spectrum (e.g., an order of magnitude greater bandwidth than the data rate) permits resolving multipath components in the time domain, perhaps even power combining the energy of the different multipath components in a rake receiver.

[0117] FIG. 14 shows a high-level block diagram of a network node 1400 (such as a software radio, a router, etc.) configured to operate according to embodiments of the present invention. As shown in FIG. 14, node 1400 comprises a receiving antenna 1405, a transmitting antenna 1410, a receiver 1415, an input filter 1480, multiple correlators 1485, a network data processor 1490, a MAC controller 1495, a spectrum analyzer 1420, a buffer 1425, a signal data processor 1430, a transmitter 1450, a compressor 1445, an output filter 1440 and a waveform profile generator 1435.

[0118] Receiver 1415 continuously monitors and receives aggregate signals from the networking environment. When a signal is received, receiver 1415 passes the signal to spectrum analyzer 1420, which is configured to continuously measure power in all the frequencies contained in a frequency band of interest. The output from spectrum analyzer 1420 is a series of power values as a function of frequency. Typically, although not necessarily, spectrum analyzer 1420 would store multiple power functions in a buffer 1425, which is coupled to a signal data processor 1430 configured to create a model or "normalized" power function, such as by computing the average or median power reading at each frequency in the band of interest over a

given period of time. Signal data processor 1430 conveys the model power function to waveform profile generator 1435, which, in preferred embodiments, is configured to subtract the model power function from a specified interference temperature, limit or threshold, in order generate an optimal waveform profile that specifies which frequency neighboring nodes should use to communicate with node 1400. More particularly, waveform profile generator 1435 produces an optimal waveform profile 1401 that requires neighboring nodes communicating with node 1400 to use zero power at frequencies node 1400 has determined are already populated with signals generated by legacy communication devices in the network.

[0119] Output filter 1440 conforms the optimal waveform profile created by waveform profile generator 1435 to a format that will be understood by neighboring node 1460. In other words, output filter 1440 performs transmit excision to remove power from certain frequencies that neighboring node 1460 has determined should not be used because those frequencies are carrying data signals from primary users (e.g., legacy and high-priority users, such as police, governmental or military entities). Optionally, node 1400 includes a compressor 1445, which may be implemented in hardware, software, or both, which compresses the optimal waveform profile 1401 prior to sending it to neighboring node 1460 via transmitter 1450 and antenna 1410. In a preferred embodiment, node 1400 would also provide feedback information to neighboring node 1460 to assure that the signal neighboring node 1460 sends back to node 1400 arrives with the same power level as that of every other neighbor, minimizing problems of near-far receiver masking.

[0120] Neighboring node 1460 typically comprises substantially the same components as node 1400. For simplicity's sake, however, neighboring node 1460 is shown in FIG. 14 as being comprised of a processor 1467, decompressor 1465, output filter 1470, receiving antenna 1455

and transmitting antenna 1475. Neighboring node 1460 receives the signal containing the optimal waveform profile 1401 from node 1400 via antenna 1455. If the signal containing optimal waveform profile 1401 is compressed, decompressor 1465 of neighboring node 1460 decompresses the signal before passing it along to processor 1467. Processor 1467 is configured, in conjunction with output filter 1470, to use the optimal waveform profile 1401 to generate and send a new signal (optimal waveform 1402) conforming to the optimal waveform profile 1401 when transmitting data to node 1400. In other words, the signal has been filtered such that there is no power transmitted at the frequencies waveform profile generator 1435 determined carried signals from legacy transmission devices.

[0121] Neighboring node 1460 transmits information back to node 1400 in the form of the optimal waveform 1402 via transmitting antenna 1475. Notably, nodes 1400 and neighboring node 1460 may or may not use a single antenna to perform both the transmit and receive functions. During this transmission, optimal waveform 1402 may be influenced and/or partially contaminated by interference 1412 produced by other emitters (e.g., legacy transmitting devices) existing in the wireless networking environment.

[0122] When the signal carrying optimal waveform 1402 (combined with noise and interference produced from interference 1412) is received at node 1400 via antenna 1405 and receiver 1415, it will again be passed to spectrum analyzer 1420 for analysis and generation of an "updated" optimal waveform profile that takes into account changes in the wireless communication environment that may have occurred since the last optimal waveform profile was generated. Such changes in the wireless communication environment might occur, for example, due to a change in the physical location of node 1400 or other mobile nodes in the network, or by new emitters coming online in the vicinity of node 1400.

[0123] Receiver 1415 also passes the incoming signal to input filter 1480 (preferably, an optimal matched filter), which is configured to zero out (or ignore) any power carried at frequencies node 1400 previously determined were occupied by signals produced by legacy systems. In other words, input filter 1480 performs receiver excision because it is configured to be most sensitive where the optimal waveform profile 1401 requires there to be power, and completely insensitive to power signals carried on frequencies where the optimal waveform profile 1401 for node 1400 requires there to be no signal. In this way, input filter 1480 removes the noise and interference caused by interference 1412.

[0124] Input filter 1480 passes the filtered signal to a set of multiple correlators 1485 (containing correlators C1 through CN), each of which is configured to respond to unique patterns associated with one or more neighboring nodes in the vicinity of node 1400. Using multiple correlators in this manner allows node 1400 to receive from multiple neighboring nodes simultaneously. Once the incoming signal has been filtered by input filter 1480 and its source has been identified by multiple correlators 1485, it is then passed on to network data processor 1490 for processing of the data carried by the signal, according to the specific requirements, applications and/or networking protocols associated with node 1400 and the wireless communications network in general.

[0125] As discussed above, node 1400 is configured to operate in half-duplex mode, meaning that it is always in either transmit mode or receive mode, but not both at the same time. Accordingly, node 1400 also includes a media access controller (designated MAC controller 1495 in FIG. 14), which is responsible for switching node 1400 back and forth between receive mode and transmit mode. When node 1400 is operating in receive mode, it is capable of receiving multiple signals from multiple neighboring nodes, each of which uses the optimal

waveform 1402, as defined by node 1400 and transmitted to those neighboring nodes. Node 1400 identifies the source of those signals using correlators C1 through CN (designated 1485 in FIG. 14).

[0126] In alternative embodiments, node 1400 may be configured to use a common, low data rate configuration channel to transmit waveform profile 1401 to neighboring node 1460.

[0127] Although the example node shown in FIG. 14 and discussed in detail above shows components, such as processors, controllers, generators, antennas, filters and buffers, as separate physical components residing at node 1400, those skilled in the art would recognize and appreciate the fact that the invention may be advantageously combined or divided, depending on the needs of the particular implementation, into more or fewer processors, controllers, generators, antennas, filters and buffers than the number shown in the embodiment of FIG. 14, and that such components do not necessarily have to reside at each of the nodes in the network. It should be apparent, for example, that, although the example node in FIG. 14 shows two separate antennas for clarity, network nodes typically use only a single antenna for both transmit and receive modes. Accordingly, such alternative configurations are not meant to fall outside the scope of the claimed invention.

[0128] FIG. 15 contains a high-level flow diagram illustrating the steps performed in an embodiment of the present invention in order to process signals and manage interference received at a node, such as node 1400 described above with reference to FIG. 14. Beginning at step 1505, the node receives an aggregate radio signal available at the receiving node. When a signal is received, the system passes the signal through two parallel processing chains.

[0129] The first processing chain, depicted on the left side of FIG. 15, comprises steps 1515, 1520, 1525, 1530 and 1535. In step 1515, a plurality of instantaneous power measurements over

a given length of time are acquired for each frequency in a band of interest and, in some embodiments, stored in a buffer as shown in FIG. 14. Next, at step 1520, the system determines a model power level based on the plurality of power levels acquired in step 1515. Such model power level may be determined, for example, by calculating the average or median power level at each frequency during the period of time. The model power level at each frequency is then subtracted from an interference limit, step 1525. The interference limit may be specified by a government agency, a rule-making body an industry standard and/or some combination of all of them.

[0130] The difference between the interference limit and the model power level, which represents the amount of power spectrum available for use by next generation systems, is used, at step 1530, to generate an optimal waveform profile (OWP) for the receiving node to receive transmissions from a neighboring node. The optimal waveform profile requires that certain frequencies will not be used to communicate with this node because using those frequencies will interfere with legacy and primary users communicating in the band of interest. At step 1535, the optimal waveform profile (OWP) is transmitted to other nodes in the network. At this point, control returns to step 1505 where the system again receives the aggregate signal available at the receiving node.

[0131] While the optimal waveform profile (OWP) is being calculated, generated and reported to other nodes in steps 1525, 1530 and 1535, the received aggregate signal is also examined in a parallel chain of steps (steps 1540, 1545, 1550 and 1555 in FIG. 15) to determine whether the signal contains data sent specifically to this node from another specific node in the network. At step 1540, for instance, the aggregate signal is filtered, such as by an optimal matched filter, to remove all power carried on frequencies corresponding to transmissions by

legacy and primary users. These frequencies are the same frequencies specified for avoidance by the optimal waveform profile (OWP) generated in step 1530. Next, at step 1545, the filtered signal is correlated to identify a source for the transmission by determining whether it contains a unique pattern associated with a particular node in the network.

[0132] If a particular node is identified as the source of the transmitted and received signal, the system may optionally instruct that node to adjust the power level on its transmission (step 1550) so as not to overwhelm other nodes in the immediate vicinity. At step 1555, the signal data is passed to a network processor for further processing in accordance with the requirements of various applications and protocols, and control passes, once again, back to step 1505, where the system continues to receive an aggregate signal.

CLUSTERING OF NODES TO MANAGE THE LARGE DYNAMIC RANGE OF RF LINKS IN A MOBILE WIRELESS NETWORK.

[0133] Typical mobile networks have RF links that have a path loss (PL) range of 60 – 120 dB. This corresponds to a line-of-sight range variation (with r^2 loss) of 1000 to 1, or ground mobile range variations (with r^4 loss) of about 30 to 1. Co-site interference limits overall network performance because (high power) transmission to a distant receiver "deafens" all nearby receivers. This 60 dB dynamic range of path loss is beyond the normal power control and spurious-free dynamic range (SFDR) capabilities of typical RF transceivers.

[0134] In a preferred embodiment of the present invention, co-site interference may be addressed by dividing the available spectrum into two bands, with simultaneously operating, non-interfering half duplex transceivers on each. One set of transceivers is used within automatically formed short-range clusters, e.g., nodes with 60 - 90 dB PL to their neighbors within a cluster (intra-cluster communications). The other set of transceivers are configured to

operate over considerably longer paths (PLs in the 90 – 120 dB range), using far greater transmitter power, to provide inter-cluster communications. Factoring the spectrum into two bands with greatly differing path loss capabilities is one way of reducing the dynamic range required of any single transceiver to a range that is much easier to manage (e.g., 30 dB).

[0135] A manager for each cluster is automatically selected, e.g., by using a K-means (position vector quantization) algorithm. The manager provides a point coordination function that controls use of any inter-cluster link. The manager is accessed over the intra-cluster links, and grants only serialized access to use an inter-cluster link. Traffic need not flow through the manager, only the channel access permission for use of the inter-cluster links. This eliminates co-site interference within each cluster, by assuring that, at most, one long range transceiver is transmitting at a time within each cluster.

[0136] Multiple CDMA correlators may be used in each short-range transceiver, and a different CDMA transmission code assigned for each neighbor. Thus, a node can receive from multiple neighbors at the same time, as long as it is not transmitting. The ability to receive from multiple neighbors simultaneously on each band recovers some of the bandwidth lost to the CDMA code's spectrum spreading. Simultaneous CDMA reception from multiple neighbors is enhanced by using closed loop power control from each neighbor (e.g., over a 30 dB dynamic range) to assure that equal power arrives at the receiver from each neighbor.

[0137] In preferred embodiments, each correlator provides "carrier sense" to indicate when a particular neighbor is transmitting. The node alternates between modes of transmitting to a single neighbor, or receiving from multiple neighbors. When no outgoing traffic is queued to a neighbor that is not currently transmitting, the node switches to receiving mode. When outgoing traffic is queued and no neighbor is transmitting to this node, the node switches to transmit

mode. The same type of multi-correlator operation may be used for the long-range transceivers to improve their aggregate reception data rates as well.

[0138] Co-site interference may also be minimized by giving each node its own receive frequency. Under this scheme, transmit frequency is changed on a packet-by-packet basis to send each packet to the appropriate neighbor node on the neighboring node's own receive frequency. This permits a node to transmit out of one directional antenna (on the appropriate transmit frequency, i.e., the neighbor's receive frequency), while simultaneously receiving through multiple other directional antennas, pointed in other directions, on this node's own receive frequency. The benefits of simultaneous transmit and receive include both higher network throughput, and lower end-to-end latency for real time traffic.

[0139] A problem arises, however, when there are a multiplicity of nodes in a network and each node uses directional antennas to transmit and receive at the same time. Suppose, for example, the node comprises a moving vehicle equipped with multiple directional antennas, one on each side of the vehicle. The directional antennas usually do not provide enough signal separation to use the same frequency to broadcast on one side of the vehicle while receiving on the opposite side. The transmitting antenna will simply overwhelm the receiving antenna. For this reason, the transceivers on each node (or, in this case, each vehicle) in the network may be configured to have its own unique receive frequency and alternate between transmit and receive modes. While the node is in receive mode, and not transmitting, it will pick up any signal on its assigned frequency.

[0140] In some networks, there is simply not enough spectrum available to allocate a unique receive frequency to every node in the network. The present invention addresses this problem by assigning a small number of receive frequencies to nodes in such a way that nodes using the

same receive frequency are far enough apart so that they do not pick up each other's transmissions. In other words, adjacent nodes are never assigned the same frequency.

[0141] FIGS. 16, 17 and 18 show the results of simulation experiments for assigning different frequencies (sometimes referred to as "coloring") a random layout of fifty nodes in a network. First, as shown in FIG. 16, an attempt was made to assign frequencies to all 50 nodes using only two frequencies. In FIG. 16, the first frequency is represented by the squares and the second frequency is represented by the circles. If a link connects two nodes having the same frequency (shape), then that link is deemed to be unusable because it means those two nodes are sharing the same receive frequency. As FIG. 16 shows, it is not possible to assign one of the two frequencies (i.e., one of the two shapes) to all 50 nodes in such a way that there are no links connecting the same shape. Links connecting the same shape are shown as dotted lines in FIG. 16. So, for example, as shown in FIG. 16, the links between nodes 1 and 7, nodes 7 and 11, nodes 11 and 21, nodes 11 and 12, nodes 13 and 3, etc., are all unusable links. In this case, only 55% of the links in FIG. 16 are usable.

[0142] FIG. 17 shows the results of attempting to assign receive frequencies to the same set of nodes using three different frequencies (shapes) instead of two. Thus, a new frequency (represented by the star shape in FIG. 17) is available to use at different nodes as assigned receive frequencies. As can be seen in FIG. 17, after all of the nodes have been assigned one of the three available receive frequencies (shape), more of the links (89%) are usable than occurred with two frequencies (shapes). However, there are still a number of unusable links between nodes having the same frequencies (e.g., links connecting nodes 1 and 7, nodes 4 and 5, nodes 12 and 13, etc).

[0143] FIG. 18 shows the results of attempting to assign receive frequencies (shapes) to the same set of 50 nodes using four frequencies (shapes) instead of three. Thus, a fourth frequency (represented in FIG. 18 by the triangle shape) is now available to assign to nodes. Having four different frequencies (i.e., four different shapes) to assign to the fifty nodes makes it possible to have no adjacent nodes with the same frequency (or same shape). Thus, 100% of the nodes are connected by usable links. This being the case, there should be enough physical separation between nodes using the same receive frequency to transmit and receive simultaneously without experiencing harmful interference.

[0144] FIG. 19 shows a high-level flow diagram illustrating the steps that may be performed by a processor configured to assign receive frequencies to a multiplicity of nodes in accordance with the present invention, to ensure that there are no adjacent nodes that use the same receive frequency. Links that are connected to nodes having the same receive frequency are unusable. As shown in FIG. 19, the first steps, step 1910 and 1920, are to select a first receive frequency and assign it to all of the nodes in the network. Next, a new frequency (receive frequency number two) is allocated, step 1930, and made the current frequency (using the variable "curr_frequency") at step 1940.

[0145] Next, in step 1950, a node that is at one end of an unusable link and that is not already using the current frequency is selected. The current frequency is assigned as the receive frequency for the selected node unless doing so would create another unusable link in the network. See step 1960. In the next step, step 1970, the system checks to see if there are any more unusable links. If the answer is no, processing stops because all links are now usable and there is no need to proceed any further. However, if it is determined at step 1970 that unusable links still exist, then the next step, step 1980, is to determine whether any of the unusable links

are connected to a node not already using the current color. If the answer is yes, then processing returns to steps 1950 and then 1960, wherein that node is selected and assigned the current frequency unless doing so would create another unusable link. If, on the other hand, it is determined at step 1980 that none of the unusable links are connected to a node not using the current frequency, then processing returns again to step 1930, where another frequency must be allocated and then assigned to nodes connected to unusable links until either all links become usable or no other nodes can be assigned the newly allocated frequency.

[0146] The above-described embodiments are by no means meant to limit the scope of the invention. Though the invention has been described with respect to preferred embodiments thereof, many variations and modifications will become apparent to those skilled in the art upon reading this disclosure and the following claims, as well as practicing the claimed invention. It is therefore the intention that the claims be interpreted as broadly as possible in view of the prior art, to include all such variations and modifications.

CLAIMS

What is claimed is:

1. A method for managing interference in a radio communications network, comprising the steps of:

receiving an aggregated radio signal at a first node in the radio communications network on a plurality of frequencies;

determining a power level for the aggregated radio signal for each frequency in the plurality frequencies;

subtracting the power level for each the frequency from a power limit to produce a power differentials for the each frequency; and

instructing a second node in the radio communications network to avoid using a transmission frequency corresponding to a non-positive power differential in the plurality of power differentials to transmit to the first node.

2. The method of claim 1, further comprising the steps of:

receiving a transmission from the second node in the radio communications network; and

discarding any portion of the transmission carried on the transmission frequency.

3. The method of claim 1, wherein the step of determining a power level is carried out by:

acquiring a plurality of instantaneous power level measurements for each the frequency; and

calculating an average power level based on the plurality of instantaneous power level measurements.

4. The method of claim 1, wherein the step of determining a power level is carried out by:

acquiring a plurality of instantaneous power level measurements for the each frequency; and

calculating a median power level based on the plurality of instantaneous power level measurements.

5. The method of claim 2, wherein the discarding step comprises applying a filter to the transmission.

6. The method of claim 1, further comprising the step of:

sending to the second node a request to adjust a transmission power level on a frequency corresponding to a positive power differential in the plurality of power differentials.

7. The method of claim 1, further comprising the step of:

instructing a plurality of other nodes in the radio communications network to avoid using the transmission frequency to transmit information to the first node.

8. The method of claim 7, further comprising the steps of:

receiving a transmission from one of the plurality of other nodes; and

discarding any portion of the second transmission carried on a frequency corresponding to a non-positive power differential in the plurality of power differentials.

9. The method of claim 8, further comprising the step of:

sending to the one of the plurality of other nodes a request to adjust a transmit power level on a frequency corresponding to a positive power differential in the plurality of power differentials.

10. The method of claim 1, further comprising the steps of:

determining an updated power level for the aggregated radio signal for each frequency in the plurality frequencies;

subtracting the updated power level for each the frequency from the power limit to produce a plurality of updated power differentials; and

instructing the second node to avoid transmitting to the first node on a frequency corresponding to a non-positive updated power differential in the plurality of updated power differentials.

11. The method of claim 1, further comprising the steps of:

generating an optimal waveform profile based on the plurality of power differentials; and

reporting the optimal waveform profile to the second node.

12. The method of claim 11, wherein the reporting step is carried out using a common network configuration channel.

13. The method of claim 11, further comprising the step of compressing the optimal waveform profile prior to performing the reporting step.

14. The method of claim 11, wherein the optimal waveform profile specifies a waveform pattern.

15. The method of claim 14, wherein the waveform pattern defines a transmission signal having a power spectral density that varies over time.

16. The method of claim 14, further comprising the steps of:

generating a second optimal waveform profile based on the plurality of power differentials; and

reporting the second optimal waveform profile to a third node in the radio communications network;

wherein the second optimal waveform profile specifies a second waveform pattern that is orthogonal to the waveform pattern.

17. The method of claim 1, wherein the power limit is specified by a rule-making body.

18. The method of claim 1, wherein the power limit is specified by an industry standard.

19. The method of claim 1, wherein the plurality of frequencies comprises all of the frequencies in a radio frequency band.

20. The method of claim 1, further comprising the steps of:

associating a unique pattern with the second node; and

determining whether the transmission contains the unique pattern.

21. A method for managing interference in a radio communications network, comprising the steps of:

receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node;

filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies; and

transmitting the transmission signal to the second node.

22. The method of claim 21, further comprising the steps of:

receiving an optimal waveform profile from the second node, the optimal waveform profile being based on a plurality of power measurements for the plurality of frequencies and a power limit; and

conforming the transmission signal to the optimal waveform profile prior to performing the transmitting step.

23. The method of claim 22, further comprising the step of decompressing the optimal waveform profile prior to performing the conforming step.

24. The method of claim 22, wherein the power limit is specified by a rule-making body.

25. The method of claim 22, wherein the power limit is specified by an industry standard.

26. A method of managing interference in a radio communications network, the radio communications network having a multiplicity of nodes, each node in the multiplicity having attached thereto a set of antennas, each antenna in the set being oriented in a unique direction relative to other antennas attached to each the node, the method comprising the steps of:

dividing the multiplicity of nodes into a plurality of node clusters;

assigning a unique receiving frequency to each node in at least one node cluster;

assigning a unique transmission frequency to each antenna in the set of antennas attached to a first node in the at least one node cluster;

wherein the unique transmission frequency assigned to the each antenna corresponds to the unique receiving frequency assigned to a neighboring node in the at least one node cluster; and

wherein the neighboring node is located in the unique direction in which each the antenna is oriented to face.

27. The method of claim 26, further comprising the step of transmitting an outgoing message from the first node to the neighboring node via a transmitting antenna in the set of antennas attached to the first node using the unique receiving frequency assigned to the neighboring node.

28. The method of claim 27, further comprising the step of transmitting a second outgoing message from the first node to another neighboring node in the at least one node cluster via a second transmitting antenna in the set of antennas attached to the first node using the unique receiving frequency assigned to the another neighboring node.

29. The method of claim 28, wherein the step of transmitting the outgoing message to the neighboring node and the step of transmitting the second outgoing message to the another neighboring node are carried out simultaneously.

30. The method of claim 27, further comprising the step of receiving, at the first node, via a second antenna in the set of antennas attached to the first node, an incoming message from another neighboring node in the at least one node cluster, using the unique receiving frequency assigned to the first node.

31. The method of claim 30, wherein the step of transmitting the outgoing message to the neighboring node and the step of receiving the incoming message from the another neighboring node are carried out simultaneously.

32. A radio communications device, comprising:

a receiver configured to receive an aggregated radio signal;

a spectrum analyzer, coupled to the receiver, configured to produce a series of power readings for the aggregated radio signal for each frequency in a plurality of frequencies;

a waveform profile generator configured to produce a waveform profile based on the series of power readings and a power limit, wherein the waveform profile defines a set of unacceptable transmission frequencies; and

a filter, coupled to the receiver, configured to detect in the aggregate radio signal a transmission signal addressed to the radio communications device, and to discard any portion of the transmission signal carried on a frequency corresponding to an unacceptable transmission frequency in the set of unacceptable transmission frequencies.

33. The radio communications device of claim 32, further comprising a signal data processor configured to generate a model power level for the aggregated radio signal for each frequency in the plurality frequencies based on the series of power readings.

34. The radio communications device of claim 33, wherein the signal data processor is further configured to calculate an average power level based on a plurality of instantaneous power level measurements.

35. The radio communications device of claim 33, wherein the signal data processor is further configured to calculate a median power level based on a plurality of instantaneous power level measurements.

36. The radio communications device of claim 32, wherein the waveform profile is further based on a set of power differentials between the power readings for each the frequency and the power limit.

37. The radio communications device of claim 32, further comprising a transmitter configured to transmit the waveform profile to a second radio communications device.

38. The radio communications device of claim 37, further comprising a correlator, coupled to the filter, configured to determine whether the transmission signal contains a pattern uniquely associated with the second radio communications device.

39. The radio communications device of claim 37, further comprising a plurality of correlators, coupled to the filter, configured to determine whether the transmission signal contains one of a multiplicity of patterns, each pattern being uniquely associated with one of a multiplicity of other radio communications devices.

40. The radio communications device of claim 39, wherein each pattern in the multiplicity of patterns is orthogonal to each other pattern in the multiplicity of patterns.

41. The radio communications device of claim 32, further comprising a media access controller configured to toggle the radio communications device between a transmit mode and a receive mode.

42. The radio communications device of claim 32, further comprising a compressor configured to compress the waveform profile.

43. A method for managing co-site interference in a wireless network having a multiplicity of nodes, comprising the steps of:

identifying a subset of nodes within the multiplicity of nodes, wherein each node in the subset is capable of transmitting data to each other node in the subset in accordance with a connectivity threshold and using a power setting that falls within a low power range;

defining a collection of transmission frequencies to be used by nodes of the subset only when transmitting to a node outside of the subset; and

permitting only one member of the subset at a time to transmit using any transmission frequency within the collection.

44. The method of claim 43, further comprising the step of serially allocating to the members of the subset permission to transmit using a transmission frequency within the collection.

45. The method of claim 43, further comprising the step of defining a range of high power levels to be used by members of the subset while using a transmission frequency within the collection.

46. The method of claim 43, further comprising repeating the identifying step.

47. The method of claim 43, further comprising repeating the identifying step according to a schedule.

48. The method of claim 43, further comprising repeating the identifying step at regular intervals.

49. The method of claim 43, further comprising repeating the identifying step if a node in the multiplicity of nodes has changed locations.

50. The method of claim 43, wherein the identifying step is carried out using a K-Means vector quantization algorithm.

51. The method of claim 44, wherein the serially allocating step is carried out using a point coordination function.

52. The method of claim 43, further comprising the steps of:

identifying a second subset of nodes within the multiplicity of nodes, wherein each node in the second subset is capable of transmitting data to each other node in the second subset in accordance with the connectivity threshold using a power setting that falls within a medium power range;

defining a second collection of transmission frequencies to be used by the nodes of the second subset to transmit using a power setting that falls outside the medium power range;

permitting only one node of the second subset at a time to transmit using any transmission frequency within the second collection.

53. The method of claim 52, further comprising the step of serially allocating to the members of the second subset permission to transmit using a transmission frequency within the second collection.

54. The method of claim 52, wherein the step of identifying a second subset is carried out using a K-Means vector quantization algorithm.

55. The method of claim 53, wherein the step of serially allocating is carried out using a point coordination function.

56. The method of claim 43, wherein all nodes in the subset are configured to receive transmissions on any transmission frequency in the collection while no node in the subset is transmitting on the any transmission frequency.

57. The method of claim 56, further comprising the steps of:

associating a defined waveform pattern with the subset of nodes; and

determining whether received transmissions contain the defined waveform pattern.

58. The method of claim 56, further comprising the steps of:

associating a unique spread spectrum code with the subset of nodes; and

determining whether received transmissions contain the spread spectrum code.

59. The method of claim 43, wherein the collection comprises a radio frequency band.

60. The method of claim 43, wherein the subset is configured as a wireless local area network.

61. The method of claim 43, wherein the subset is configured as a wireless metropolitan area network.

62. The method of claim 43, wherein the subset is configured as a wireless wide area network.

63. The method of claim 43, wherein the subset is configured as a wireless Intranet.

64. The method of claim 43, wherein the wireless network is the Internet.

65. A method for managing congestion at an elevated node in a wireless network having a multiplicity of nodes, comprising the steps of:

identifying a subset of nodes within the multiplicity of nodes, each node in the subset being capable of transmitting data to each other node in the subset in accordance with a connectivity threshold and using a power setting that falls within a low power range;

defining a collection of transmission frequencies to be used by nodes of the subset only when transmitting to the elevated node; and

permitting only one member of the subset at a time to transmit using any transmission frequency within the collection.

66. The method of claim 65, further comprising the step of serially allocating to the nodes of the subset permission to transmit using a transmission frequency within the collection.

67. The method of claim 65, further comprising the step of defining a range of high power levels to be used by nodes of the subset while using a transmission frequency within the collection.

68. The method of claim 65, further comprising repeating the identifying step.

69. The method of claim 65, further comprising repeating the identifying step according to a schedule.

70. The method of claim 65, further comprising repeating the identifying step at regular intervals.

71. The method of claim 65, further comprising repeating the identifying step if a node in the multiplicity of nodes has changed locations.

72. The method of claim 65, wherein the identifying step is carried out using a K-Means vector quantization algorithm.

73. The method of claim 66, wherein the step of serially allocating is carried out using a point coordination function.

74. The method of claim 65, wherein all nodes in the subset are configured to receive transmissions on any transmission frequency in the collection while no node in the subset is transmitting on the any transmission frequency.

75. The method of claim 74, further comprising the steps of:

associating a defined waveform pattern with the subset of nodes; and

determining whether received transmissions contain the defined waveform pattern.

76. The method of claim 74, further comprising the steps of:

associating a unique spread spectrum code with the subset of nodes; and

determining whether received transmissions contain the spread spectrum code.

77. The method of claim 65, wherein the collection comprises a radio frequency band.

78. The method of claim 65, wherein the subset is configured as a wireless local area network.

79. The method of claim 65, wherein the subset is configured as a wireless metropolitan area network.

80. The method of claim 65, wherein the subset is configured as a wireless wide area network.

81. The method of claim 65, wherein the subset is configured as a wireless Intranet.

82. The method of claim 65, wherein the wireless network is the Internet.

83. A wireless network, comprising:

a plurality of short-range links;

a multiplicity of nodes configured to

automatically identify a cluster of nodes within the multiplicity capable of transmitting data to each other node in the cluster via the plurality

of short-range links using a power setting that falls within a low power range, and

select a node in the cluster to act as a long-range transmission manager, wherein the long-range transmission manager is configured to permit only one member of the cluster at a time to transmit using any power setting that falls outside the low power range.

84. The wireless network of claim 83, wherein the long-range transmission manager is further configured to allocate to the one member permission to transmit using a transmission frequency that falls within a collection of transmission frequencies.

85. The wireless network of claim 84, wherein each node in the cluster of nodes is configured to receive a data signal on the transmission frequency while no node in the cluster is transmitting on the transmission frequency.

86. The wireless network of claim 85, wherein each node in the cluster comprises:

a correlator configured to determine whether the data signal contains a pattern associated with the cluster.

87. A radio communications device for a wireless network having a multiplicity of other radio communications devices, comprising:

a transmitter configured to send data to any other radio communications device in the multiplicity using a power setting that falls within a low power range; and

a media access controller configured to receive a plurality of requests from the multiplicity of other radio communications devices to transmit using a power setting that falls within a high-power range;

wherein the media access controller is configured to grant only one request in the plurality of requests at a time.

88. The radio communications device of claim 87, further comprising a receiver configured to receive any transmission having a power level that falls within the high-power range while no radio communications device in the multiplicity of other radio communications devices is transmitting using the power level.

89. The radio communications device of claim 88, further comprising:

a correlator configured to determine whether the any transmission contains a pattern associated with a particular radio communications device in the multiplicity of radio communications devices.

90. The radio communications device of claim 88, further comprising:

a plurality of correlators, each one of the plurality of correlators being configured to determine which of the multiplicity of radio communications devices sent the any transmission.

91. In a wireless communications network comprising a multiplicity of nodes and configured to transmit a data stream along a route from a source node in the network to a destination node in the network according to a routing protocol, a method of managing real-time data traffic, the method comprising the steps of:

receiving at an intermediate node in the route a data packet from the data stream and a request to transmit the data packet to a next node in the route;

determining whether the next node is operating in a receiving mode;

if the next node is operating in the receiving mode, transmitting the data packet to the next node; and

if the next node is not operating in the receiving mode, forwarding the data packet to any other node in the multiplicity of nodes that is both in the receiving mode and nearer to the destination node than the intermediate node.

92. The method of claim 91, wherein the step of forwarding comprises the step of determining whether the any other node is operating in the receiving mode.

93. The method of claim 91, further comprising the step of periodically repeating the step of determining whether the next node is operating in the receiving mode.

94. The method of claim 91, further comprising the step of incorporating the data packet into a waveform containing a pattern uniquely associated with the next node.

95. The method of claim 94, wherein the next node comprises a correlator configured to detect the pattern.

96. The method of claim 91, further comprising the step of incorporating the data packet into a waveform containing a pattern uniquely associated with the any other node.

97. The method of claim 96, wherein the any other node comprises a correlator configured to detect the pattern.

SPECTRUM-ADAPTIVE NETWORKING

ABSTRACT OF THE DISCLOSURE

The present invention increases the available spectrum in a wireless network by sharing existing allocated (and in-use) portions of the RF spectrum in a manner that will minimize the probability of interfering with existing legacy users. The invention provides interference temperature-adaptive waveforms, and a variety of physical and media access control protocols for generating waveforms based on measurement and characterization of the local spectrum. The invention measures the local spectrum at a receiving node, generates an optimal waveform profile specifying transmission parameters that will water-fill unused spectrum up to an interference limit without causing harmful interference to primary and legacy transmitters using the same frequency bands, and enables simultaneous transmit and receive modes at a multiplicity of transceivers in a wireless network. The invention also provides closed loop feedback control between nodes, co-site interference management, intersymbol interference mitigation, wide sense stationary baseband signaling and modulation, and power limited signaling for avoiding detection and interception.

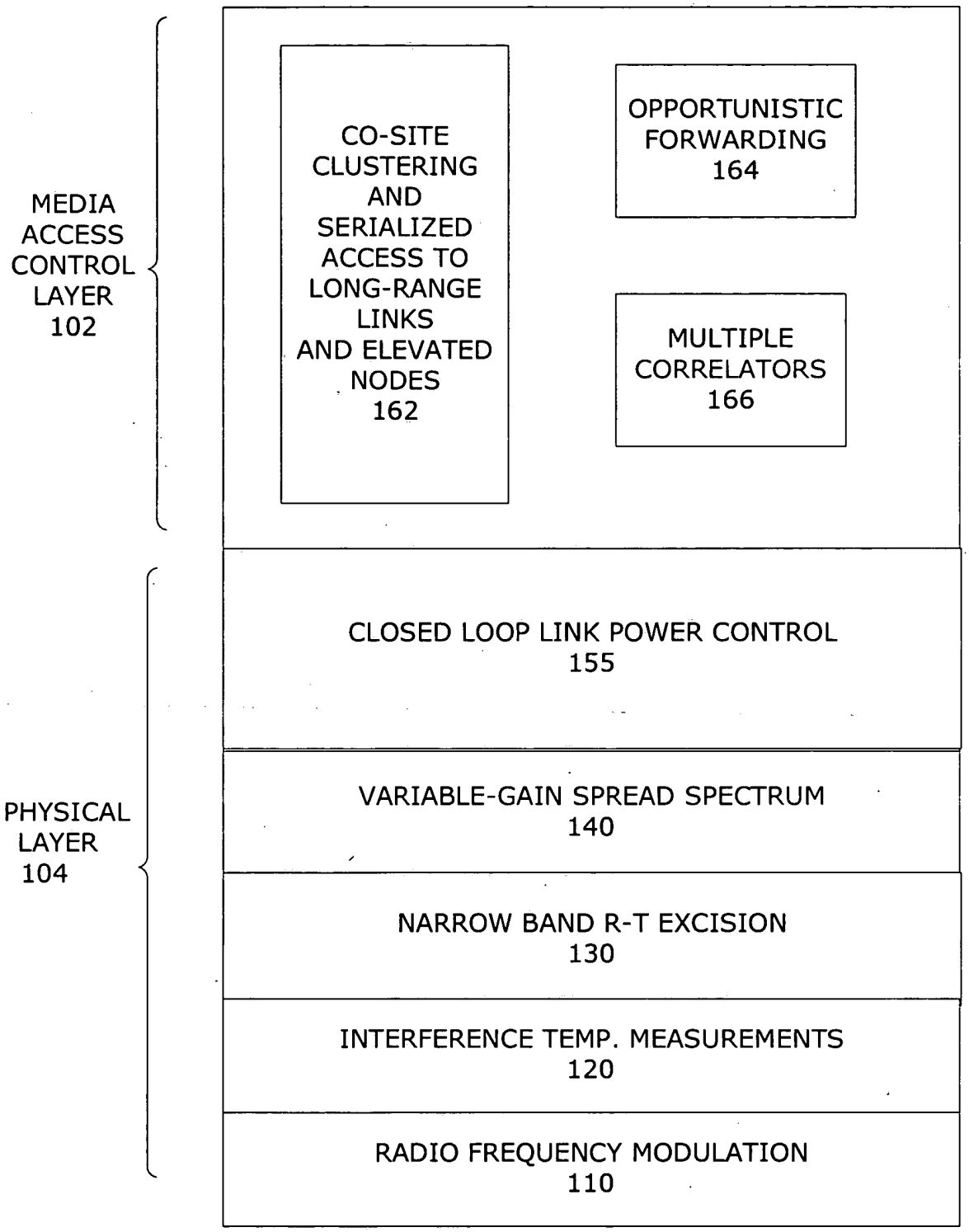

MEDIA ACCESS CONTROL LAYER 102
CO-SITE CLUSTERING AND SERIALIZED ACCESS TO LONG-RANGE LINKS AND ELEVATED NODES 162
OPPORTUNISTIC FORWARDING 164
MULTIPLE CORRELATORS 166
PHYSICAL LAYER 104
CLOSED LOOP LINK POWER CONTROL 155
VARIABLE-GAIN SPREAD SPECTRUM 140
NARROW BAND R-T EXCISION 130
INTERFERENCE TEMP. MEASUREMENTS 120
RADIO FREQUENCY MODULATION 110

FIG. 1

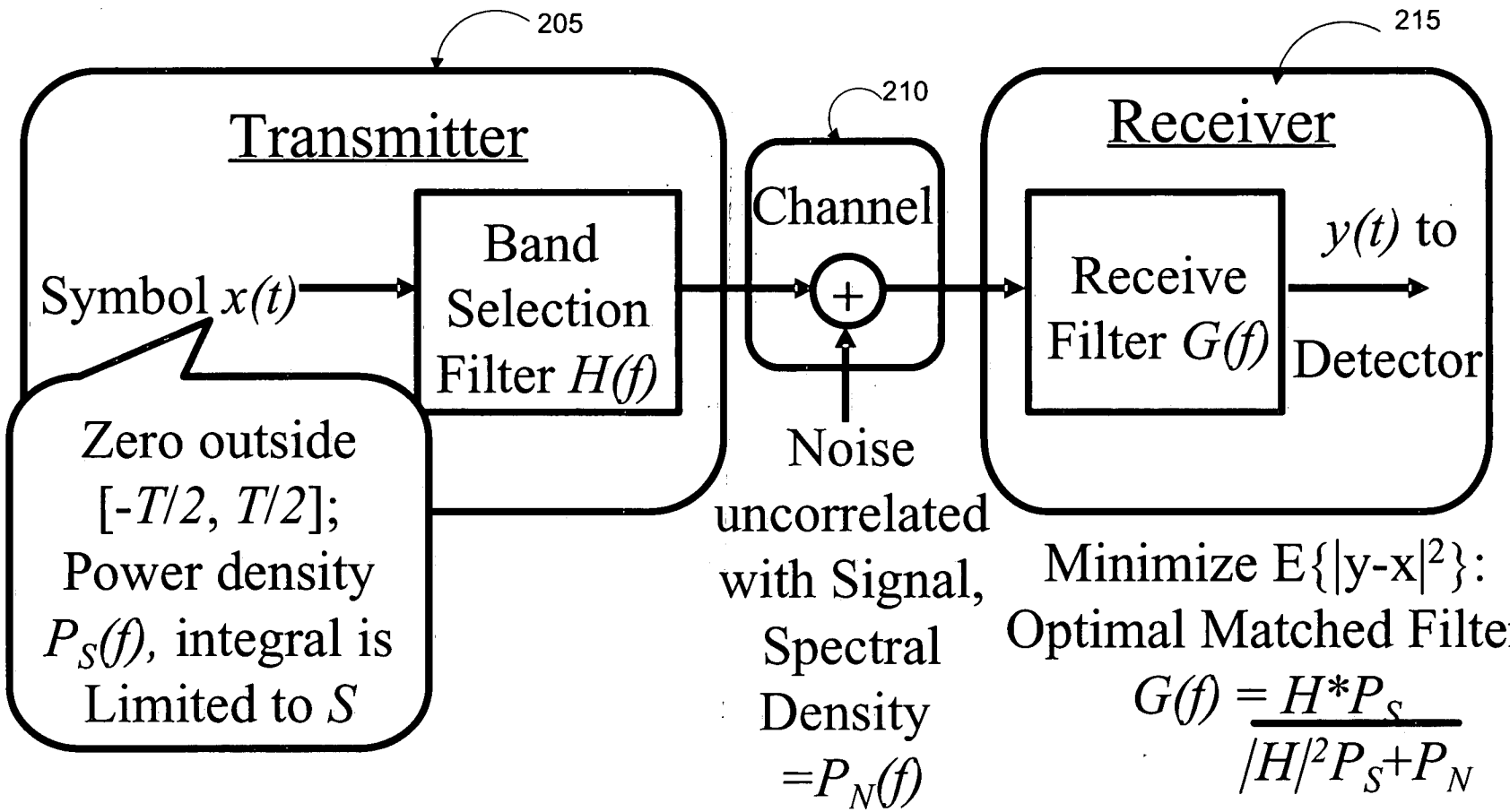

205
Transmitter
Symbol $x(t)$
Band Selection Filter $H(f)$
Zero outside $[-T/2, T/2]$; Power density $P_S(f)$, integral is Limited to S
210
Channel
+
Noise uncorrelated with Signal, Spectral Density $=P_N(f)$
215
Receiver
Receive Filter $G(f)$
$y(t)$ to Detector
Minimize $E\{|y-x|^2\}$: Optimal Matched Filter
$G(f) = \frac{H^* P_S}{|H|^2 P_S + P_N}$

FIG. 2

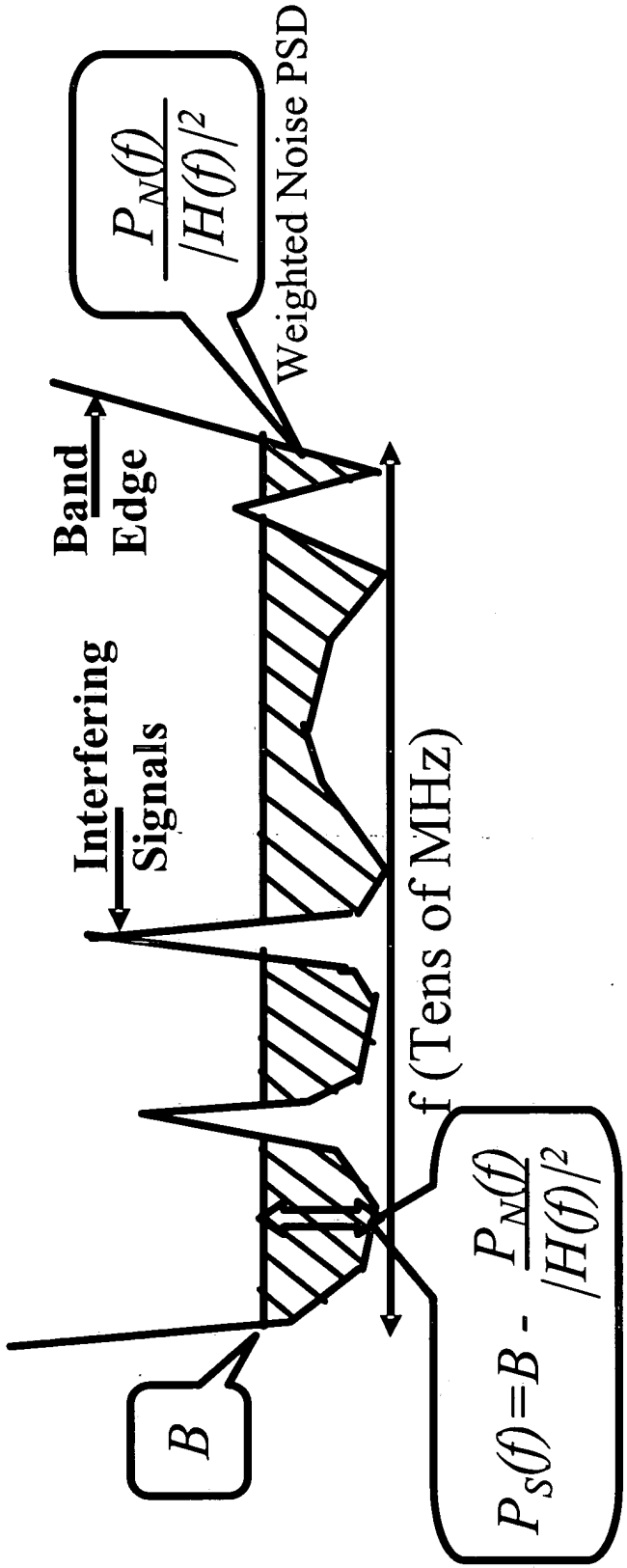

$\frac{P_N(f)}{|H(f)|^2}$
Weighted Noise PSD
Band Edge
Interfering Signals
f (Tens of MHz)
B
$P_S(f)=B-\frac{P_N(f)}{|H(f)|^2}$

FIG. 3

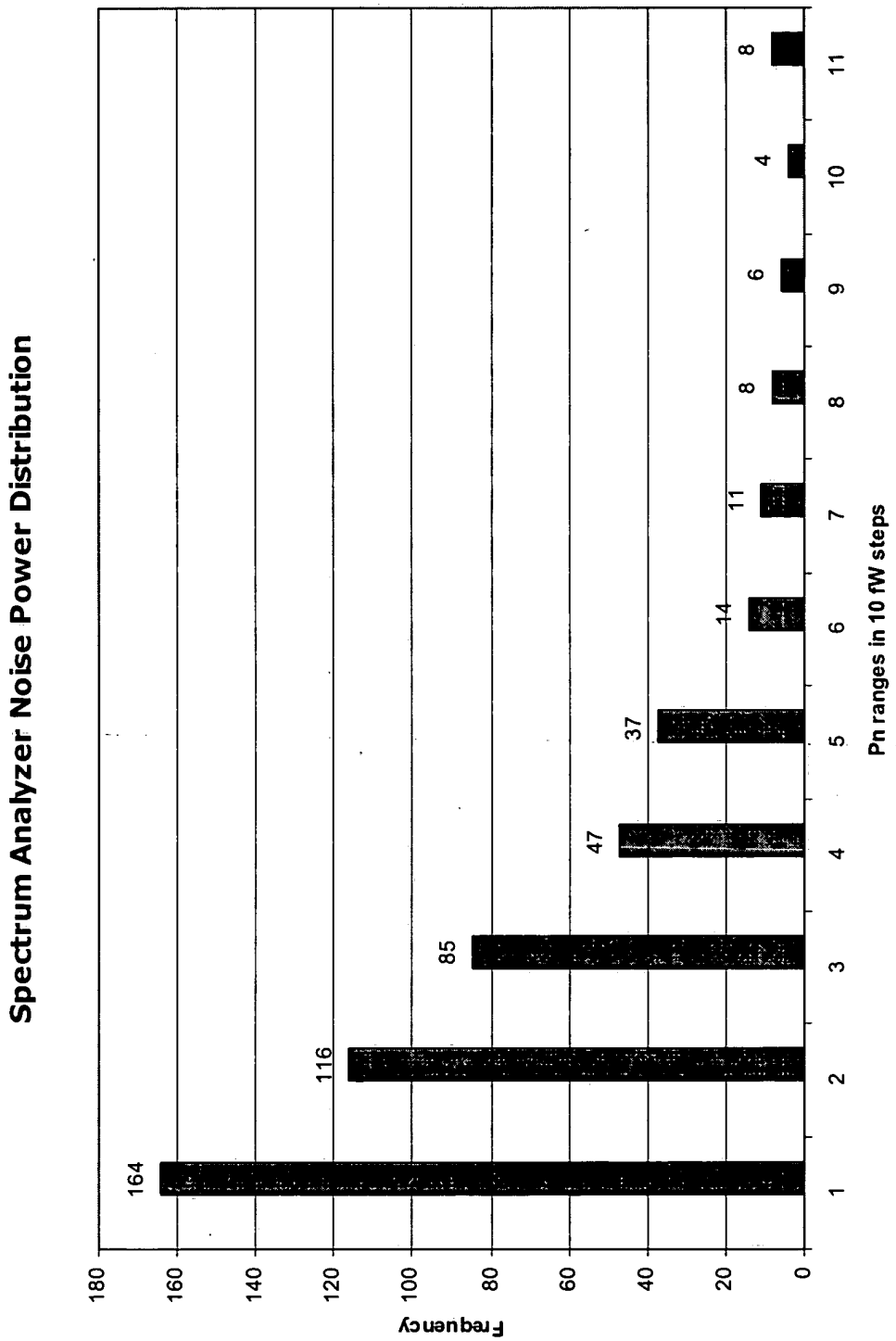

Spectrum Analyzer Noise Power Distribution
Frequency
Pn ranges in 10 fW steps
0
20
40
60
80
100
120
140
160
180
1
2
3
4
5
6
7
8
9
10
11
164
116
85
47
37
14
11
8
6
4
8

FIG. 4

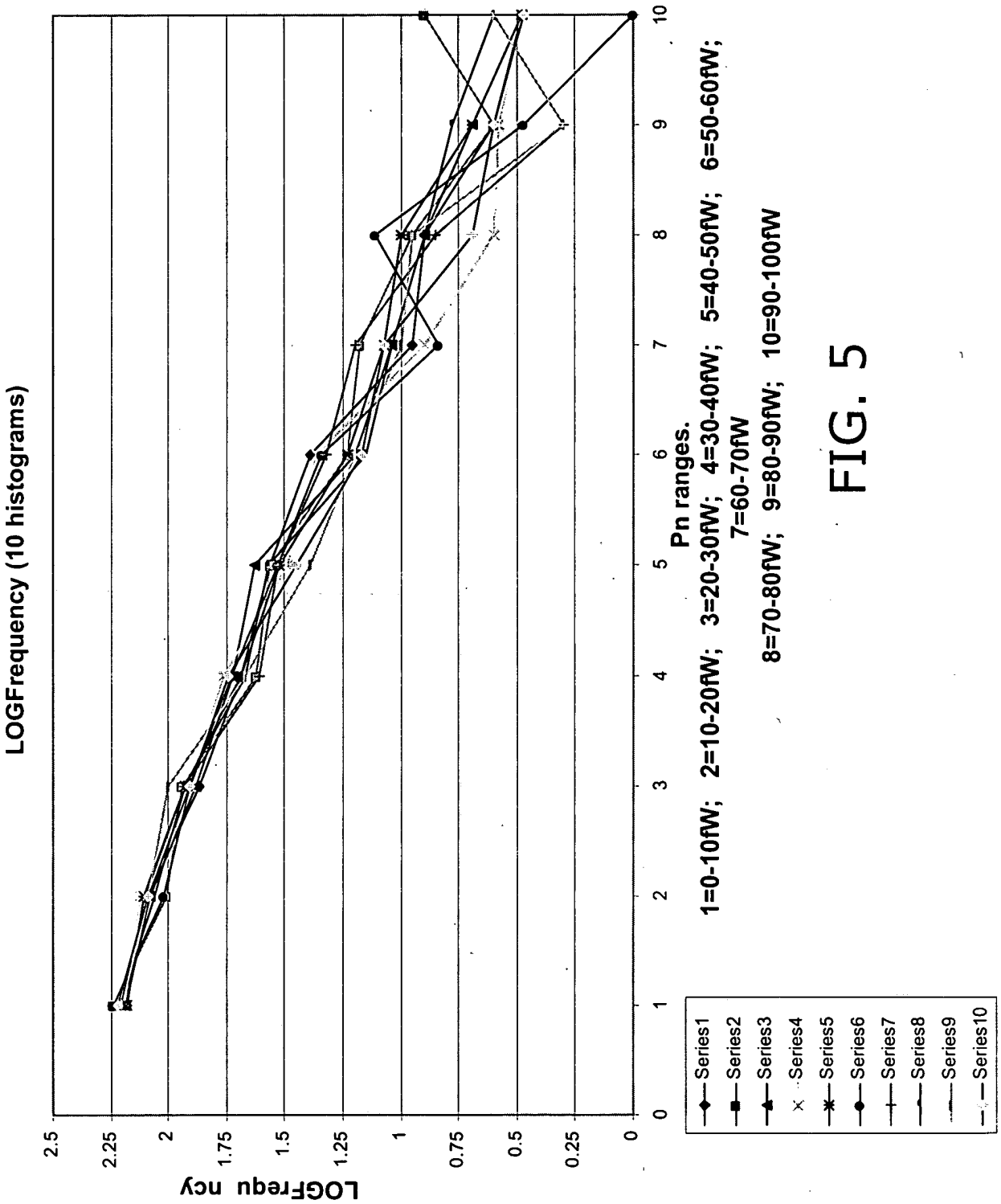

LOGFrequency (10 histograms)
LOGFrequ ncy
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
0
1
2
3
4
5
6
7
8
9
10
Pn ranges.
1=0-10fW; 2=10-20fW; 3=20-30fW; 4=30-40fW; 5=40-50fW; 6=50-60fW;
7=60-70fW
8=70-80fW; 9=80-90fW; 10=90-100fW
Series1
Series2
Series3
Series4
Series5
Series6
Series7
Series8
Series9
Series10

FIG. 5

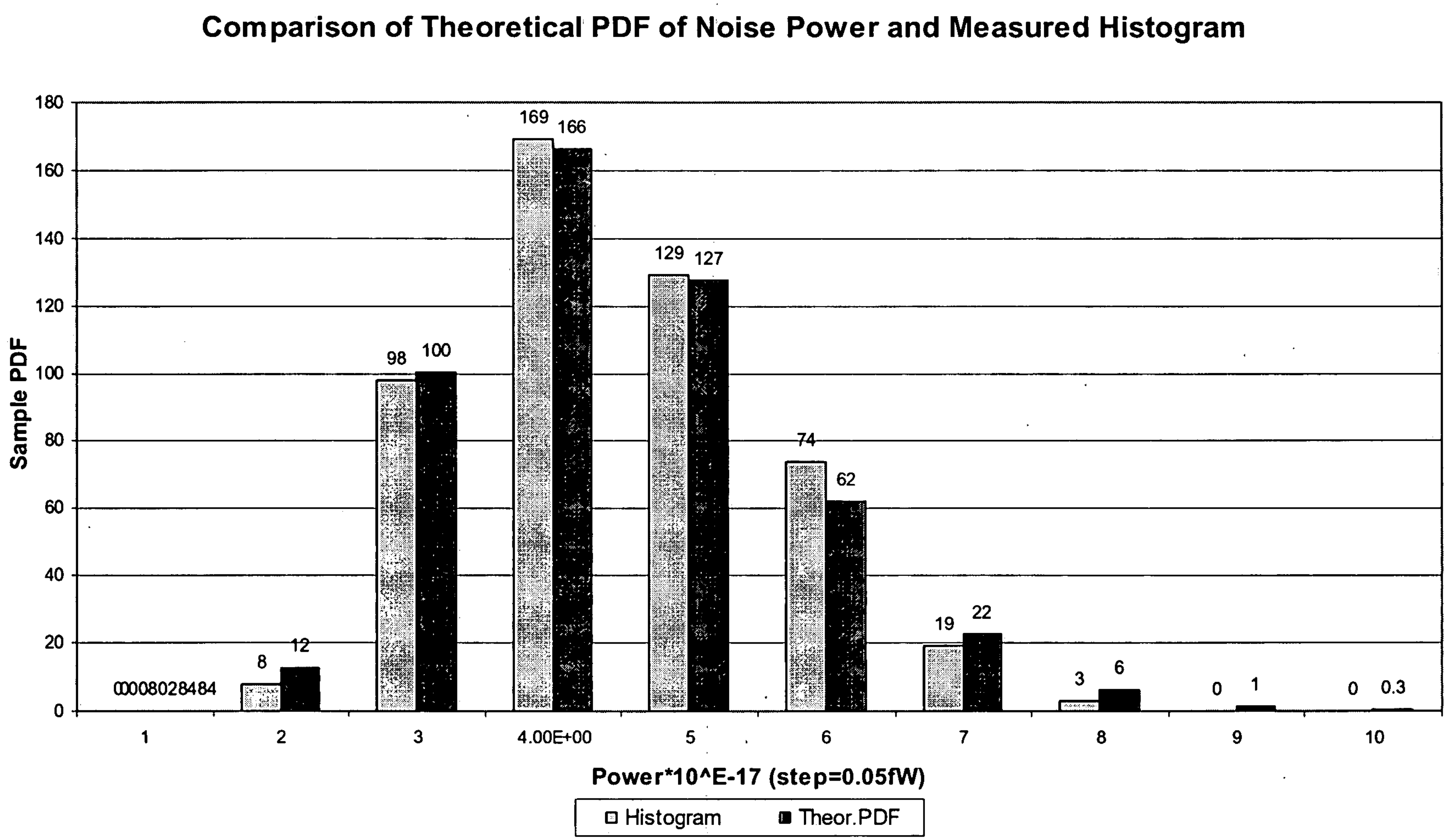

Comparison of Theoretical PDF of Noise Power and Measured Histogram
Sample PDF
180
160
140
120
100
80
60
40
20
0
0008028484
8
12
98
100
169
166
129
127
74
62
19
22
3
6
0
1
0
0.3
1
2
3
4.00E+00
5
6
7
8
9
10
Power*10^E-17 (step=0.05fW)
Histogram
Theor.PDF

FIG. 6

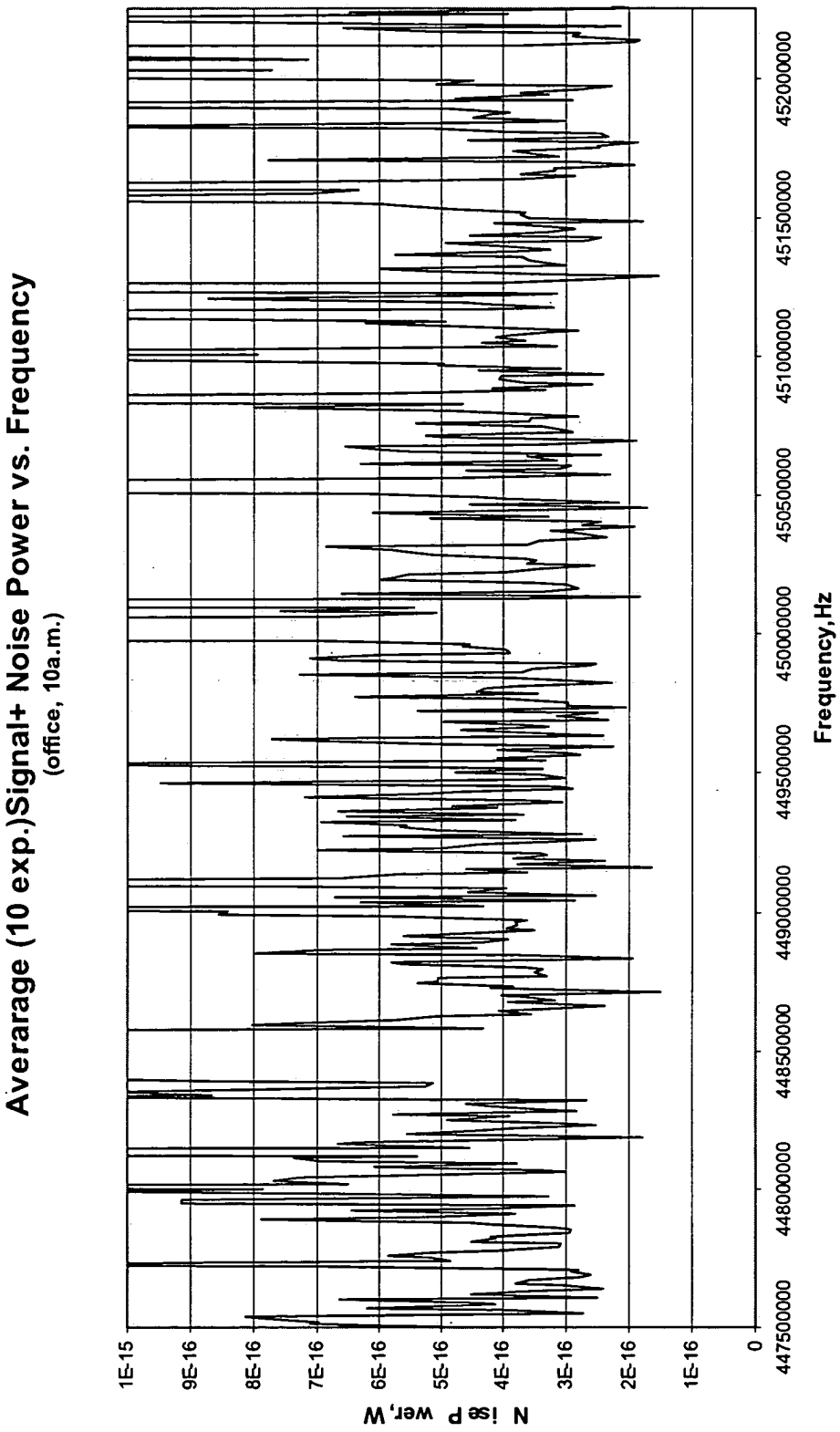

Averarage (10 exp.)Signal+ Noise Power vs. Frequency
(office, 10a.m.)
N ise P wer,W
1E-15
9E-16
8E-16
7E-16
6E-16
5E-16
4E-16
3E-16
2E-16
1E-16
0
447500000
448000000
448500000
449000000
449500000
450000000
450500000
451000000
451500000
452000000
Frequency,Hz

FIG. 7

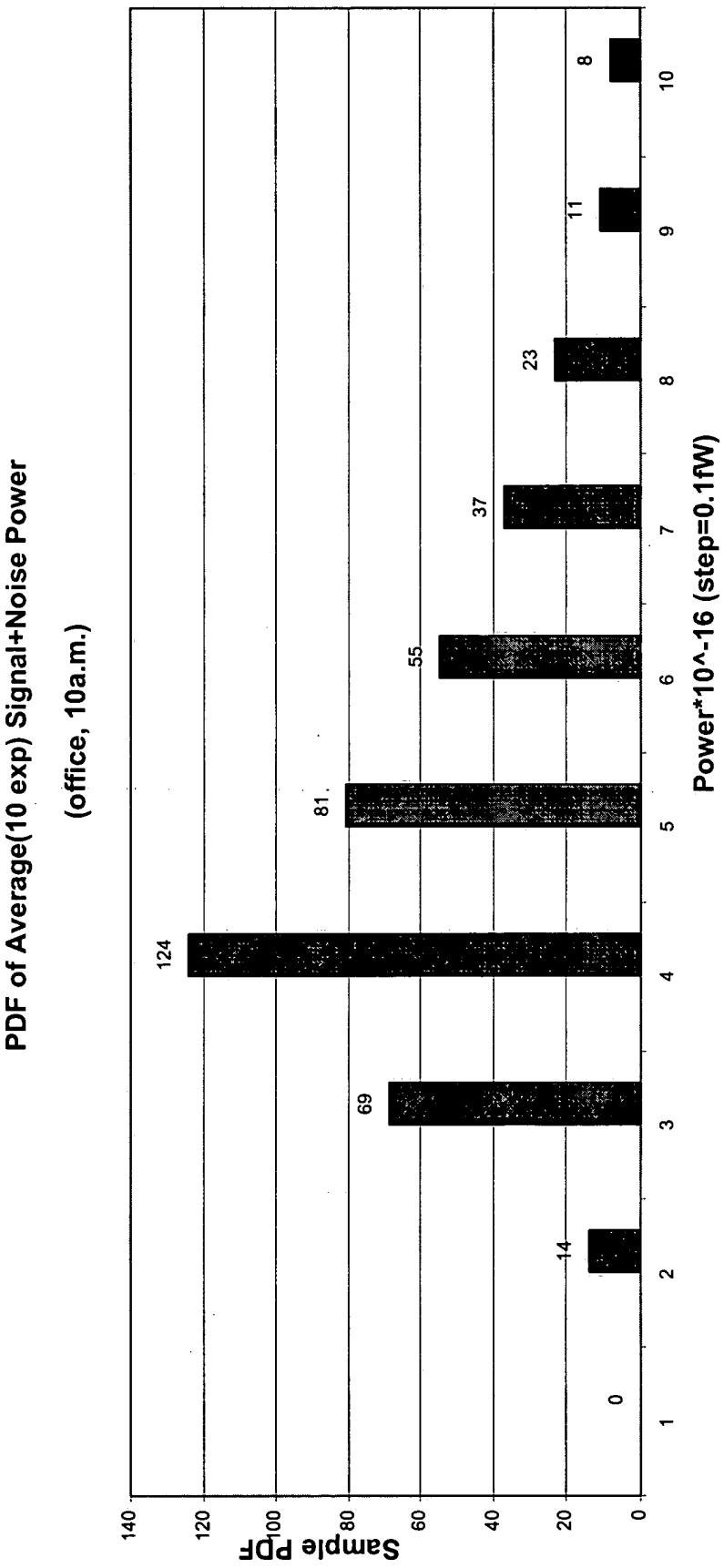

PDF of Average(10 exp) Signal+Noise Power
(office, 10a.m.)
Sample PDF
Power*10^-16 (step=0.1fW)
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7
8
9
10
0
14
69
124
81
55
37
23
11
8

FIG. 8

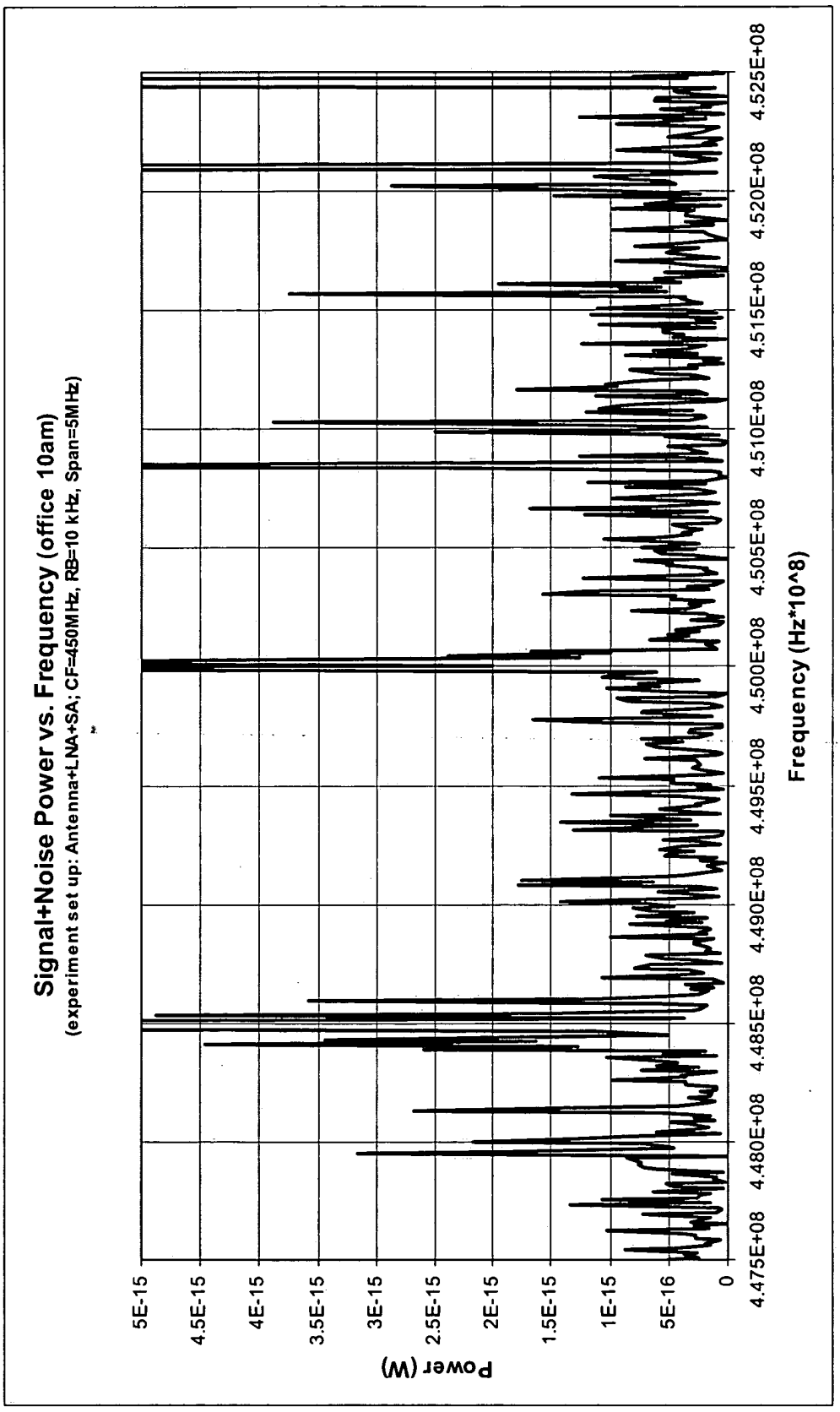

Signal+Noise Power vs. Frequency (office 10am)
(experiment set up: Antenna+LNA+SA; CF=450MHz, RB=10 kHz, Span=5MHz)
Power (W)
5E-15
4.5E-15
4E-15
3.5E-15
3E-15
2.5E-15
2E-15
1.5E-15
1E-15
5E-16
0
Frequency (Hz*10^8)
4.475E+08
4.480E+08
4.485E+08
4.490E+08
4.495E+08
4.500E+08
4.505E+08
4.510E+08
4.515E+08
4.520E+08
4.525E+08

FIG. 9

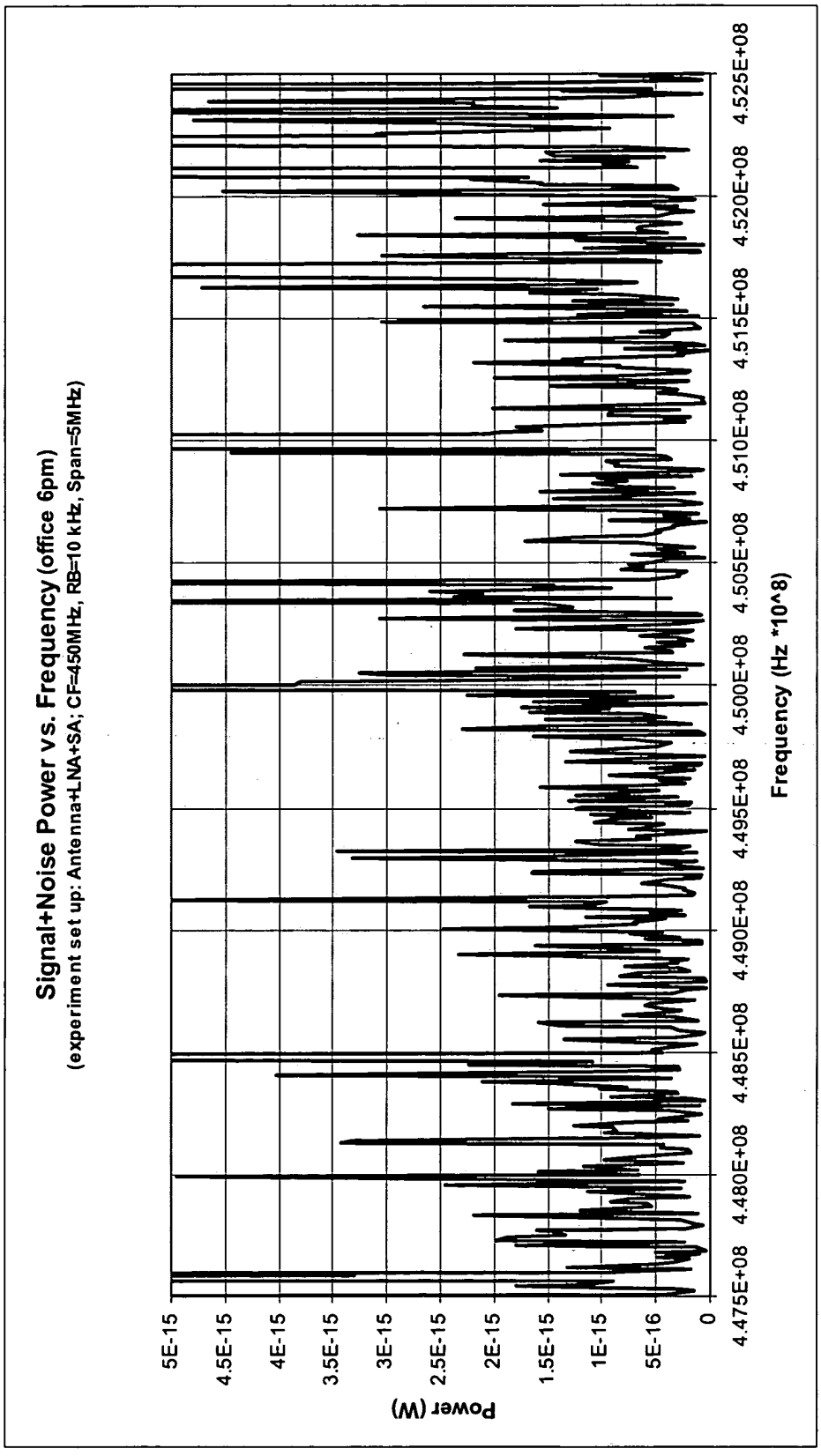

Signal+Noise Power vs. Frequency (office 6pm)
(experiment set up: Antenna+LNA+SA; CF=450MHz, RB=10 kHz, Span=5MHz)
Power (W)
5E-15
4.5E-15
4E-15
3.5E-15
3E-15
2.5E-15
2E-15
1.5E-15
1E-15
5E-16
0
4.475E+08
4.480E+08
4.485E+08
4.490E+08
4.495E+08
4.500E+08
4.505E+08
4.510E+08
4.515E+08
4.520E+08
4.525E+08
Frequency (Hz *10^8)

FIG. 10

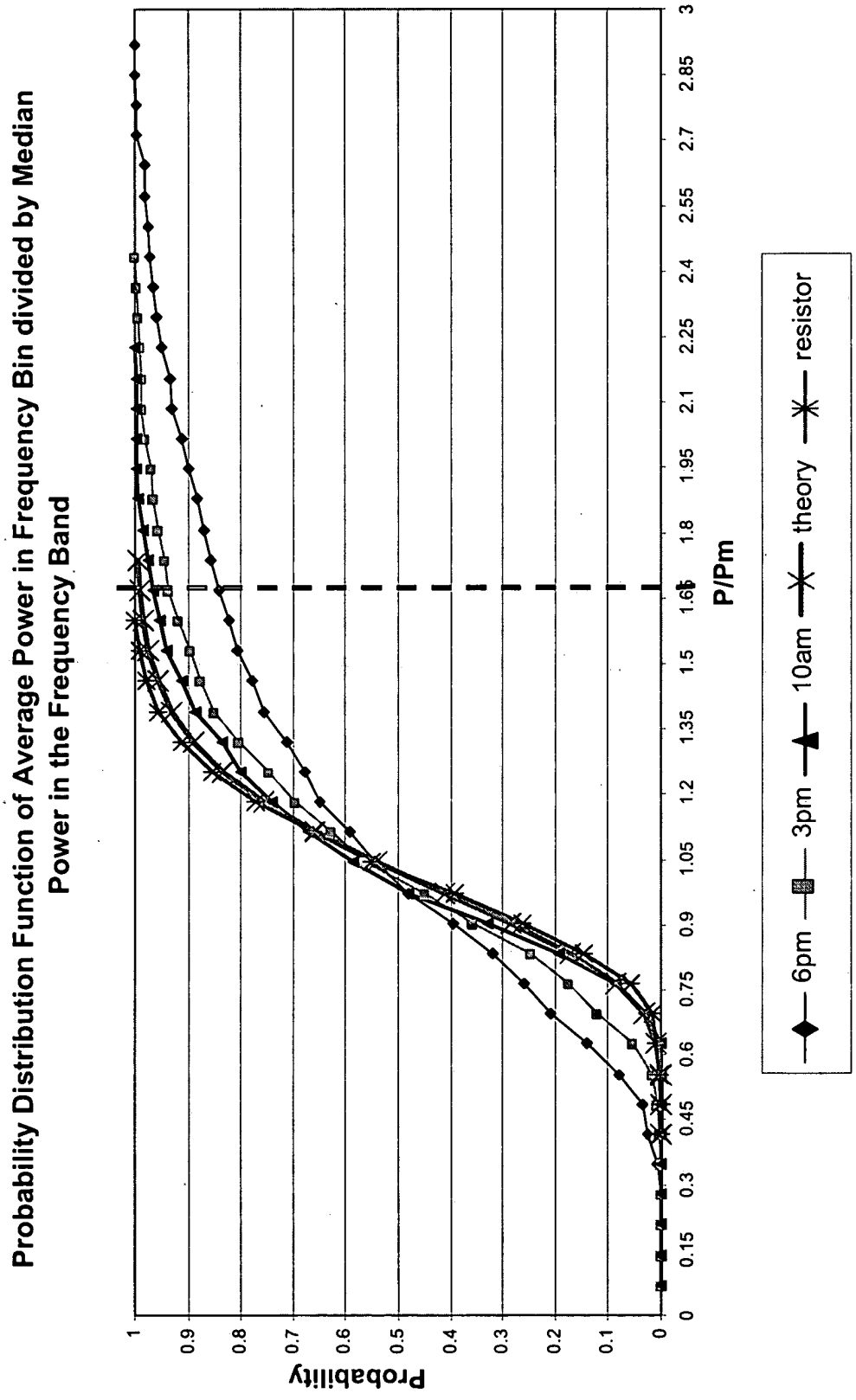

Probability Distribution Function of Average Power in Frequency Bin divided by Median Power in the Frequency Band
Probability
P/Pm
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.15
0.3
0.45
0.6
0.75
0.9
1.05
1.2
1.35
1.5
1.65
1.8
1.95
2.1
2.25
2.4
2.55
2.7
2.85
3
6pm
3pm
10am
theory
resistor

FIG. 11

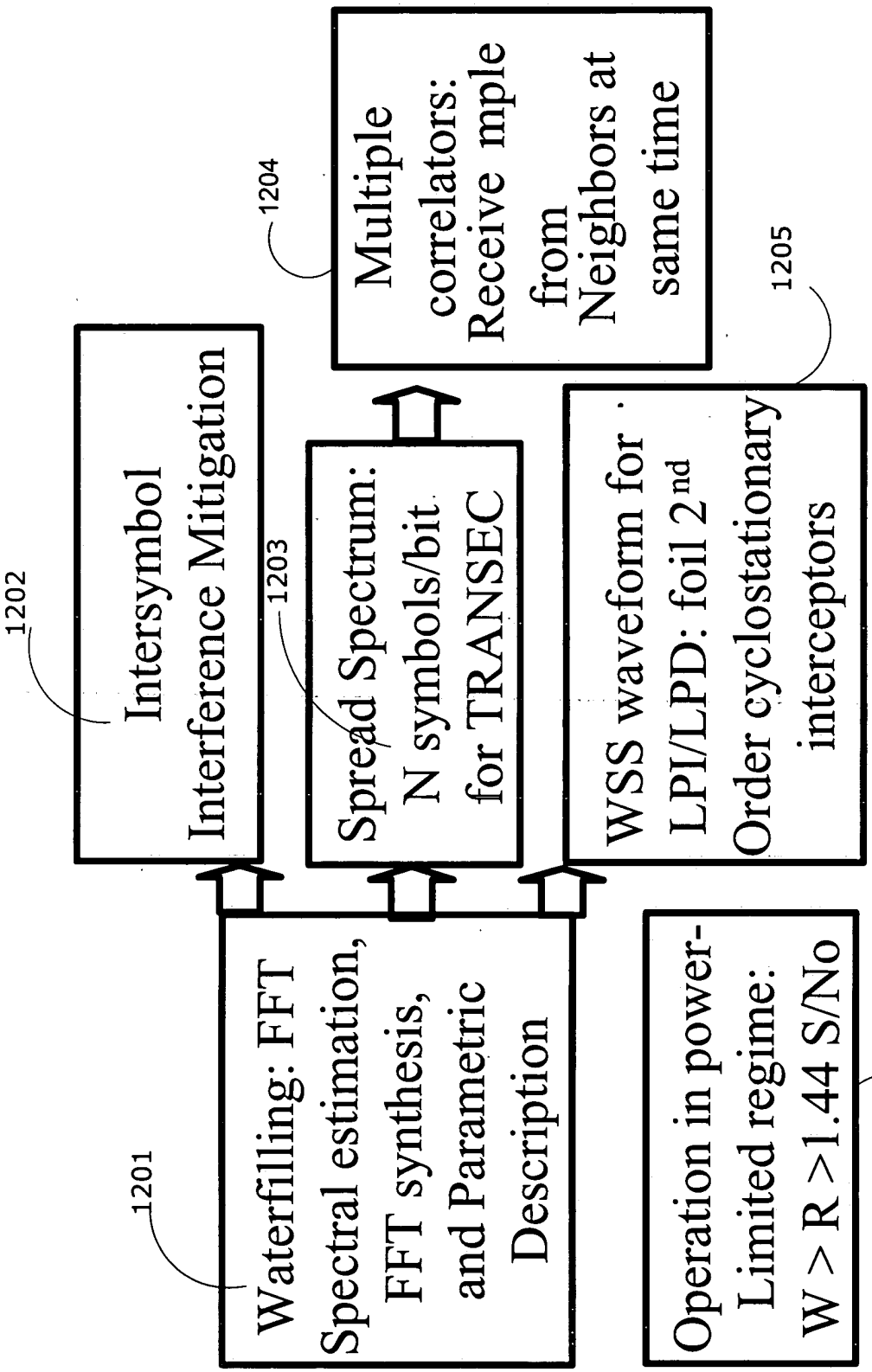

Waterfilling: FFT Spectral estimation, FFT synthesis, and Parametric Description
1201
Intersymbol Interference Mitigation
1202
Spread Spectrum: N symbols/bit for TRANSEC
1203
Multiple correlators: Receive mple from Neighbors at same time
1204
WSS waveform for LPI/LPD: foil 2nd Order cyclostationary interceptors
1205
Operation in power-Limited regime: W > R >1.44 S/No
1206

FIG. 12

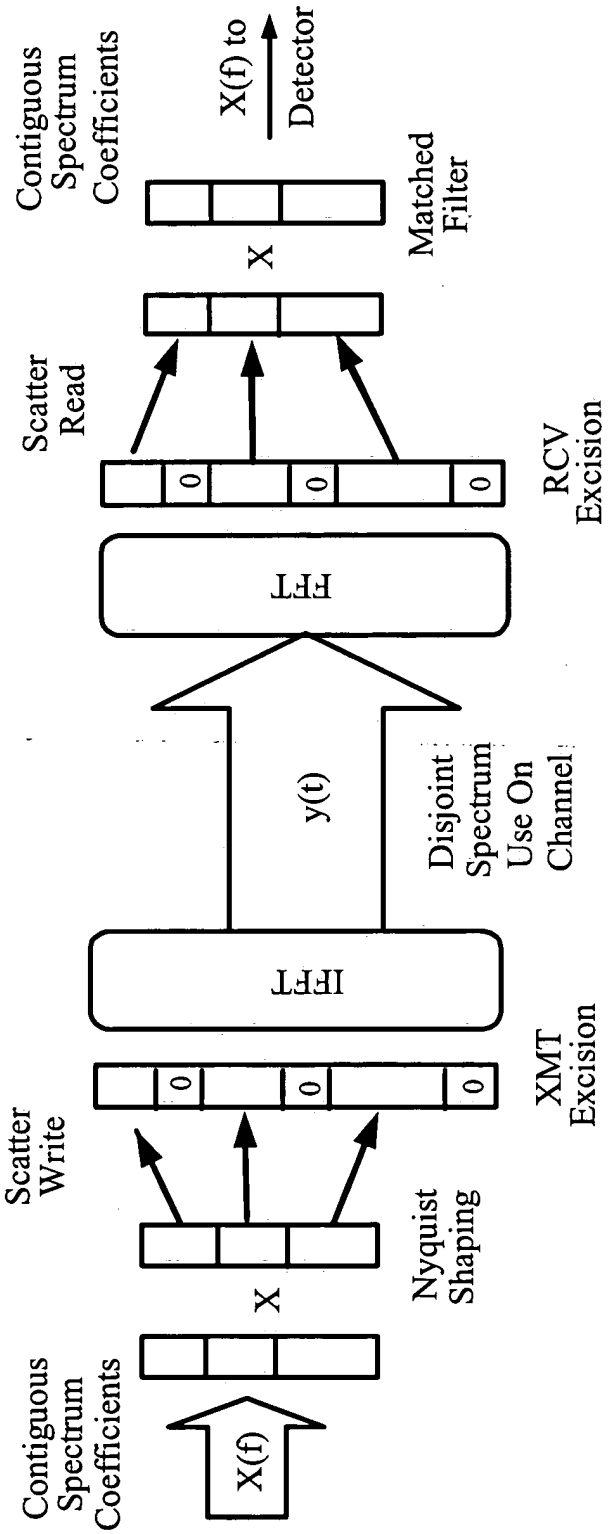

Contiguous Spectrum Coefficients
X(f)
X
Nyquist Shaping
Scatter Write
XMT Excision
IFFT
y(t)
Disjoint Spectrum Use On Channel
FFT
RCV Excision
Scatter Read
X
Matched Filter
X(f) to Detector
Contiguous Spectrum Coefficients

FIG. 13

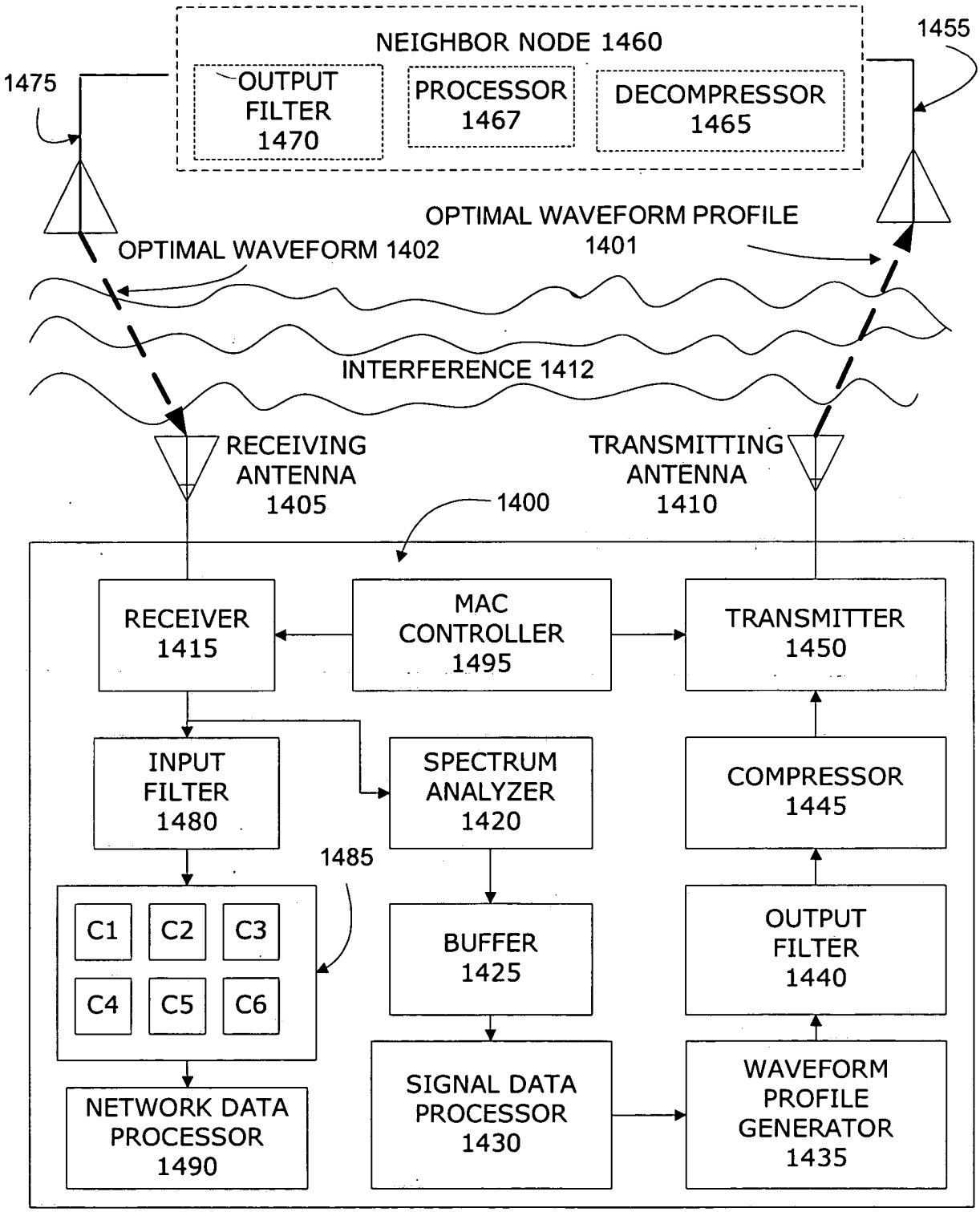

NEIGHBOR NODE 1460
1455
1475
OUTPUT FILTER 1470
PROCESSOR 1467
DECOMPRESSOR 1465
OPTIMAL WAVEFORM PROFILE 1401
OPTIMAL WAVEFORM 1402
INTERFERENCE 1412
RECEIVING ANTENNA 1405
TRANSMITTING ANTENNA 1410
1400
RECEIVER 1415
MAC CONTROLLER 1495
TRANSMITTER 1450
INPUT FILTER 1480
SPECTRUM ANALYZER 1420
COMPRESSOR 1445
1485
C1
C2
C3
C4
C5
C6
BUFFER 1425
OUTPUT FILTER 1440
NETWORK DATA PROCESSOR 1490
SIGNAL DATA PROCESSOR 1430
WAVEFORM PROFILE GENERATOR 1435

FIG. 14

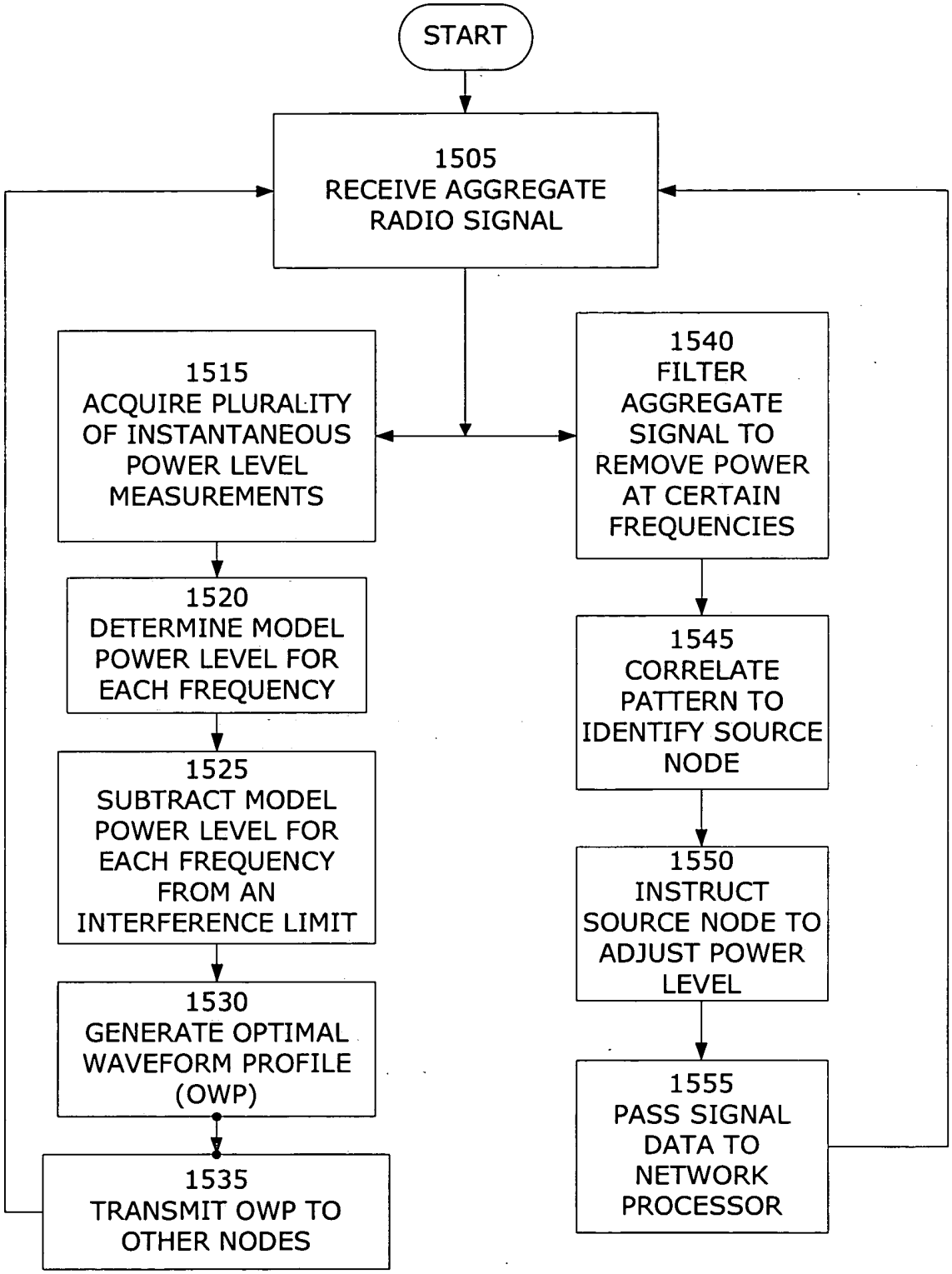

START
1505
RECEIVE AGGREGATE RADIO SIGNAL
1515
ACQUIRE PLURALITY OF INSTANTANEOUS POWER LEVEL MEASUREMENTS
1520
DETERMINE MODEL POWER LEVEL FOR EACH FREQUENCY
1525
SUBTRACT MODEL POWER LEVEL FOR EACH FREQUENCY FROM AN INTERFERENCE LIMIT
1530
GENERATE OPTIMAL WAVEFORM PROFILE (OWP)
1535
TRANSMIT OWP TO OTHER NODES
1540
FILTER AGGREGATE SIGNAL TO REMOVE POWER AT CERTAIN FREQUENCIES
1545
CORRELATE PATTERN TO IDENTIFY SOURCE NODE
1550
INSTRUCT SOURCE NODE TO ADJUST POWER LEVEL
1555
PASS SIGNAL DATA TO NETWORK PROCESSOR

FIG. 15

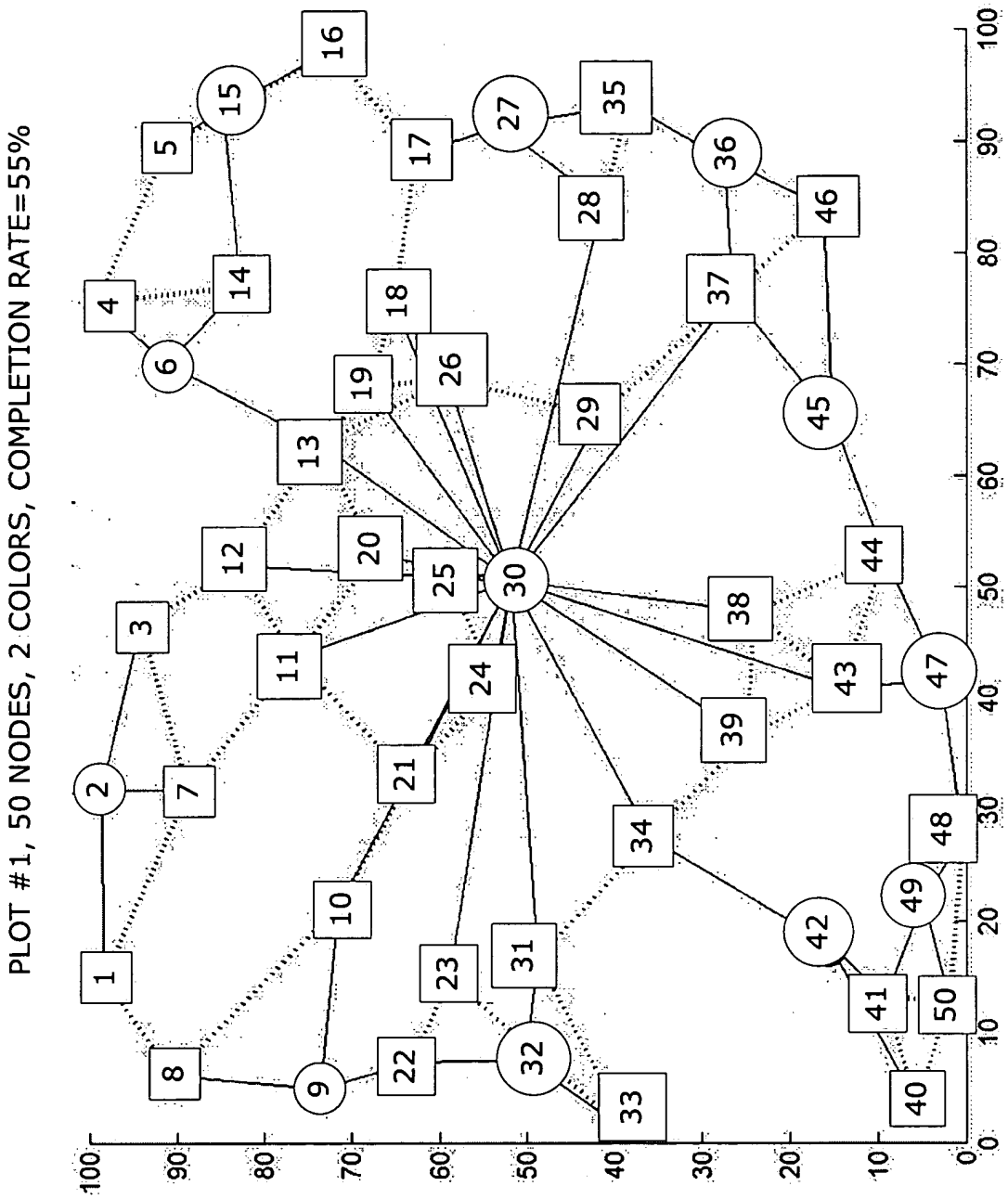
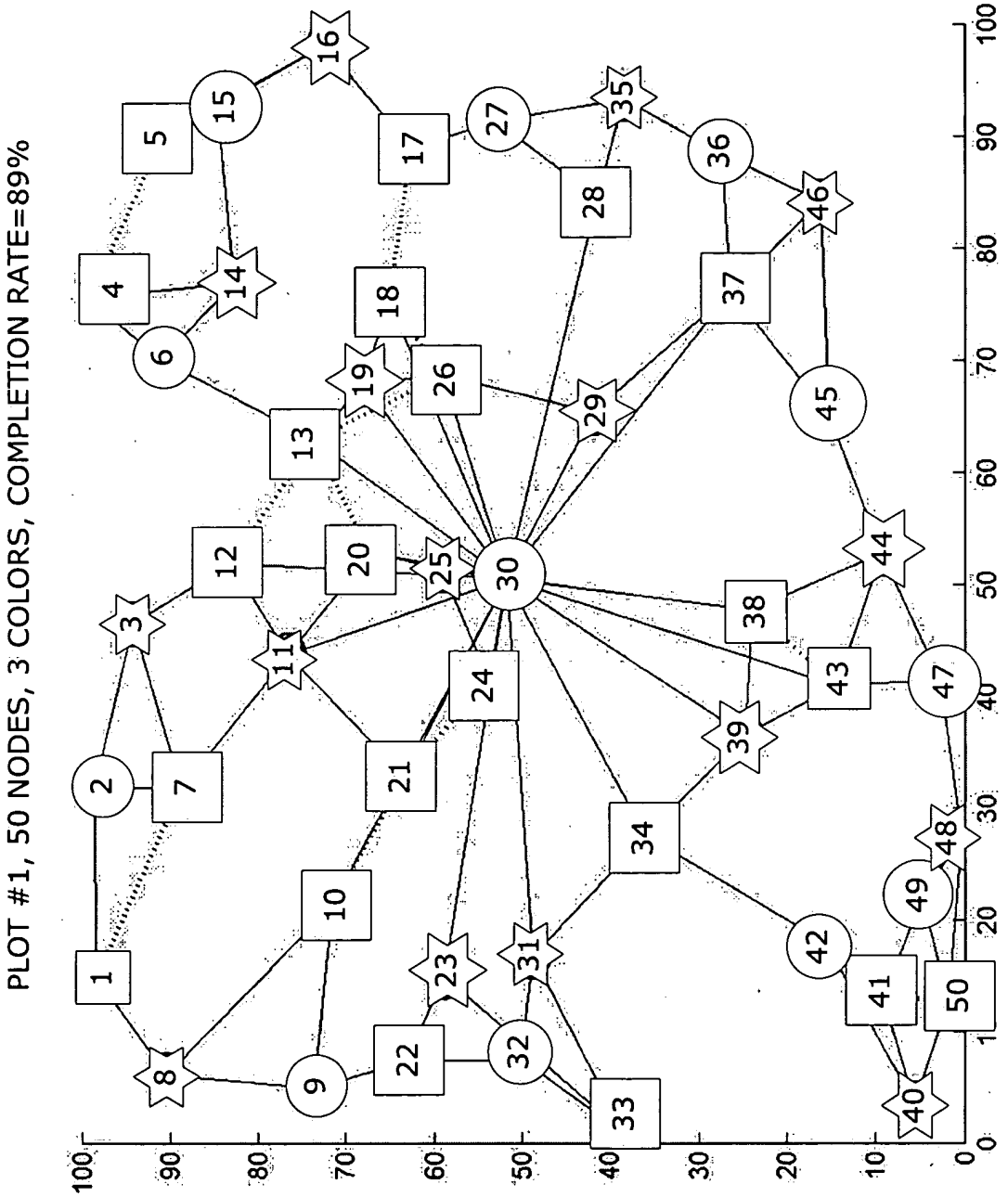

PLOT #1, 50 NODES, 2 COLORS, COMPLETION RATE=55%
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
0
10
20
30
40
50
60
70
80
90
100

FIG. 16


PLOT #1, 50 NODES, 3 COLORS, COMPLETION RATE=89%
0
10
20
30
40
50
60
70
80
90
100
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
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44
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48
49
50

FIG. 17

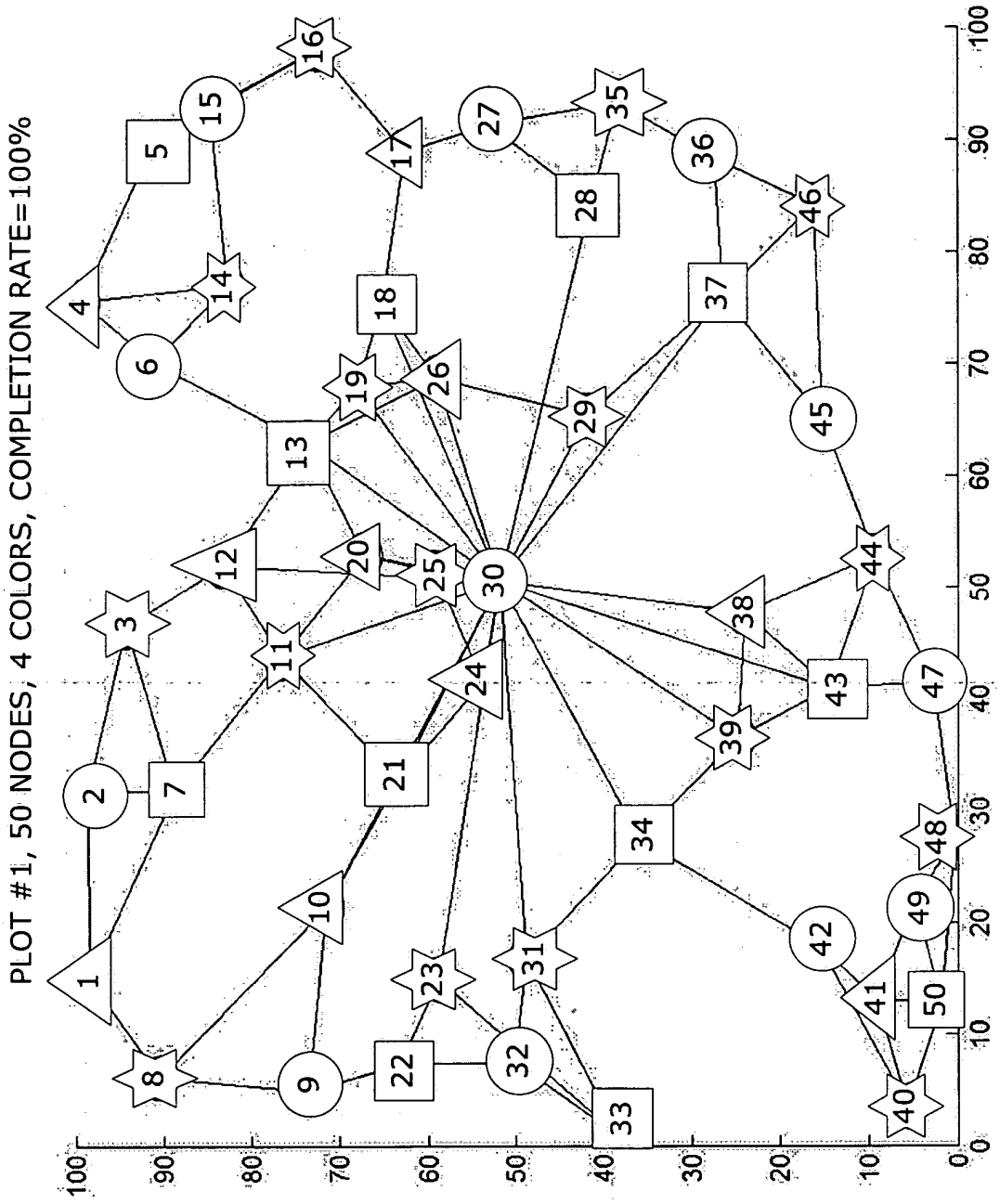
PLOT #1, 50 NODES, 4 COLORS, COMPLETION RATE=100%
0
10
20
30
40
50
60
70
80
90
100

FIG. 18

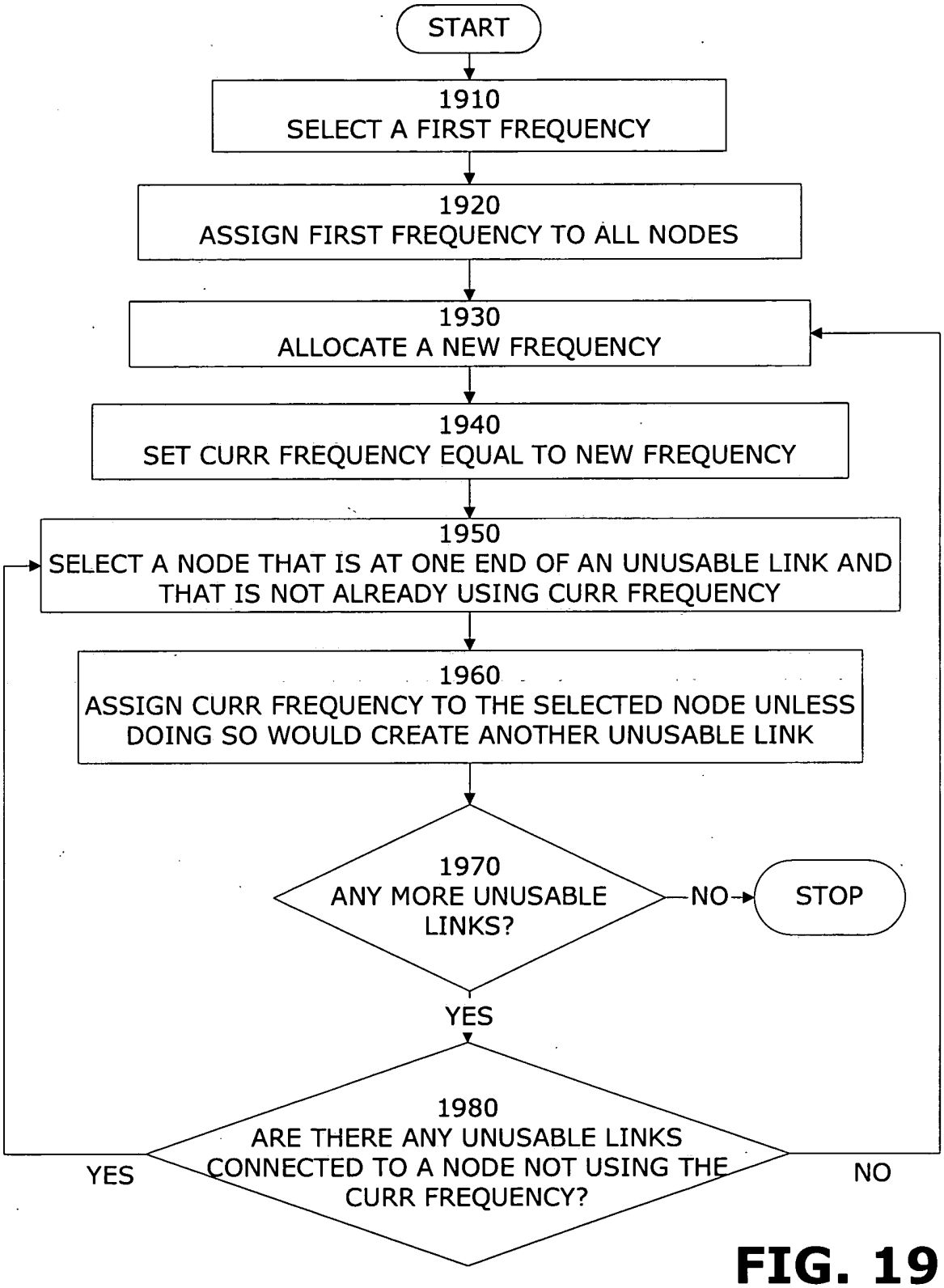
START
1910
SELECT A FIRST FREQUENCY
1920
ASSIGN FIRST FREQUENCY TO ALL NODES
1930
ALLOCATE A NEW FREQUENCY
1940
SET CURR FREQUENCY EQUAL TO NEW FREQUENCY
1950
SELECT A NODE THAT IS AT ONE END OF AN UNUSABLE LINK AND THAT IS NOT ALREADY USING CURR FREQUENCY
1960
ASSIGN CURR FREQUENCY TO THE SELECTED NODE UNLESS DOING SO WOULD CREATE ANOTHER UNUSABLE LINK
1970
ANY MORE UNUSABLE LINKS?
NO
STOP
YES
1980
ARE THERE ANY UNUSABLE LINKS CONNECTED TO A NODE NOT USING THE CURR FREQUENCY?
YES
NO

FIG. 19

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

Attorney Docket No. 02-4099

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SPECTRUM-ADAPTIVE NETWORKING

the specification of which (check one) [X] is attached hereto. [ ] was filed on as Appln. Serial No. and was amended on (if applicable). I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
(Number)	(Country)	(Day/Month/Year filed)	[_] Yes [_] No

I hereby claim the benefit under Title 35, United States Code, 119(e) of any United States provisional applications(s) listed below.

60/420,930	24 October 2002
(Application Number)	(Filing Date)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date for this application:

(Appln. Serial No.)	(Filing Date)	(Status--patented, pending, abandoned)

Attorney Docket No. 02-4099

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Leonard C. Suchyta, Reg. No. 25,707, James Weixel, Reg. No. 44,399, Loren Swingle, Reg. No. 32,764, Adam T. Bernstein, Reg. No. 36,746, and Joel Wall, Reg. No. 25,648 Andrea G. Reister, Reg. No. 36,253; Paul J. Berman, Reg. No. 36,744

Address all telephone calls to **James K. Weixel** at telephone no. **(781) 466-2220**

Address all correspondence to **Leonard C. Suchyta**
c/o Christian Andersen
Verizon Corporate Services Group Inc.
600 Hidden Ridge, HQE03H01
Irving, TX 75038

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF SOLE OR FIRST INVENTOR **Jerry D. Burchfiel**

Inventor's signature Jerry D. Burchfiel Date 10/16/03

Residence **Waltham, Massachusetts** Citizenship **USA**

Post Office Address **270 Bishops Forest Dr., Waltham, MA 02452**

Application Data Sheet

Application Information

Application Type::	Regular
Subject Matter::	Utility
Suggested Group Art Unit::	N/A
CD-ROM or CD-R?::	None
Sequence submission?::	None
Computer Readable Form (CRF)?::	No
Title::	SPECTRUM-ADAPTIVE NETWORKING
Attorney Docket Number::	02-4099
Request for Early Publication?::	No
Request for Non-Publication?::	No
Total Drawing Sheets::	19
Small Entity?::	No
Petition included?::	No
Secrecy Order in Parent Appl.?::	No

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	US
Status::	Full Capacity
Given Name::	Jerry
Middle Name::	D.
Family Name::	Burchfiel
City of Residence::	Waltham
State or Province of Residence::	MA
Country of Residence::	US
Street of mailing address::	270 Bishops Forest Drive
City of mailing address::	Waltham
State or Province of mailing address::	MA

Postal or Zip Code of mailing address:: 02452

Correspondence Information

Correspondence Customer Number:: 32127

Representative Information

Representative Customer Number:: 32127

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This application is a	nonprovisional of	60/420,930	October 24, 2002

Assignee Information

Assignee name:: BBNT SOLUTIONS LLC

Docket No.: 02-4099
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Jerry D. Burchfiel

Application No.: To be Assigned | Group Art Unit: To be Assigned

Filed: October 22, 2003 | Examiner: To be Assigned

For: SPECTRUM-ADAPTIVE NETWORKING

Information Disclosure Statement

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

Sir:

Listed on accompanying Form PTO/SB/08a/b are documents that may be considered material to the examination of this application, in compliance with the duty of disclosure requirements of 37 C.F.R. §§ 1.56, 1.97 and 1.98.

Where the publication date of a listed document does not provide a month of publication, the year of publication of the listed document is sufficiently earlier than the effective U.S. filing date and any foreign priority date so that the month of publication is not in issue. Applicants have listed publication dates on the attached PTO/SB/08a/b based on information presently available to the undersigned. However, the listed publication dates should not be construed as an admission that the information was actually published on the date indicated.

Applicants reserve the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior

art, and/or to prove that this information may not be enabling for the teachings purportedly offered.

This statement should not be construed as a representation that a search has been made, or that information more material to the examination of the present patent application does not exist. The Examiner is specifically requested not to rely solely on the material submitted herewith. It is further understood that the Examiner will consider information that had been cited by or submitted to the U.S. Patent and Trademark Office in a prior application relied on under 35 U.S.C. § 120. 1138 OG 37, 38 (May 19, 1992).

Applicants have checked the appropriate boxes below.

☒ 1. This Information Disclosure Statement is being filed within three months of the U.S. filing date OR before the mailing date of a first Office Action on the merits. No statement under 37 C.F.R. § 1.97(e) or fee is required.

☐ 2. This Information Disclosure Statement is being filed more than three months after the U.S. filing date AND after the mailing date of the first Office Action on the merits, but before the mailing date of a Final Rejection or Notice of Allowance.

- ☐ a. I hereby state that each item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(1).
- ☐ b. I hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to my knowledge after making reasonable inquiry, no item of information contained in this Information Disclosure Statement was known to any individual designated in 37 C.F.R. § 1.56(c)

more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(2).

☐ c. Attached is our Check No. _____ in the amount of $ _____ in payment of the fee under 37 C.F.R. § 1.17(p).

☐ 3. This Information Disclosure Statement is being filed more than three months after the U.S. filing date and after the mailing date of a Final Rejection or Notice of Allowance, but before payment of the Issue Fee. It is hereby requested that the Information Disclosure Statement be considered. Attached is our Check No. _____ in the amount of $ _____ in payment of the fee under 37 C.F.R. § 1.17(i).

☐ a. I hereby state that each item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(1).

☐ b. I hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to my knowledge after making reasonable inquiry, no item of information contained in this Information Disclosure Statement was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(2).

☐ 4. Relevance of the non-English language document(s) is discussed in the present specification.

☐ 5. The document(s) was/were cited in a corresponding foreign application. An English language version of the foreign search report is attached for the Examiner's information.

☐ 6. A concise explanation of the relevance of the non-English language document(s) appears below:

☐ 7. The Examiner's attention is directed to co-pending U.S. Patent Application No. _____, filed _____, which is directed to related technical subject matter. The identification of this U.S. Patent Application is not to be construed as a waiver of secrecy as to that application now or upon issuance of the present application as a patent. The Examiner is respectfully requested to consider the cited application and the art cited therein during examination.

☐ 8. Copies of the documents were cited by or submitted to the Office in Application No. _____, filed _____, which is relied upon for an earlier filing date under 35 U.S.C. § 120. Thus, copies of these documents are not attached. 37 C.F.R. § 1.98(d).

It is respectfully requested that the Examiner initial and return a copy of the enclosed PTO/SB/08a/b, and to indicate in the official file wrapper of this patent application that the documents have been considered.

The U.S. Patent and Trademark Office is hereby authorized to charge any fee deficiency, or credit any overpayment, to our Deposit Account No. 50-0740, referencing Docket No. 02-4099.

Dated: October 22, 2003

Respectfully submitted,

By _____

Andrea G. Reister
Registration No.: 36,253
COVINGTON & BURLING
1201 Pennsylvania Avenue, N.W.
Washington, DC 20004-2401
(202) 662-6000
Attorney for Applicant

PTO/SB/08a/b (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	Not Yet Assigned
Filing Date	October 22, 2003
First Named Inventor	Jerry D. Burchfiel
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	02-4099

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	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, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	CA	Notice of Proposed Rulemaking in Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure *U-NII) devices in the 5 GHz band Before the Federal Communications Commission, Doc. No. 03-122 RM - 10371, FCC 03-110 1-28 (June 4, 2003) .	
	CB	Li PING et al., Low-Rate Turbo-Hadamard Codes1, 1-38, (unpublished manuscript, on file with the Department of Electronic Engineering, City University of Hong Kong).	
	CC	Spectrum Policy Task Force Report, Federal Communications Commission, ET Doc. No. 02-135 (November 2002).	

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature		Date Considered	

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2003

Application or Docket Number: 10685763

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	97	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	97 minus 20=	*77
INDEPENDENT CLAIMS	8 minus 3 =	*5
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	385.00	OR	BASIC FEE	770.00
X$ 9=		OR	X$18=	1386
X43=		OR	X86=	430
+145=		OR	+290=	
TOTAL		OR	TOTAL	2586

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the ntry in column 1 is less than th 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 appropriat box in column 1.

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

10/24/2003 HMARZI1 00000011 10689763

01 FC:1001	770.00	OP
02 FC:1201	430.00	OP
03 FC:1202	1386.00	OP

PTO-1556
(5/87)

*U.S. Government Printing Office: 2002 — 489-267/69033

CLAIMS ONLY	SERIAL NO.	FILING DATE
	APPLICANT(S)	

CLAIMS

	AS FILED		AFTER 1ST AMENDMENT		AFTER 2ND AMENDMENT							
	IND	DEP	IND	DEP	IND	DEP		IND	DEP	IND	DEP	IND	DEP
1							51						
2							52						
3							53						
4							54						
5							55						
6							56						
7							57						
8							58						
9							59						
10							60						
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13							63						
14							64						
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16							66						
17							67						
18							68						
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20							70						
21							71						
22							72						
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24							74						
25							75						
26							76						
27							77						
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29							79						
30							80						
31							81						
32							82						
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37							87						
38							88						
39							89						
40							90						
41							91						
42							92						
43							93						
44							94						
45							95						
46							96						
47							97						
48							98						
49							99						
50							100						
TOTAL IND.							TOTAL IND.						
TOTAL DEP.							TOTAL DEP.						
TOTAL CLAIMS							TOTAL CLAIMS						

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
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