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Application Number: 15223819 Document Date: 07/29/2016

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- Drawing

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Form Revision Date: August 26, 2013

91172-725400

PTO/AIA/80 (07-12)
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: **20350**

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	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(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number: **20350**

OR

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

Assignee Name and Address: **DALI SYSTEMS CO. LTD.**
Maples Corporate Services Limited
PO Box 309, Ugland House, South Church Street
George Town, Grand Cayman KY1-1104, Cayman Islands

A copy of this form, together with a statement under 37 CFR 3.73(c) (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(c) may be completed by one of the practitioners appointed in this form, 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

Signature		Date	9/23/12
Name	Albert S. Lee	Telephone	604 420 3760
Title	President & CEO		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Electronic Acknowledgement Receipt	
EFS ID:	26495265
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	29-JUL-2016
Filing Date:	
Time Stamp:	16:01:01
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS_102440US.pdf	1823920 0837745b450f62f6ec06513074 3c8fce18e3 3d7	no	9
Warnings:					

Information:					
2		SPEC_CLM_ABST_102440US.pdf	166750 203a9e4ecdbdbe2367d61a788c084df5c24f9515	yes	22
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Specification		1	20	
	Claims		21	21	
	Abstract		22	22	
Warnings:					
Information:					
3	Drawings-other than black and white line drawings	DWGS_FINAL_.pdf	5195313 3382f12223491e9db566e2eec49b2bf2450 1d6d3	no	8
Warnings:					
Information:					
4	Oath or Declaration filed	DECS_102440US.pdf	1790404 c4b38e4dc4122fa1635a1e99ab3aa8bb66a 5a9ad	no	4
Warnings:					
Information:					
5	Assignee showing of ownership per 37 CFR 3.73	373C_102440US.pdf	120677 77ccf17d5865b6acf164823246e08ab0b7ee d5ac	no	3
Warnings:					
Information:					
6	Power of Attorney	UnivPOA_POSTAIA.pdf	543378 302602c1d61317ac9d82d9826d07afe741f 5432e	no	1
Warnings:					
Information:					
		Total Files Size (in bytes):	9640442		

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

PTO/AIA/14 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

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

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Shawn	Patrick	Stapleton	

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

City	Burnaby, BC	Country of Residence	CA

Mailing Address of Inventor:

Address 1	Maples Corporate Services Limited
Address 2	P.O. Box 309, Ugland House, South Church Street
City	George Town, Grand Cayman
State/Province	
Postal Code	KY1-1104
Country	KY

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Paul		Lemson	

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

City	Woodinvile	State/Province	WA	Country of Residence	US

Mailing Address of Inventor:

Address 1	Maples Corporate Services Limited
Address 2	P.O. Box 309, Ugland House, South Church Street
City	George Town, Grand Cayman
State/Province	
Postal Code	KY1-1104
Country	KY

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Bin		Lin	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

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

City	Burnaby, BC	Country of Residence i	CA

Mailing Address of Inventor:

Address 1	Maples Corporate Services Limited
Address 2	P.O. Box 309, Ugland House, South Church Street

City	George Town, Grand Cayman	State/Province	
Postal Code	KY1-1104	**Country** i	KY

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Albert	S.	Lee	

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

City	San Mateo	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	Maples Corporate Services Limited
Address 2	P.O. Box 309, Ugland House, South Church Street

City	George Town, Grand Cayman	State/Province	
Postal Code	KY1-1104	**Country** i	KY

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

Correspondence Information:

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

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

Customer Number	20350		
Email Address	ipefiling@kilpatricktownsend.com	Add Email	Remove Email

Application Information:

Title of the Invention	DISTRIBUTED ANTENNA SYSTEM		
Attorney Docket Number	091172-1017552-102440US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	8	**Suggested Figure for Publication (if any)**	

EFS Web 2.2.12

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

Filing By Reference:

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

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

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

Publication Information:

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

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

Representative Information:

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

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	20350		

Domestic Benefit/National Stage Information:

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

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	14800515	2015-07-15

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14800515	Continuation of	14260145	2014-04-23	9137078	2015-09-15
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14206145	Continuation of	13211247	2011-08-16	8737300	2014-05-27
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
13211247	Claims benefit of provisional	61439940	2011-02-07		
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.					Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

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

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

PTO/AIA/14 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

Applicant Information:

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

Applicant 1 Remove

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

Clear

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

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

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Dali Systems Co. Ltd.		
Mailing Address Information For Applicant:			
Address 1	Maples Corporate Services Limited		
Address 2	P.O. Box 309, Ugland House, South Church Street		
City	George Town, Grand Cayman	**State/Province**	
Country	KY	Postal Code	KY1-1104
Phone Number		Fax Number	
Email Address			

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

Assignee Information including Non-Applicant Assignee Information:

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

PTO/AIA/14 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

Assignee 1

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

Remove

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

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

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

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

Signature:

Remove

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

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

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

Signature	/Kelvin B. Catmull/			Date (YYYY-MM-DD)	2016-07-29
First Name	Kelvin B.	Last Name	Catmull	Registration Number	57535

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

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	091172-1017552-102440US
	Application Number	
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

DISTRIBUTED ANTENNA SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] The present application is a continuation of U.S. Patent Application No. 14/800,515 filed July 15, 2015; which is a continuation of U.S. Patent Application No. 14/260,145, filed April 23, 2014; which is a continuation of U.S. Patent Application No. 13/211,247, filed August 16, 2011; which claims the benefit of U.S. Provisional Patent Application No. 61/439,940, filed February 7, 2011; the disclosures of which are hereby incorporated by reference for all purposes.

FIELD OF THE INVENTION

[0002] The present invention generally relates to wireless communication systems employing Distributed Antenna Systems (DAS) as part of a distributed wireless network. More specifically, the present invention relates to a DAS utilizing one or more remotely monitored and controlled digital access units configured to assign particular packet transmissions to selected ones of a plurality of remote units, which can in some embodiments be configured in a daisy-chained rings.

BACKGROUND OF THE INVENTION

[0003] Wireless and mobile network operators face the continuing challengeof building networks that effectively manage high data-traffic growth rates. Mobility and an increased level of multimedia content for end users requires end-to-end network adaptations that support both new services and the increased demand for broadband and flat-rate Internet access. One of the most difficult challenges faced by network operators is maximizing the capacity of their DAS networks while ensuring cost-effective DAS deployments and at the same time providing a very high degree of DAS remote unit availability.

[0004] In order to provide DAS network capacity which is high enough to meet short-term needs of network subscribers in specific locations yet also avoid costly and inefficient

deployment of radio resources, DAS network planners prefer to employ DAS architectures and solutions which provide a high degree of dynamic flexibility. Therefore, it would be advantageous for wireless network operators to employ a DAS solution which has a high degree of flexibility to implement dynamic rearrangements based on ever-changing network conditions and subscriber needs. Also, the more future-proof a DAS deployment can be, generally the lower its life cycle cost.

[0005] DAS network planners and system integrators employ a wide range of innovative approaches for helping to ensure that a particular DAS deployment is as cost-effective as possible. The types of costs considered by network planners and integrators include DAS deployment or DAS installation cost, as well as operational costs including maintenance costs, emergency restoration costs and network re-arrangement costs. Rearrangement costs are particularly significant for indoor DAS applications, due to frequent changes in building use and facility needs changes. Therefore, it would be advantageous to employ DAS systems and methods which are based on as few DAS transport facilities as possible to minimize installation and/or lease costs and have self-healing capabilities to avoid the need for costly emergency restoration services.

[0006] In order to obtain a high degree of DAS remote unit availability, two primary conditions must be satisfied. First, the DAS remote unit itself must be inherently reliable. Second, the transport media e.g., optical fiber, must be very reliable. It is well known that electronic and/or optical connections themselves are a significant root cause of failure or reduced availability in a DAS network. Companies who maintain outdoor DAS networks have reported that a failure of outside plant optical fiber facilities is not as rare as would be desirable. Therefore, it would be advantageous to employ systems and methods which offer higher redundancy and/or self-healing features in the event of failure of a transport media connection.

SUMMARY OF THE INVENTION

[0007] The present invention substantially achieves the advantages and benefits discussed above and overcomes the limitations of the prior art discussed above by providing a distributed antenna system responsive to one or more base stations and having at least one but in some embodiments a plurality of Digital Access Units ("DAU's"), each operating to control the packet

traffic of an associated plurality of Digital Remote Units ("DRU's"). In embodiments employing multiple DAU's, the DAU's can be daisy-chained linearly or in a ring configuration. Likewise, depending upon the implementation, the DRU's associated with a given DAU can be configured in either a linear or ring Daisy chain configuration.

[0008] The data received from the base stations is down-converted, digitized and converted to baseband with the DAU. The data streams are then I/Q mapped and framed and independently serialized, such that multiple data streams are available in parallel from the DAU. In at least some embodiments, the DAU communicates with the associated DRU's via an optical transport arrangement. It will be appreciated by those skilled in the art that, using the present invention, it is possible to configure a distributed antenna system having n base stations, each providing m RF outputs for transmission by one or more associated DAU's to o DRU's, where the only limits are imposed by the technical performance specifications of the particular DAS, such as delay.

[0009] By the use of a ring configuration for connecting, in at least some embodiments, the DRU's and/or the DAU's, fault tolerance is built into the system, with resulting high availability. In single DAU embodiments, each DRU is accessible through two paths, and therefore remains available even in the event of a line break. In multi-DAU embodiments, where the DAU's are linearly daisy-chained, each DRU is accessible from multiple DRU's such that even some DAU failures will not prevent system operation. In embodiments employing a ring connection for the DAU's, multiple paths exist to each DAU, and thus provide an additional level of fault tolerance as well as dynamic load balancing and resource management as discussed in greater detail hereinafter.

[0010] Thus, the configuration of the advanced system architecture of the present invention provides a high degree of flexibility to manage, control, enhance and facilitate the radio resource efficiency, usage, availability, and overall performance of the distributed wireless network. The present invention enables specialized applications and enhancements including Flexible Simulcast, automatic traffic load-balancing, network and radio resource optimization, network calibration, autonomous/assisted commissioning, carrier pooling, automatic frequency selection, radio frequency carrier placement, traffic monitoring, traffic tagging, and indoor location determination using pilot beacons. The present invention can also serve multiple operators,

multi-mode radios (modulation-independent) and multi-frequency bands per operator to increase the efficiency and traffic capacity of the operators' wireless networks.

[0011] Further the present invention provides a high degree of dynamic flexibility, supports dynamic re-arrangements, and provides a low life cycle cost. This advanced system architecture enables deployment of DAS networks using fewer DAS transport facilities to reduce costs, while providing self-healing features. The present invention also offers redundancy and enhanced system availability.

[0012] It is an object of the present invention to provide Flexible Simulcast capabilities, as disclosed in U.S. Provisional Application S.N. 61/382,836, entitled "Remotely Reconfigurable Distributed Antenna System and Methods," filed September 14, 2010, incorporated herein by reference, in a high-availability ring configuration using, for example, optical fiber transport. As discussed above, the ring configuration insures that a break in any optical fiber cable will not shut down the daisy-chained network, because the downlink and uplink signals can be rerouted around the cable break to the respective DRUs.

[0013] It is a further object of the present invention to balance the bidirectional data rate on the optical fibers so as to increase the maximum achievable data rate during operation on the ring network of DRUs.

[0014] It is a further object of the present invention to provide higher transport network capacity in the event the data transport is asymmetrical between the downlink and uplink, as is typically the case for mobile broadband networks.

[0015] It is a further object of the present invention to provide an adaptive and automatic control for optimizing the transport media capacity on the ring.

[0016] It is a further object of the present invention to provide a method of summing co-channel users' uplink signals in the DRU daisy chain.

[0017] Applications of the present invention are suitable to be employed with distributed base stations, distributed antenna systems, distributed repeaters, mobile equipment and wireless terminals, portable wireless devices, and other wireless communication systems such as

microwave and satellite communications. The present invention is also field upgradable through a link such as an Ethernet connection to a remote computing center.

[0018] Appendix I is a glossary of terms used herein, including acronyms.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Further objects and advantages of the present invention can be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

[0020] Figure 1 is a block diagram according to one embodiment of the invention showing the basic structure and an example of a unidirectional, channelized downlink transport, one ring scenario based on having one DAU and four DRUs.

[0021] Figure 2 is a block diagram in accordance with an embodiment of the invention showing the basic structure and an example of a unidirectional, channelized uplink transport, one ring scenario based on having one DAU and four DRUs.

[0022] Figure 3 is a block diagram in accordance with an embodiment of the invention showing the basic structure and an example of a unidirectional, channelized uplink transport, two ring scenario based on having one DAU and eight DRUs.

[0023] Figure 4 is a block diagram in accordance with an embodiment of the invention showing the basic structure and an example of a unidirectional channelized uplink or downlink transport. This example of a five ring scenario comprises two DAUs and twenty DRUs. Figure 4 provides an example of a daisy chain ring network.

[0024] Figure 5 illustrates an embodiment of a cellular network system employing multiple DRUs according to the present invention.

[0025] Figure 6 illustrates an embodiment of a multi-band system employing six different services operating in different frequency channels with multiple DRUs according to the present invention.

[0026] Figure 7 illustrates in block diagram form the interaction between the DAU embedded software control module and the DRU embedded software control module.

[0027] Figure 8 illustrates in block diagram form an embodiment of a DAS according to an aspect of the invention, including daisy-chained DAU's.

DETAILED DESCRIPTION OF THE INVENTION

[0028] The present invention is a novel Reconfigurable Distributed Antenna System that provides a high degree of flexibility to manage, control, re-configure, enhance and facilitate the radio resource efficiency, usage and overall performance of the distributed wireless network. Figure 1 illustrates an embodiment of the Distributed Antenna System 100 that provides an example of a unidirectional, channelized downlink transport in accordance with the present invention. In Figures 1-4, a dotted line denotes a distinct subset of uplink and downlink channels identified as "A." A dashed line denotes a distinct subset of uplink and downlink channels identified as "B." The subset of uplink and downlink channels in A do not include those of B and *vice versa*. The system employs a Digital Access Unit functionality 105 (hereinafter "DAU"). The DAU 105 serves as an interface between associated base stations (BTS) 110A-B and a plurality of digital remote units (DRU) 125A-n, although only four DRU's are shown in Figure 1. In the present description, "DRU" will be used interchangeably with Remote Radio Head Unit, or "RRU", because of the similarity of the functions discussed herein, although those skilled in the art will recognize that a DRU communicates with a DAU, whereas an RRU communicates with a base station. In addition, those skilled in the art will recognize that a DAU is monitored and controlled by a remote network operations center ("NOC"), as indicated at bidirectional link 115 in Figure 1. Such links are typically Ethernet connections or external modems, but can be any form of link suitable for remote monitoring and control. The NOC has the capability to remotely configure the DAU parameter settings which in turn configures the DRU's parameter settings. The NOC can request information from the DAUs. The DAUs can subsequently request information from the DRUs. The information requested includes but is not limited to uplink power, downlink power, optical error rate, gain settings, active carriers, etc.

[0029] For the downlink (DL) path, RF input signals 120A through 120n are received at the DAU 105 from one or more base station units (BTS) indicated at 110A through 11 Op. The RF input signals are separately down-converted, digitized, and converted to baseband (using a Digital Down-Converter) by the DAU. Data streams are then I/Q mapped and framed and specific parallel data streams are then independently serialized and translated to optical signals

using pluggable SFP modules, again by the DAU 105. The independently serialized, parallel data streams are then delivered to different DRU's 125A-125*k*, typically over optical fiber cable arranged, in at least some embodiments, in a ring configuration indicated at connection pairs 140A-145A, or, in other embodiments, a daisy chain configuration. In addition, each DAU can support a plurality of rings with associated DRU's, where the additional rings are indicated by fiber optic pairs up through 140*o*-145*o*.. It will be appreciated by those skilled in the art that the number of RF inputs, DAU's and DRU's and rings is limited only by network performance factors, such as delay. In addition, as discussed in connection with Figure 4 herein, the DAS can be further extended by using a ring or daisy-chain of DAU's, each of which supports an arrangement of DRU's and rings as shown in Figure 1.

[0030] One function of the DAU 105 is to determine the direction in which downlinked channels are propagated around the ring. As just one example, the embodiment shown in Figure 1 is configured to have downlink channels A, B, C and D propagate in a first direction, for example clockwise, and channels E, F, G, and H propagate in the counter direction, although it will be understood that the number of channels propagating in each direction need not be equal, nor adjacent, nor sequential. Likewise, the number of channels received at each DRU is assigned by the DAU and need not be equal, adjacent or sequential, but instead will typically be any configuration that optimizes network utilization.

[0031] Referring next to Figure 2, an embodiment of an uplink (UL) path in accordance with the invention can be better appreciated. Channels received at the antenna associated with each DRU are converted into optical signals by each DRU 125A-125*k*. Optical signals received from the DRU's are de-serialized and de-framed by the DAU 105, and are also up-converted digitally using a Digital Up-Converter implemented within the DAU 105. Each data stream is then independently converted to the analog domain and up-converted to the appropriate RF frequency band, still within the DAU 105 in the illustrated implementation, although this functionality can be separate. The RF signals are then delivered to the appropriate one of a plurality of BTS' 110A-110*p*. As with the arrangement shown in Figure 1, the direction of propagation of each channel is controlled by the DAU, with some channels propagating in a clockwise direction and others in a counterclockwise direction. Also as discussed in connection with Figure 1, while

adjacent channels are shown as propagating in the same direction in Figure 2, this is not required and any channel can be selected to propagate in either direction.

[0032] Referring again to Figure 1, it will be appreciated by those skilled in the art that, in some implementations of a DAS, more than one carrier can exist in each channel, and, as such, a DRU may receive a channel comprising a signal containing two or more carriers, or a wireless operator may have more than one RF carrier per channel allocated to a single base station. This is referred to as a "composite signal". The manner in which a composite downlink signal is managed by the present invention can be better understood with reference to Figure 1. In such instances, the DAU will receive a composite downlink input signal 130 from, e.g., a first base station 110A belonging to one wireless operator, enters the DAU 105 at the RF input port 120A. Composite signal 130 comprises carriers A-D. A second composite downlink input signal from e.g., a *p*th base station 110p belonging to the same wireless operator enters DAM at the DAU1 RF input port 120*n*. Composite signal 135 comprises carriers E-H. The functionality of the DAU 105, and DRU's 125A-125*k*, respectively, are explained in detail in U.S. Provisional Application S.N. 61/374,593, entitled "Neutral Host Architecture for a Distributed Antenna System," filed August 17, 2010, the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0033] One optical output of DAU 105 is fed to DRU 125A, via bidirectional optical cable 140A. A second optical output of DAU 105 is fed via bidirectional optical cable 145A to DRU3. Similarly, bidirectional optical cables 150, 155 and 160 connect DRU's 125A-n in a ring configuration, such that DRU 125A connects to DRU 125B via cable 150A, DRU 125B connects to DRU 125n via cable 15013, and DRU 125k connects to DRU 125C, or the kth-1 DRU, via cable 150m. This connection facilitates networking of DAU 105, which means that all of Carriers A-H are available within DAU 105 to transport data to DRU's 125A-k depending on software settings within the networked DAU system. Depending upon the embodiment, the software settings within DRU 125A are configured either manually or automatically, such that carriers A-H are present in the downlink output signal 155A at the antenna port of DRU 125A. The presence of all eight carriers means that DRU 125A is potentially able to access the full capacity of both base stations feeding DAU 105. A possible application for DRU125A is a

cafeteria in an enterprise building during the lunch hour where a large number of wireless subscribers are gathered.

[0034] DRU 125B is fed by a second optical port of DRU 125A via bidirectional optical cable 150A. The optical cable 150A performs the function of daisy chaining DRU 125A with DRU12513. As with DRU 125A, the software settings within DRU 125B are configured either manually or automatically such that Carriers A, C, D and F are present in downlink output signal 155E at the antenna port of DRU 1258. The capacity of DRU 125B is set to a much lower value than DRU 125A by virtue of its specific channel settings as controlled by DAU 105. The individual Digital Remote Units have integrated frequency selective DUCs and DDCs with gain control for each carrier. The DAU's can remotely turn on and off the individual carriers via the gain control parameters.

[0035] In a similar manner as described previously for DRU 125A, the software settings within DRU 125C are configured either manually or automatically such that Carriers B and F are present in downlink output signal 155C at the antenna port of DRU 125C. Compared to the downlink signal 155B at the antenna port of DRU 12513, the capacity of DRU 125C, which is also configured via its software settings, is much less than the capacity of DRU 125B. DRU 125n is fed by the optical cable 150m connected to the second optical port of the nth-1 DRU, shown for simplicity in Figure 1 as DRU 125C. The software settings within DRU 125n are configured either manually or automatically such that carriers A, D, E and H are present in downlink output signal 155D at the antenna port of DRU 125n. Typically, the capacity of DRU 125n is set to a much lower value than DRU 125A, however, the relative capacity settings of each of DRU's 125A-n can be adjusted dynamically to meet the capacity needs within the coverage zones determined by the physical positions of antennas connected to those DRU's. As noted above, the ring connection is completed by interconnecting DRU 125B and DRU 125n through optical cable 150B. The ring configuration insures that any optical cable breaks will not shut down the daisy chained network. The downlink and uplink signals will be rerouted around the cable break to the respective DRUs.

[0036] The present invention facilitates conversion and transport of several discrete relatively narrow RF bandwidths. This approach allows conversion of only those multiple specific relatively narrow bandwidths which carry useful or specific information. This approach also

allows more efficient use of the available optical fiber transport bandwidth for neutral host applications, and allows transport of more individual operators' band segments over the optical fiber. As disclosed in U.S. Provisional Application S.N. 61/374593, entitled "Neutral Host Architecture for a Distributed Antenna System," filed August 17, 2010 together with U.S. Provisional Application S. N. 61/382,836, entitled "Remotely Reconfigurable Distributed Antenna System and Methods", filed September 14, 2010, both assigned to the assignee of the present invention, and also referring to Figure 1 of the instant patent application, Digital Up Converters located within the DRU can be dynamically reconfigured as the result of commands from the NOC to transport from the DAU input to any specific DRU output any specific narrow frequency band or bands, RF carriers or RF channels which are available at the respective RF input port of either DAU. This capability is illustrated in Figure 1 where only specific frequency bands or RF carriers appear at the output of a given DRU. More specifically, through commands received from the NOC, the FPGA's in the DAU and one or more of the associated DRU's can be reprogrammed or reconfigured to convert and transport only the desired narrow bandwidths.

[0037] A related capability of the present invention is that not only can the Digital Up Converters located within each DRU be configured to transport any specific narrow frequency band from the DAU input to any specific DRU output, but also the Digital Up Converters within each DRU can be configured to transport any specific time slot or time slots of each carrier from the DAU input to any specific DRU output. The carriers and time slots are monitored by the DAU by filtering the signals and performing power detection of the individual time slots, which information can be conveyed to the NOC as desired. Then, as with the Digital Up Converters, the Field Programmable Gate Arrays (FPGA) in the DAU or DRU can be dynamically reconfigured by commands received from the NOC in a manner analogous to software programmability. The DAU detects which carriers and corresponding time slots are active. This information is relayed to the individual DRUs via the management control and monitoring protocol software. This information is then used, as appropriate, by the DRUs for turning off and on individual carriers and their corresponding time slots.

[0038] Data transport between the Base Station and the subscribers is typically asymmetrical, whereby the downlink data rate is higher than the uplink rate. The ring network configuration of

Daisy Chained DRUs can exploit this data rate asymmetry to maximize the data transport on the optical fibers 150A-150m.

[0039] The present invention balances the bidirectional data rate on the optical fibers so as to increase the maximum achievable data rate on the ring network of DRUs. The individual downlink channels are transmitted in a unidirectional sense along the ring network. Referring to Figure 1, downlink channels A, B, C, and D are transmitted in a clockwise sense around the ring of DRU's 125A-*k*. On the other hand, downlink channels E, F, G and H are transmitted in a counterclockwise sense around the ring of DRUs. Referring to Figure 2, the uplink channels J, K, L and M are transmitted in a counterclockwise sense whereas uplink channels N, O, P and Q are transmitted in a clockwise sense around the ring of DRUs. If the downlink and uplink data rates were the same, there would be no advantage in the transport mechanism. However, if the data transport is asymmetrical between the downlink and uplink then a significant advantage can be gained. For example, for a factor of two difference between the downlink and uplink data rates, a 4/3 factor increase in data transport can be achieved. The larger the asymmetry between the downlink and uplink data rates, the larger will be the increase in data transport using the unidirectional channel transport mechanism around the ring.

[0040] Referring again to Figure 1, a further embodiment in accordance with another aspect of the present invention may be better understood. In the event that there is a significant change in asymmetry between the downlink and uplink data rates and/or if there is a change in channel complement at the BTS, the Management Control module [discussed in connection with Figure 7 herein] which is typically comprised within each DAU is able to automatically and adaptively re-allocate data transport resources on the clockwise direction of the ring and on the counter-clockwise direction of the ring to maximize the overall transport capacity. As stated previously, the larger the degree of asymmetry between uplink and downlink data rates for a particular DAU, the higher the increase in data transport using the unidirectional channel transport mechanism around the ring. If there is more than one DAU present, in an embodiment one DAU is designated a Master DAU by the NOC, and the Management Control module located in the Master DAU makes decisions to optimize the overall transport capacity. In the event the master DAU fails, the NOC can designate another DAU as master. Alternatively, any suitable failover algorithm can be implemented.

[0041] Referring to Figure 3, an alternative embodiment of the present invention wherein a single DAU controls a plurality of rings, each comprising a plurality of daisy-chained DRU's, can be better understood. In Figure 3, two daisy-chained rings, indicated at 300 and 305, are shown although the number of rings could be greater and is determined mainly as a matter of design preference up to limits imposed by network performance. The rings each link a plurality of DRU's 310A-*n* and 315A-*m*, to a single DAU 320. The directional flow of the data transport is shown as the dashed lines 325 and dotted lines 330. The downlink channels available from the plurality of DRU's are divided into two subsets which flow in opposite directions around the two daisy-chained rings. The uplink channels are transported in a similar fashion. The channels are grouped into the two subsets so as to maximize the data transport to and from the DRUs. The DAU in turn communicates with one or more BTS's via RF Ports 335A p.

[0042] Heuristic algorithms may be used to allocate RF channel data in a Dual-ring DAS. For Figure 3, there are two fibre rings R1, R2 (clockwise and counter clockwise) and a set T of $n \geq 2$ independent RF channels Ki, $1 \leq i \leq n$ (including uplink and downlink). A channel Ki requires a bandwidth of b(Ki) to transport on a fibre ring. A time-bounded algorithm exists which obtains a schedule having the optimal bandwidth allocation (i.e. the maximum aggregate bandwidth of each ring is as small as possible). A large number of advanced heuristic algorithms have been developed to solve such scheduling optimization problems. Some examples are genetic algorithm, evolutionary algorithm, greedy search, Tabu search, harmony search, simulated annealing, ant colony optimization, etc. For purposes of simplicity and clarity, a simple heuristic algorithm for two rings is described here, although the number of rings is not limited to two.

[0043] The algorithm begins by sorting the channels Ki decreasingly by bandwidth b(Ki). Then it schedules the channel in such a way that each channel is assigned to the ring which has the smaller aggregate bandwidth. The formal description of the algorithm follows.

[0044] Input: T = set of n independent channels Ki with required bandwidth b(Ki), $1 \leq i \leq n$.

[0045] Output: L_1, L_2 and D_1, D_2. Lj is the set of channels schedule on ring Rj, and D_j is the maximum aggregate bandwidth of ring Rj, Dj = $Dj = (\sum b(J), J \varepsilon L_j)$, $1 \leq j \leq 2$.

[0046] ALGORITHM (T, L, D)

[0047] Step 1 (initialize K*i* and D_1, D_2) Sort K*i* such that $b(Ki) \leq b(Ki_{+1})$, $1 \leq i \leq n-1$. $D_1 \leftarrow 0$, $D_2 \leftarrow 0$.

[0048] Step 2 (Schedule a channel)

[0049] For i =1 to n, step 1 do

[0050] If $D_1 \leq D_2$, then [assign K*i* onto L_1, $D_1 \leftarrow D_1 + b(Ki)$].

[0051] else [assign K*i* onto L_2, $D_2 \leftarrow D_2 + b(Ki)$].

[0052] Referring next to Figure 4, a still further an alternative embodiment of the present invention may be understood. The arrangement illustrated in Figure 1 comprised downlink signals from two separate base stations belonging to the same wireless operator entering the DAU 105 at input ports 110A and 110p, respectively. In the embodiment of Figure 4, a first composite signal enters a first DAU 400 at that DAU's RF input port from a base station 405, and a second composite downlink input signal from, e.g., a second base station 410 belonging to a different wireless operator enters DAU 415 at that second DAU's RF input port. DAU 400 directly supports two rings 420 and 425, DAU 415 directly supports two rings 430 and 435, and a ring 440 is shared between DAU 400 and DAU 405. Each of the rings comprises daisy-chained DRU's generally indicated at 445 and connected via, for example, fiber optic links, as discussed in connection with Figure 1. It will be noted that channels A are transported in the opposite sense as channels B. The downlink channels in subset A are transported counterclockwise around each ring, whereas the channels in subset B are transported in a clockwise sense around each ring. In this embodiment, signals belonging to both the first operator and the second operator are converted and transported to the DRU's 445 on ring 440 because DAU 400 and DAU 405 are daisy-chained through the fiber optic cable 440. This embodiment provides an example of a neutral host wireless system, where multiple wireless operators share a common infrastructure comprised of DAU 400, DAU 415, and DRU's 445. All the previously mentioned features and advantages accrue to each of the two wireless operators. It will further be appreciated that, while Figure 4 illustrates only two DAU's linked in daisy-chain style, it is possible to daisy chain a larger plurality of DAU's, and the daisy-chained DAU's can also be configured in a ring configuration similar to the manner in which the DRU's are connected. This arranged is illustrated in Figure 8, below.

[0053] As disclosed in U.S. Provisional Application S.N. 61/374,593, entitled "Neutral Host Architecture for a Distributed Antenna System," filed August 17, 2010 and again referring to Figure 1 of the instant patent application, the Digital Up Converters present in the DRU's of the present invention can be programmed to process various signal formats and modulation types including FDMA, CDMA, TDMA, OFDMA and others. Also, the Digital Up Converters present in the respective DRUs can be programmed to operate with signals to be transmitted within various frequency bands subject to the capabilities and limitations of the system architecture disclosed in U.S. Provisional Application S.N. 61/374593, mentioned above. In one embodiment of the present invention where a wideband CDMA signal is present within, e.g., the bandwidth corresponding to a first carrier at the input port to DAU 105, the transmitted signal at the antenna ports of DRU 125A, DRU 1256 and DRUk will be a wideband CDMA signal which is virtually identical to the signal present within the bandwidth corresponding to that first carrier at the input port to DAU 105.

[0054] As disclosed in U.S. Provisional Application S.N. 61/374,593, again identified above, and also referring to Figure 1 of the instant patent application, it is to be understood that the Digital Up Converters present in the respective DRUs can be programmed to transmit any desired composite signal format to each of the respective DRU antenna ports. As an example, the Digital Up Converters present in DRU 125A and DRU 125B can be dynamically software-reconfigured as described previously so that the signal present at the antenna port of DRU 125A would correspond to the spectral profile shown in Figure 1 as 155A and also that the signal present at the antenna port of DRU 125B would correspond to the spectral profile shown in Figure 1 as 155B. The application for such a dynamic re-arrangement of DRU capacity would be e.g., if a company meeting were suddenly convened in the area of the enterprise corresponding to the coverage area of DRU 125B.

[0055] Referring again to Figure 2, another embodiment of the Distributed Antenna System of the present invention can be better understood. As disclosed in the aforementioned U.S. Provisional Application S.N. 61/374,593, and also as shown in Figure 2, the optical ring transport mechanism can be implemented with regard to uplink signals. As discussed previously with regard to downlink signals and by referring to Figure 1, the uplink system shown in Figure 2 is mainly comprised of DAU 105, together with DRU's 125A-125k. In a manner similar to the

downlink operation explained by referring to Figure 1, the operation of the uplink system shown in Figure 2 can be understood as follows.

[0056] The Digital Down Converters present in each of DRU's 125A-*k* are dynamically software-configured as described previously so that uplink signals of the appropriate desired signal format(s) present at the receive antenna ports of the respective DRU's 125A-125k are selected based on the desired uplink band(s) to be processed and filtered, converted and transported to the appropriate uplink output port of DAU 105. The DAU and DRUs frame the individual data packets corresponding to their respective radio signature using the Common Public Interface Standard (CPRI). Other Interface standards are applicable provided they uniquely identify data packets with respective DRUs. Header information is transmitted along with the data packet which indentifies the DRU and DAU that corresponds to the individual data packet.

[0057] In one example for the embodiment shown in Figure 2, DRU's 125A and 125C are configured to receive uplink signals within the Channel K bandwidth, whereas DRU 1256 and DRU 125*n* are both configured to reject uplink signals within the Channel K bandwidth. When DRU 125C receives a strong enough signal at its receive antenna port within the Channel K bandwidth to be properly filtered and processed, the Digital Down Converters within DRU 125C facilitate processing and conversion. Similarly, when DRU 125A receives a strong enough signal at its receive antenna port within the Channel K bandwidth to be properly filtered and processed, the Digital Down Converters within DRU 125A facilitate processing and conversion. The signals from DRU 125A and DRU 125C are combined based on the active signal combining algorithm, and are fed to the base station connected to the uplink output port of DAU 105. The term simulcast is frequently used to describe the operation of DRU125A and DRU 125C with regard to uplink and downlink signals within Channel K bandwidth. The term Flexible Simulcast refers to the fact that the present invention supports dynamic and/or manual rearrangement of which specific DRU are involved in the signal combining process for each Channel bandwidth.

[0058] Referring still to Figure 2, the Digital Down Converters present in DRU 125A are configured to receive and process signals within Channel J-Q bandwidths. The Digital Down Converters present in DRU 1256 are configured to receive and process signals within Channel J,

L, M and O bandwidths. The Digital Down Converters present in DRU 125C are configured to receive and process signals within Channel K and O bandwidths. The Digital Down Converters present in DRU 125*n* are configured to receive and process signals within Channel J, M, N and Q bandwidths. The respective high-speed digital signals resulting from processing performed within each of the four DRU are routed to the DAU. As described previously, the uplink signals from the four DRUs are combined within the respective DAU corresponding to each base station.

[0059] In summary, the Reconfigurable Distributed Antenna System of the present invention described herein efficiently conserves resources and reduces costs. The reconfigurable system is adaptive or manually field-programmable, since the algorithms can be adjusted like software in the digital processor at any time.

[0060] Referring next to Figure 5, an alternative embodiment of the present invention may be better understood. Figure 5 provides a daisy chain example of a distributed antenna system (DAS). Each DRU has a coverage radius that can be adjusted based on the power transmission from that particular remote unit. The DAU controls the various DRU's transmission power and can optimize the overall coverage zone. In the illustrated embodiment, DAU 502, again under the control of a NOC (not shown), is associated with a base station 501 and in turn interfaces with three DRU's 503, 504 and 505. A user 506 with a mobile device is provided relatively uniform coverage throughout the area covered by the three DRU's.

[0061] Referring next to Figure 6, a still further alternative embodiment may be better appreciated. Figure 6 shows an embodiment of a multi-band system illustrating one DAU supporting up to six different services operating at different frequency bands, with three optical rings of DRU's 1-60. The input frequency bands 605-630 (here denoted as six frequency bands at 700, 800, 850, 1900, 2100 and 2600 MHz) are input into the DAU 600 from the BTS's (not shown). The DAU includes, among other functionalities discussed herein, an RF IN portion for each band, and a digital distribution matrix for distributing the frequency bands to a plurality of DRU's, indicated as DRU1-DRU60, daisy-chained along three separate rings 635, 640 and 645 for achieving the desired coverage. The frequency bands are transported to either all or a subset of DRUs. The particular number of frequency bands, DAU's, DRU's and rings is exemplary

only, and can, in practice, be any number appropriate to the performance capabilities and needs of the network.

[0062] Referring next to Figure 7 that illustrates embedded software control modules, the software embedded in the DAU and DRU, which controls the operation of key functions of these devices, can be better understood. In particular, the DAU embedded software control module 700 comprises a DAU Management Control Module 705 and a DAU monitoring module 710. The DAU Management Control Module 705 communicates with the NOC 715, and also the DAU monitoring module 710. One such key function is determining and/or setting the appropriate amount of radio resources (such as RF carriers, CDMA codes or TDMA time slots) assigned to a particular DRU or group of DRUs to meet desired capacity and throughput objectives. As noted previously, the NOC 715 monitors the DAS operation and sends commands to the DAU's for configuring various functions of the DRU's as well as the DAU, in at least some embodiments.

[0063] The DAU Monitoring module, in addition to other functions, detects which carriers and corresponding time slots are active for each DRU. The DAU Management Control module communicates with the DRU Embedded Software Control module 720 over a fiber optic link control channel via a control protocol. In an embodiment, the control protocol comprises headers together with packets of data, such that both control information and data are transmitted to the DRU's together as a message. DRU functions or features that the header would control in the DRU are typically implementation specific and can include, among other things, measuring uplink and downlink power, measuring gain of uplink and downlink, and monitoring alarms in the DRU.

[0064] In turn, the DRU Management Control module 725 within the DRU Embedded Software Control Module sets the individual parameters of all the DRU Digital Up-Converters 730 to enable or disable specific radio resources from being transmitted by a particular DRU or group of DRUs, and also sets the individual parameters of all the DRU Digital Down-Converters 735 to enable or disable specific radio resources from being transmitted by a particular DRU or group of DRUs. In addition, the DRU Embedded Software Control Module comprises a DRU Pilot Beacon Control Module 740, which communicates with a DRU Pilot Beacon 745.

[0065] Referring next to Figure 8, an embodiment of a daisy-chained configuration of DAU's is illustrated, together with a daisy-chained configuration of DRU's. In an embodiment, a plurality of base stations 800A-800n are each associated with one of DAU's 805A-n. The DAU's are daisy-chained, and each DAU communicates with one or more daisy-chains 810A-810m of DRU's which may or may not be arranged in a ring configuration. It will be appreciated that the DAU's can also be configured in a ring configuration, as discussed above.

[0066] An algorithm operating within the DAU Monitoring module which detects which carriers and corresponding time slots for each carrier are active for each DRU provides information to the DAU Management Control module to help identify when, e.g., a particular downlink carrier is loaded by a percentage greater than a predetermined threshold whose value is communicated to the DAU Management Control module by the DAU's Remote Monitoring and Control function 715. If that occurs, the DAU Management Control module can adaptively modify the system configuration to begin to deploy, typically although not necessarily slowly, additional radio resources (such as RF carriers, CDMA codes or TDMA time slots) for use by a particular DRU which need those radio resources within its coverage area. At the same time, usually the DAU Management Control module adaptively modifies the system configuration to begin to remove, again typically slowly, certain radio resources (such as RF carriers, CDMA codes or TDMA time slots) for use by a particular DRU where that DRU no longer needs those radio resources within its coverage area.

[0067] Although the present invention has been described with reference to the preferred embodiments, it will be understood that the invention is not limited to the details described thereof. Various substitutions and modifications have been suggested in the foregoing description, and others will occur to those of ordinary skill in the art. Therefore, all such substitutions and modifications are intended to be embraced within the scope of the invention as defined in the appended claims.

APPENDIX I

Glossary of Terms

ACLR	Adjacent Channel Leakage Ratio
ACPR	Adjacent Channel Power Ratio
ADC	Analog to Digital Converter
AQDM	Analog Quadrature Demodulator
AQM	Analog Quadrature Modulator
AQDMC	Analog Quadrature Demodulator Corrector
AQMC	Analog Quadrature Modulator Corrector
BPF	Bandpass Filter
BTS	Base Transceiver System or Base Station
CDMA	Code Division Multiple Access
CFR	Crest Factor Reduction
DAC	Digital to Analog Converter
DAU	Digital Access Unit
DET	Detector
DHMPA	Digital Hybrid Mode Power Amplifier
DDC	Digital Down Converter
DNC	Down Converter
DPA	Doherty Power Amplifier
DQDM	Digital Quadrature Demodulator
DQM	Digital Quadrature Modulator
DSP	Digital Signal Processing
DUC	Digital Up Converter
EER	Envelope Elimination and Restoration
EF	Envelope Following
ET	Envelope Tracking
EVM	Error Vector Magnitude
FFLPA	Feedforward Linear Power Amplifier
FIR	Finite Impulse Response

	FPGA	Field-Programmable Gate Array
	GSM	Global System for Mobile communications
	I-Q	In-phase / Quadrature
	IF	Intermediate Frequency
5	LINC	Linear Amplification using Nonlinear Components
	LO	Local Oscillator
	LPF	Low Pass Filter
	MCPA	Multi-Carrier Power Amplifier
	MDS	Multi-Directional Search
10	OFDM	Orthogonal Frequency Division Multiplexing
	PA	Power Amplifier
	PAPR	Peak-to-Average Power Ratio
	PD	Digital Baseband Predistortion
	PLL	Phase Locked Loop
15	PN	Pseudo-Noise
	QAM	Quadrature Amplitude Modulation
	QPSK	Quadrature Phase Shift Keying
	RF	Radio Frequency
	RRH	Remote Radio Head
20	RRU	Remote Radio Head Unit
	SAW	Surface Acoustic Wave Filter
	UMTS	Universal Mobile Telecommunications System
	UPC	Up Converter
	WCDMA	Wideband Code Division Multiple Access
25	WLAN	Wireless Local Area Network

WHAT IS CLAIMED IS:

1. A method for routing and switching operator RF signals comprising:

providing one or more remote radio units, each configured to receive one or more downlink radio frequencies and to transmit one or more uplink radio frequencies,

providing at least one digital access unit configured to communicate with at least some remote radio units,

linking in a loop configuration the one or more remote radio units and the at least one digital access unit whereby each remote radio unit can be accessed in either direction around the loop, and

routing and switching packetized signals among the one or more radio units and the at least one digital access units.

ABSTRACT OF THE DISCLOSURE

The present disclosure is a novel utility of a software defined radio (SDR) based Distributed Antenna System (DAS) that is field reconfigurable and support multi-modulation schemes (modulation-independent), multi-carriers, multi-frequency bands and multi-channels. The present invention enables a high degree of flexibility to manage, control, enhance, facilitate the usage and performance of a distributed wireless network such as Flexible Simulcast, automatic traffic load-balancing, network and radio resource optimization, network calibration, autonomous/assisted commissioning, carrier pooling, automatic frequency selection, frequency carrier placement, traffic monitoring, traffic tagging, pilot beacon, etc. As a result, a DAS in accordance with the present invention can increase the efficiency and traffic capacity of the operators' wireless network.

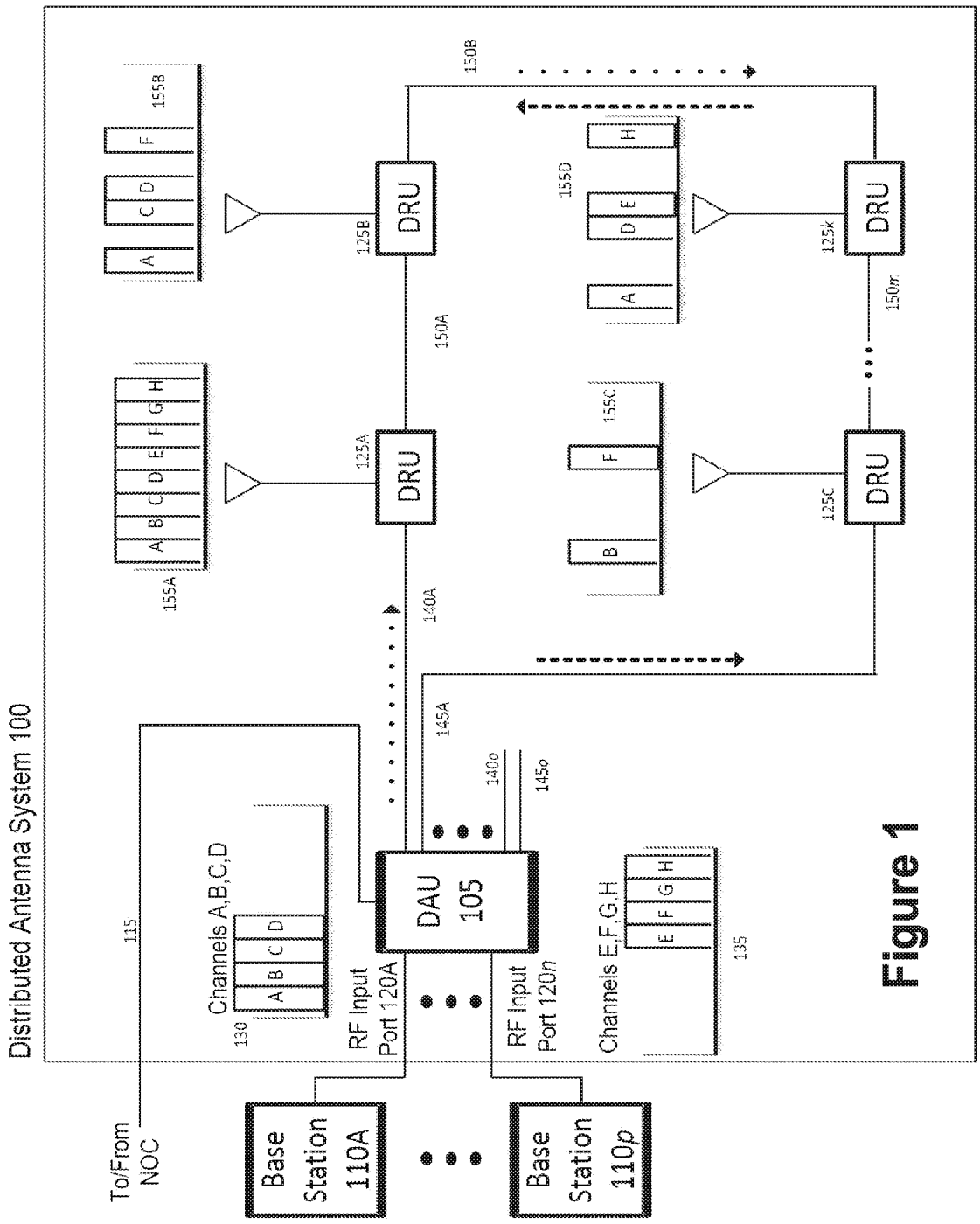

Distributed Antenna System 100
To/From NOC
115
Base Station 110A
Base Station 110p
DAU 105
RF Input Port 120A
RF Input Port 120n
Channels A,B,C,D
130
Channels E,F,G,H
135
140A
140p
145A
145p
150A
150B
150m
155A
155B
155C
155D
125A
125B
125C
125k
DRU
A
B
C
D
E
F
G
H

Figure 1

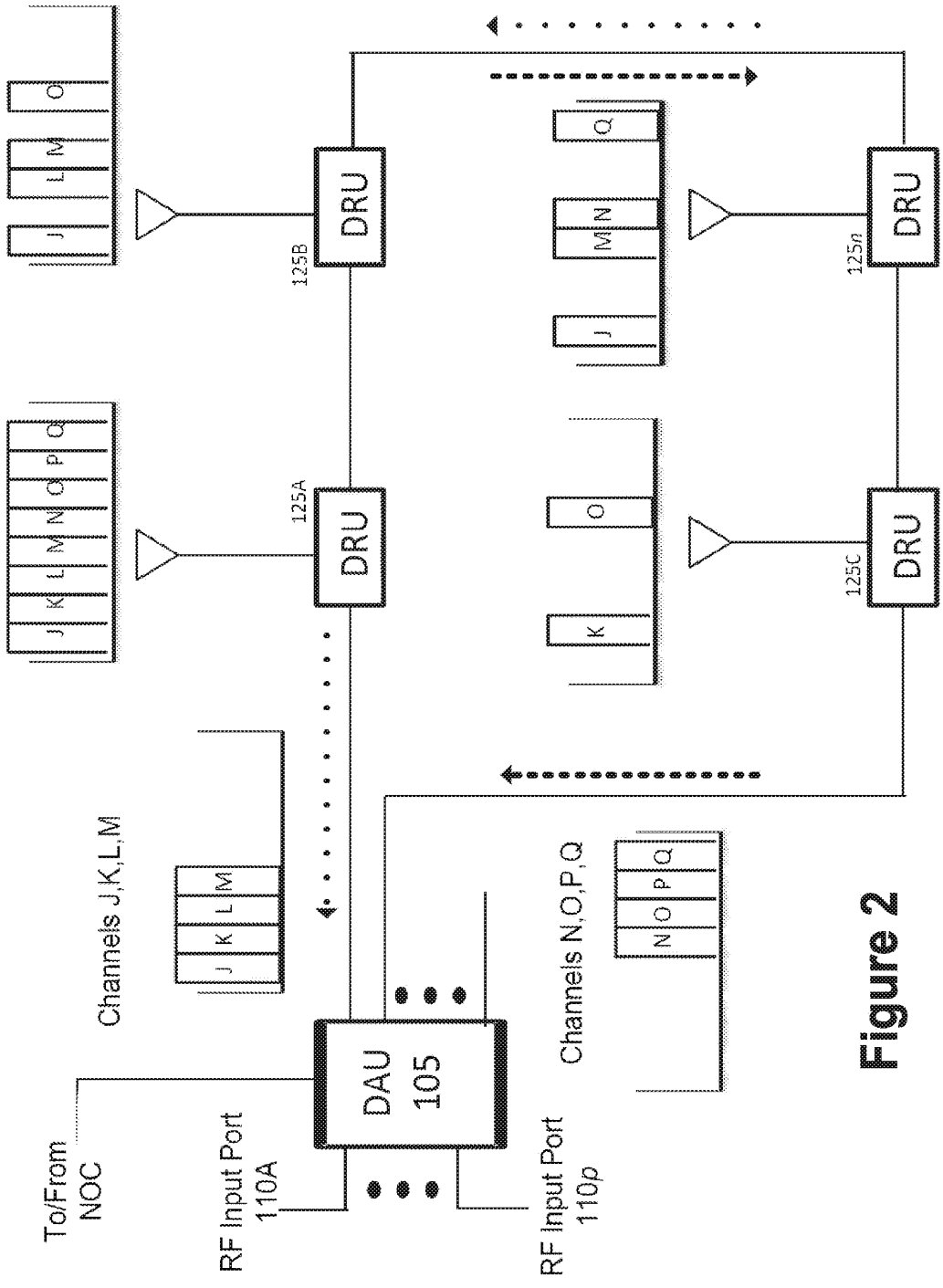

DRU
125A
125B
125C
125n
DAU
105
To/From
NOC
RF Input Port
110A
RF Input Port
110p
Channels J,K,L,M
Channels N,O,P,Q
J K L M N O P Q

Figure 2

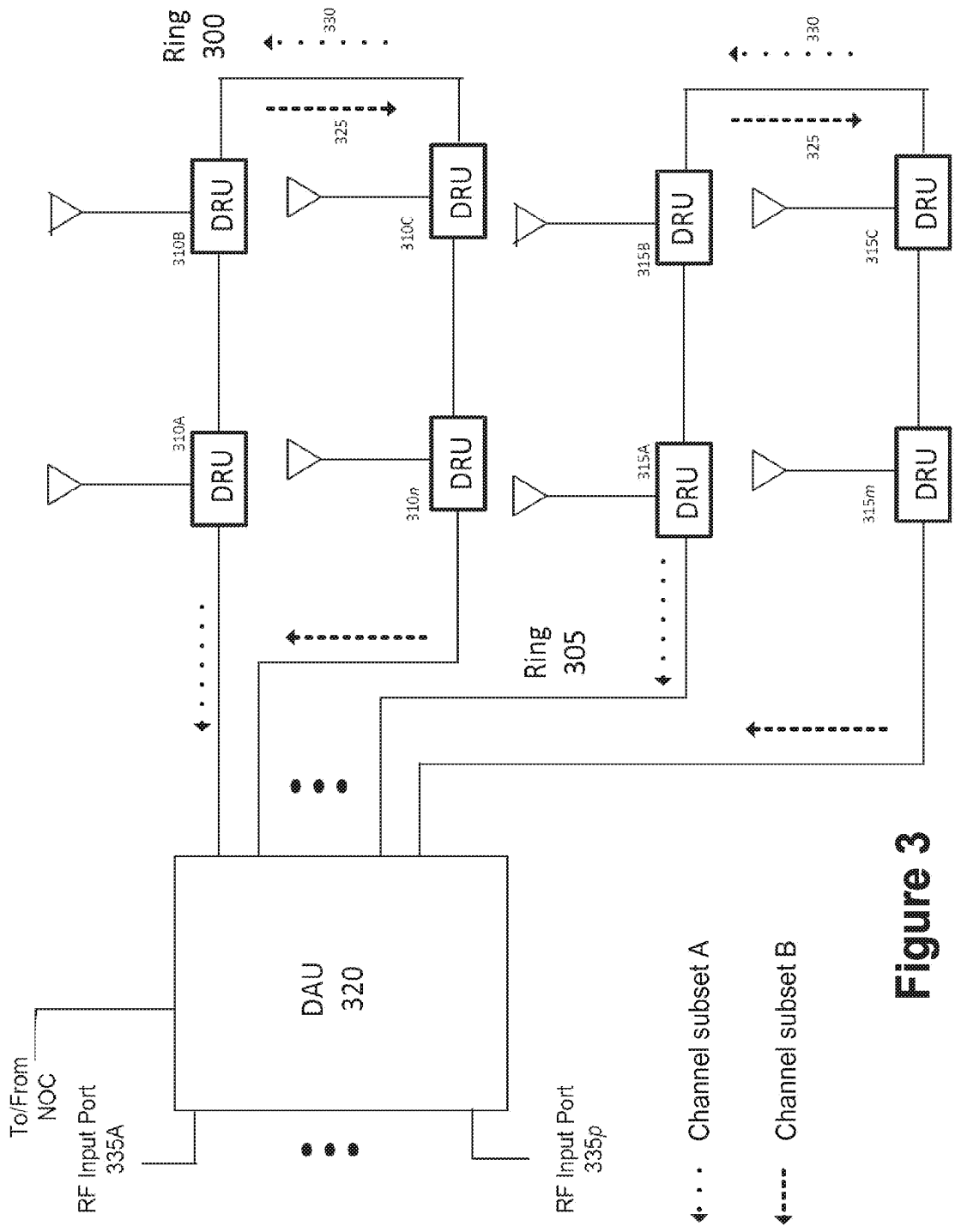

Ring
300
330
325
DRU
310A
310B
310C
310n
315A
315B
315C
315m
Ring
305
DAU
320
To/From
NOC
RF Input Port
335A
RF Input Port
335p
Channel subset A
Channel subset B

Figure 3

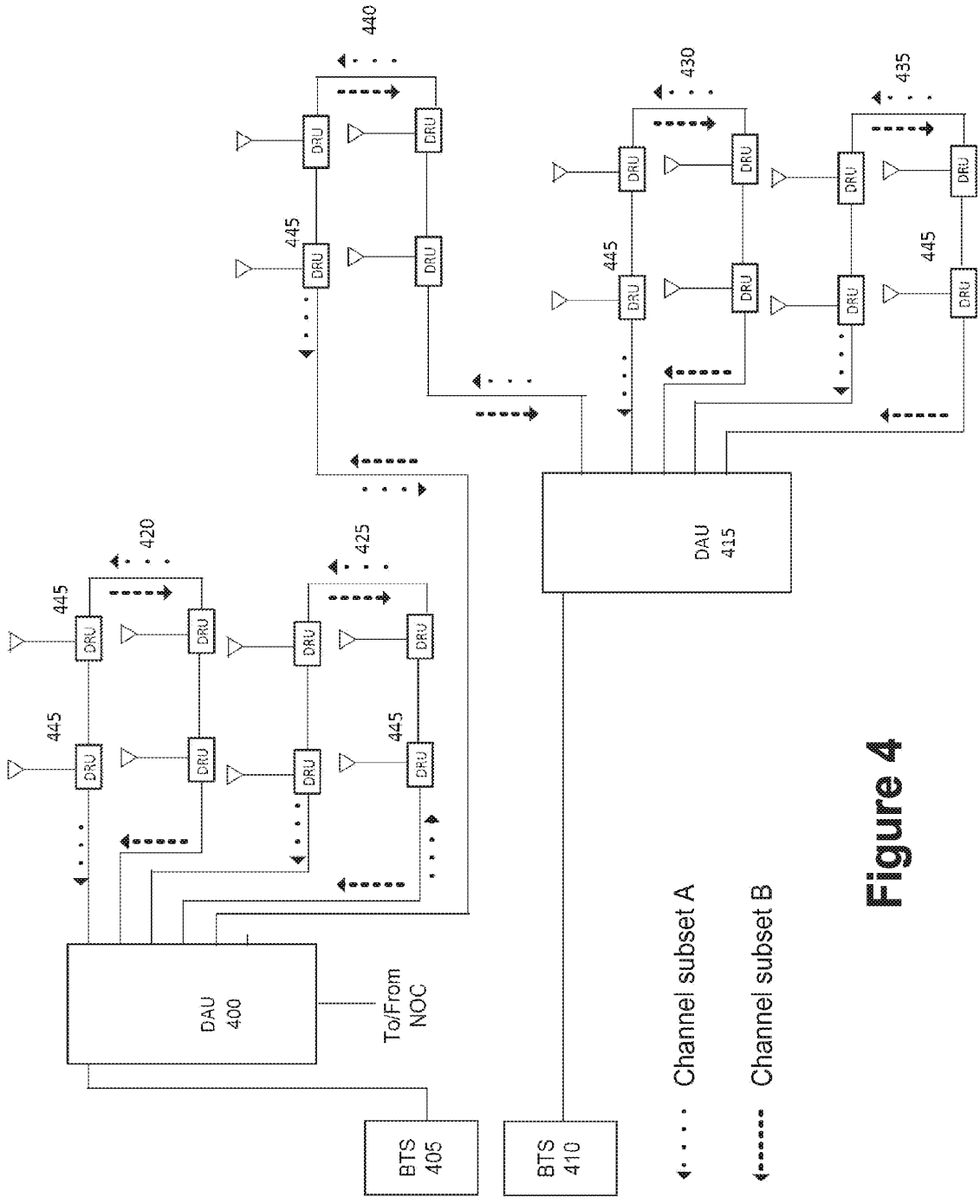

440
430
435
445
DRU
420
425
DAU
400
DAU
415
To/From
NOC
BTS
405
BTS
410
Channel subset A
Channel subset B

Figure 4

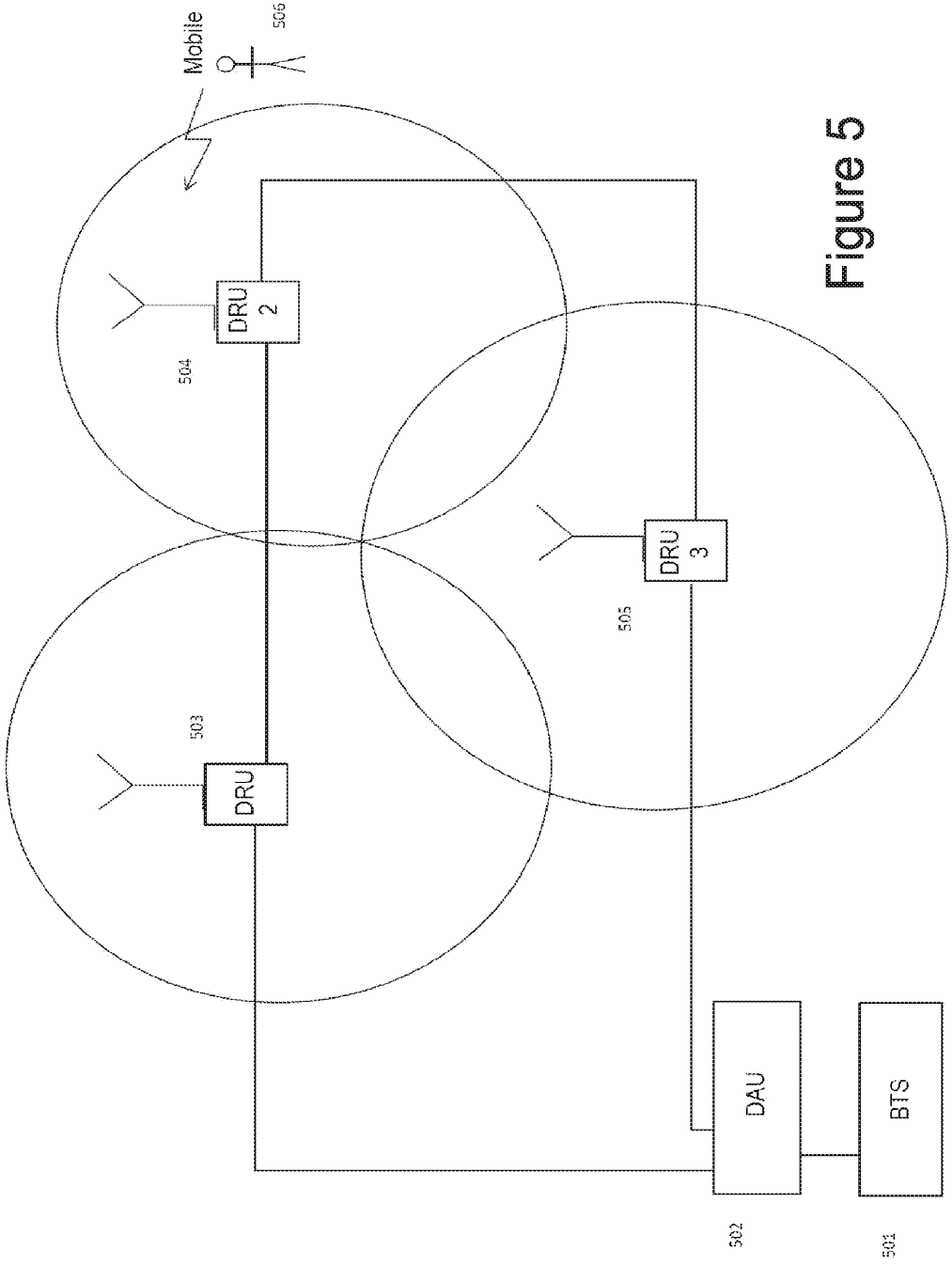


Figure 5

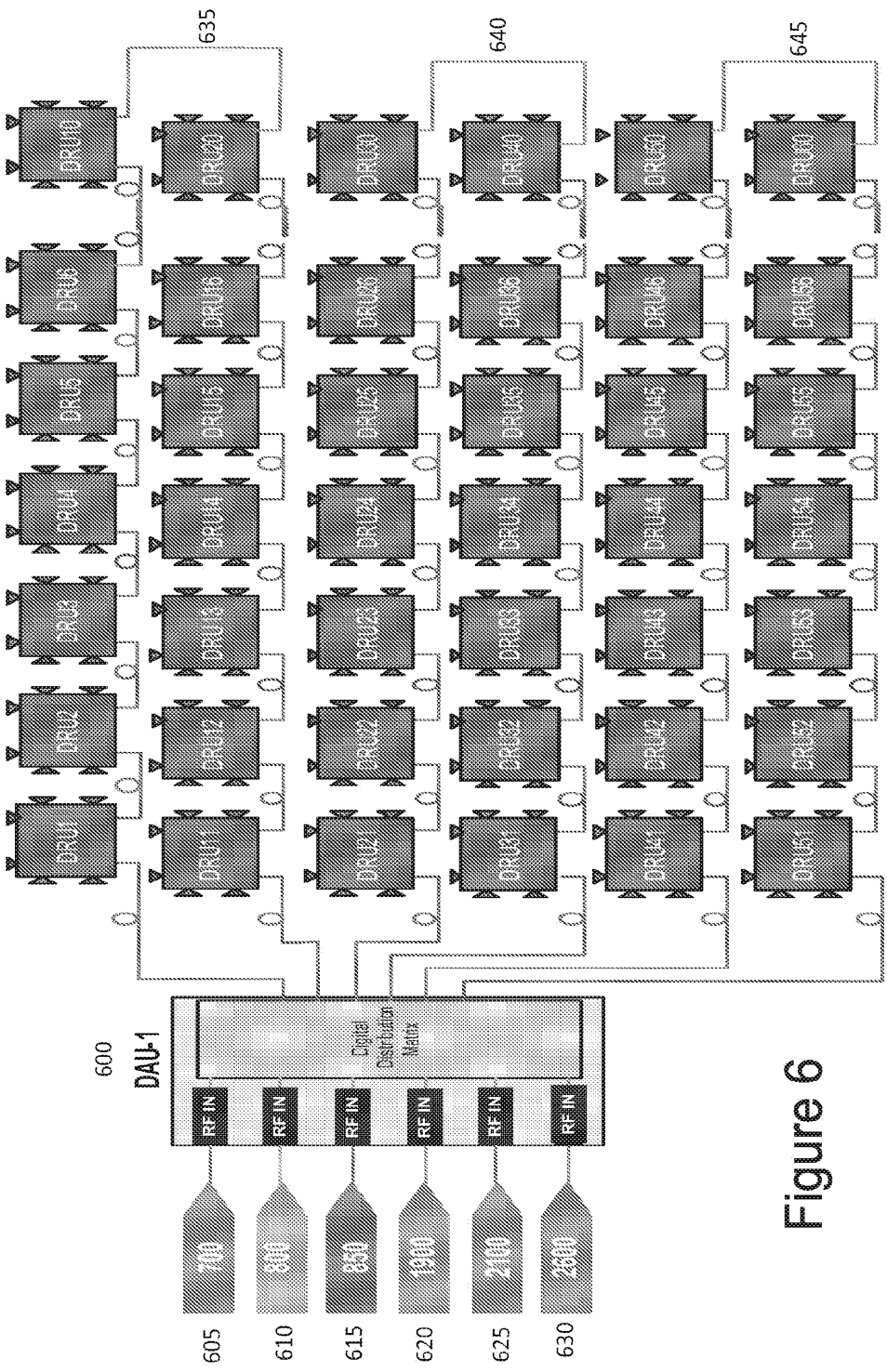

600
DAU-1
Digital Distribution Matrix
RF IN
700
800
840
900
2100
2600
605
610
615
620
625
630
635
640
645

Figure 6

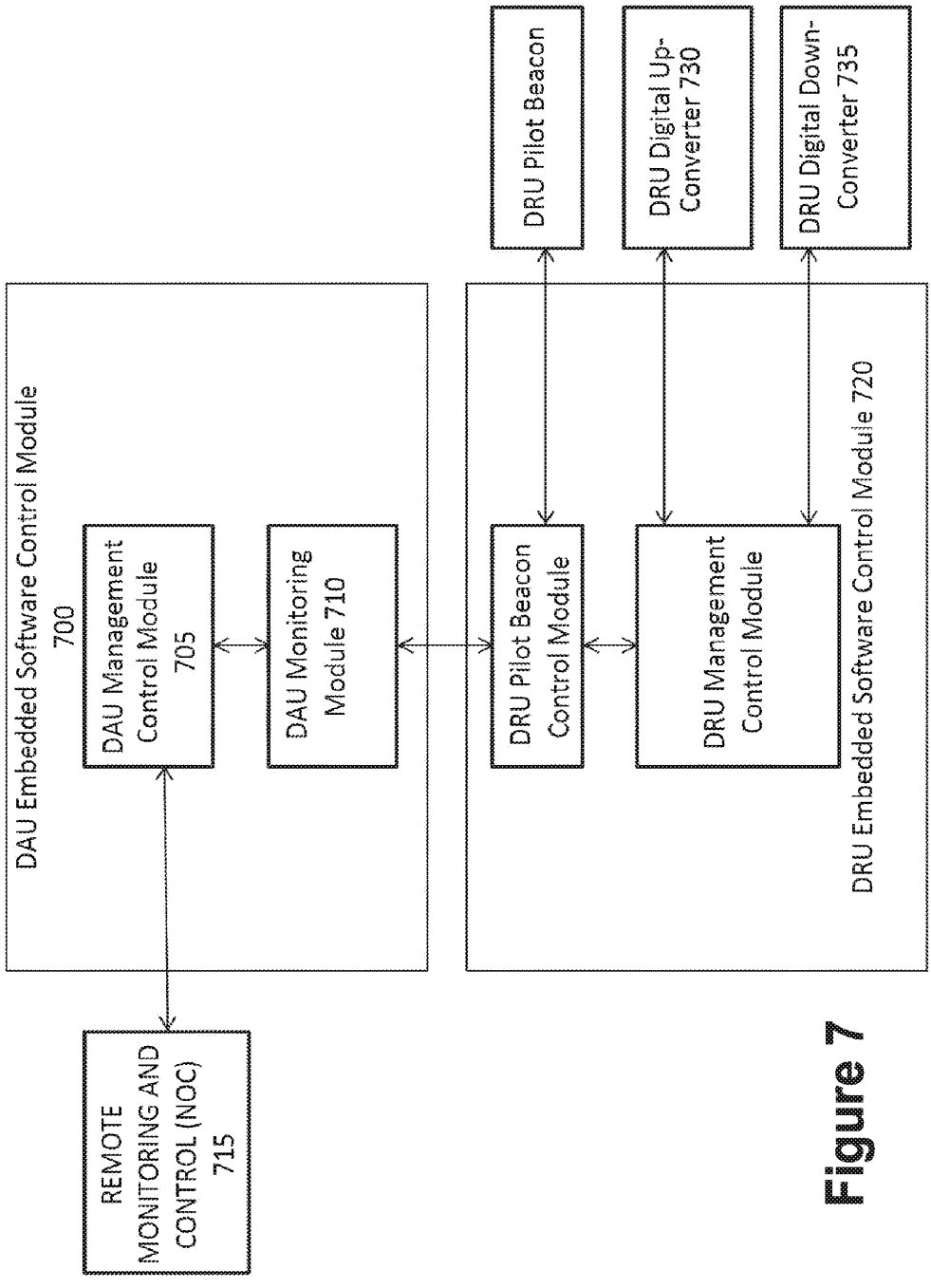

DAU Embedded Software Control Module
700
DAU Management Control Module 705
DAU Monitoring Module 710
REMOTE MONITORING AND CONTROL (NOC) 715
DRU Embedded Software Control Module 720
DRU Pilot Beacon Control Module
DRU Management Control Module
DRU Pilot Beacon
DRU Digital Up-Converter 730
DRU Digital Down-Converter 735

Figure 7

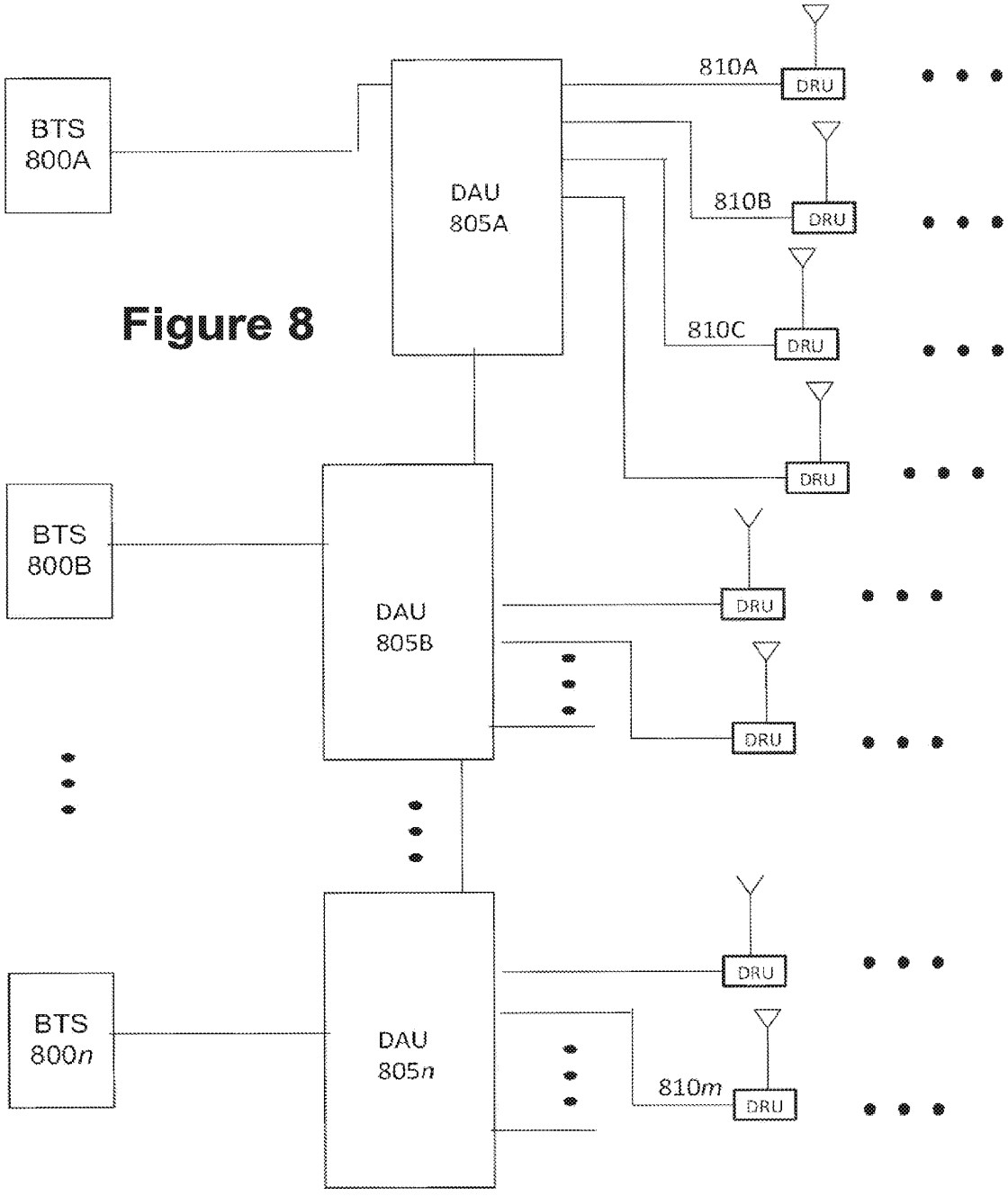

BTS
800A
DAU
805A
810A
DRU
810B
DRU
810C
DRU
DRU
BTS
800B
DAU
805B
DRU
DRU
BTS
800n
DAU
805n
DRU
810m
DRU

Figure 8

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	DISTRIBUTED ANTENNA SYSTEM

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 14/800,515

filed on July 15, 2015

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Shawn Patrick Stapleton Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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LEGAL NAME OF INVENTOR

Inventor: Paul Lemson Date (Optional): OCT 4 2015

Signature: _____

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LEGAL NAME OF INVENTOR

Inventor: Bin Lin Date (Optional): _____

Signature: _____

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LEGAL NAME OF INVENTOR

Inventor: Albert S. Lee Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Dali Systems Co. Ltd.

Application No./Patent No.: unassigned Filed/Issue Date: herewith

Titled: DISTRIBUTED ANTENNA SYSTEM

Dali Systems Co. Ltd., a corporation

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

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

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

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

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

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

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

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

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

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

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

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

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

   1. From: Shawn Patrick Stapleton, Paul Lemson and Bin Lin To: DALI SYSTEMS CO. LTD.

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

      Reel 027052, Frame 0064, or for which a copy thereof is attached.

   2. From: Albert S. Lee To: DALI SYSTEMS CO. LTD.

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

      Reel 036229, Frame 0936, or for which a copy thereof is attached.

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

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

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

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

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

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

4. From: _____ To: _____

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

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

5. From: _____ To: _____

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

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

6. From: _____ To: _____

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

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

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

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

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

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

/Kelvin B. Catmull/	July 29, 2016
Signature	Date
Kelvin B. Catmull	Attorney of Record, Reg. No. 57353
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/223,819	07/29/2016	2414	0.00	091172-1017552-102440US	1	1

CONFIRMATION NO. 3273

FILING RECEIPT

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

OC000000085030973

Date Mailed: 08/12/2016

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Shawn Patrick Stapleton, Burnaby, CANADA;
Paul Lemson, Woodinvile, WA;
Bin Lin, Burnaby, CANADA;
Albert S. Lee, San Mateo, CA;

Applicant(s)

Dali Systems Co. Ltd., George Town, CAYMAN ISLANDS;

Power of Attorney: The patent practitioners associated with Customer Number 20350

Domestic Priority data as claimed by applicant

This application is a CON of 14/800,515 07/15/2015 PAT 9419837
which is a CON of 14/260,145 04/23/2014 PAT 9137078
which is a CON of 13/211,247 08/16/2011 PAT 8737300
which claims benefit of 61/439,940 02/07/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 08/11/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/223,819**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

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

DISTRIBUTED ANTENNA SYSTEM

Preliminary Class

370

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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

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

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

NOT GRANTED

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

SelectUSA

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

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/223,819

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	300		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	1 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 210 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	730		TOTAL	

APPLICATION AS AMENDED - PART II

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

FORMALITIES LETTER

OC000000085030974

Date Mailed: 08/12/2016

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
- The application search fee must be submitted.
- The application examination fee must be submitted.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.
  The surcharge is due for any one of:
  - late submission of the basic filing fee, search fee, or examination fee,
  - late submission of inventor's oath or declaration,
  - filing an application that does not contain at least one claim on filing, or
  - submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- $ **70** basic filing fee.
- $ **70** surcharge.
- $ **300** search fee.
- $ **360** examination fee.
- $(**0**) previous unapplied payment amount.
- $ **800** TOTAL FEE BALANCE DUE.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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**.

/ldvan/

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on November 14, 2016.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner:
Application No.: 15/223,819	Technology Center/Art Unit: 2414
Filed: Jul 29, 2016	RESPONSE TO NOTICE OF MISSING PARTS
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	

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

Commissioner:

Pursuant to the Notice to File Missing Parts of Nonprovisional Application, dated August 12, 2016, transmitted herewith are papers in the above-identified application.

☒ Formalities Letter – Notice to File Missing Parts of Application – Filing Date Granted.
☐ Executed Declaration.
☐ Power of Attorney and Certificate of Assignee under 37 C.F.R. § 3.73(b).
☒ Petition for Extension of Time Under 37 C.F.R. § 1.136.
☐ Application Data Sheet
☐ The fee is calculated on the attached PTO/SB/17.
☒ Payment in the amount of **$900** is submitted.
☐ Form PTO-2038 is attached.
☒ The Commissioner is hereby authorized to charge any additional fees required under 37 CFR §1.16, or credit any overpayment, to Account No. 20-1430.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535
Tel: (650) 326-2400
Email: kcatmull@kilpatricktownsend.com

68905164V.1

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

FORMALITIES LETTER

OC000000085030974

Date Mailed: 08/12/2016

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
- The application search fee must be submitted.
- The application examination fee must be submitted.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.
  The surcharge is due for any one of:
  - late submission of the basic filing fee, search fee, or examination fee,
  - late submission of inventor's oath or declaration,
  - filing an application that does not contain at least one claim on filing, or
  - submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- $ **70** basic filing fee.
- $ **70** surcharge.
- $ **300** search fee.
- $ **360** examination fee.
- $(**0**) previous unapplied payment amount.
- $ **800** TOTAL FEE BALANCE DUE.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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**.

/ldvan/

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on Novenber 14, 2016.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Not Yet Assigned
Application No.: 15/223,819	Technology Center/Art Unit: 2414
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	PRELIMINARY AMENDMENT
Customer No.: 20350	

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

Commissioner:

Prior to examination of the above-referenced application, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 6 of this paper.

Amendments to the Claims:

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

Listing of Claims:

1. (Canceled)

2. (New) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time; and

wherein the first set of downlink channel signals is different from the second set of downlink channel signals.

3. (New) The host unit of claim 2, wherein the host unit is configurable to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

4. (New) The host unit of claim 2, wherein the host unit is configurable, based on a change in network conditions, to dynamically change from (a) sending the digital

representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

5. (New) The host unit of claim 2, wherein the host unit is configurable, based on load balancing, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

6. (New) The host unit of claim 2, wherein the host unit is configurable, based on a change in subscriber needs, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

7. (New) The host unit of claim 2, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

8. (New) The host unit of claim 2, wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface.

9. (New) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

10. (New) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal in compliance with the Common Public Interface Standard (CPRI) standard.

11. (New) A system for transporting wireless communications, comprising:

a host unit;

a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time;

wherein the first set of downlink channel signals is different from the second set of downlink channel signals; and

wherein the host unit is capable of receiving digital signals from each of the plurality of remote units.

12. (New) The system of claim 11, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

13. (New) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through a direct connection.

14. (New) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through an indirect connection.

15. (New) The system of claim 11, wherein each remote unit comprises at least one interface to communicatively couple the remote unit to another one of the plurality of remote units in a daisy-chain configuration.

16. (New) A method for providing digital signals in a Distributed Antenna System (DAS), comprising:

transmitting from a host unit, at a first point in time, a first set of downlink channel signals to a first remote unit;

transmitting from the host unit, at a second point in time, a second set of downlink channel signals to the first remote unit;

wherein the first set of downlink channel signals is different from the second set of downlink channel signals.

17. (New) The method of claim 16, wherein the host unit dynamically changes based on a change in network conditions from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

18. (New) The method of claim 16, wherein the host unit dynamically changes based on load balancing from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

19. (New) The method of claim 16, wherein the host unit dynamically changes based on a schedule from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

20. (New) The method of claim 16, wherein the downlink channel signals are packetized.

21. (New) The method of claim 20, wherein the downlink channel signals are packetized in compliance with the Common Public Interface Standard (CPRI) standard.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 2-21 will be pending in this application. Claim 1 has been canceled and new claims 2-21 have been added. No new matter is added.

CONCLUSION

In view of the foregoing, Applicant believes all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

Except for the issue fees payable under 37 C.F.R. § 1.18, the Director is authorized to charge any additional fees during pendency of this application, including any required extension of time fees, or credit any overpayment to Deposit Account Number 20-1430. This paragraph is intended to be a constructive petition for extension of time in accordance with 37 C.F.R. § 1.136(a)(3).

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (650) 326-2400 or kcatmull@kilpatricktownsend.com.

Respectfully submitted,

/Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP
KBC:bsk

68690952V.1

PTO/SB/22 (03-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 091172-1017552-102440US
Application Number 15/223,819	Filed July 29, 2016
For DISTRIBUTED ANTENNA SYSTEM	
Art Unit 2414	Examiner

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

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

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

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

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

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

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

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

☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number _____.

☑ Payment made via EFS-Web.

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

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 57535.

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

/Kelvin B. Catmull/	2016-11-14
Signature	Date
Kelvin B. Catmull	650-326-2400
Typed or printed name	Telephone Number

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

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal					
Application Number:	15223819				
Filing Date:	29-Jul-2016				
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM				
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton				
Filer:	Kelvin B. Catmull/Brian Kanter				
Attorney Docket Number:	091172-1017552-102440US				
Filed as Small Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
UTILITY FILING FEE (ELECTRONIC FILING)		4011	1	70	70
UTILITY SEARCH FEE		2111	1	300	300
UTILITY EXAMINATION FEE		2311	1	360	360
Pages:					
Claims:					
Miscellaneous-Filing:					
LATE FILING FEE FOR OATH OR DECLARATION		2051	1	70	70
Petition:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 1 month with $0 paid	2251	1	100	100
Miscellaneous:				
		Total in USD ($)		**900**

Electronic Acknowledgement Receipt	
EFS ID:	27498477
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull/Brian Kanter
Filer Authorized By:	Kelvin B. Catmull
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	14-NOV-2016
Filing Date:	29-JUL-2016
Time Stamp:	15:18:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$900
RAM confirmation Number	111516INTEFSW15192500
Deposit Account	201430
Authorized User	IPPayments KilpatrickTownsend
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	RespMP_NoticeMP.pdf	1699213 e03ad1ac260e1e90443660a09c7efad6791b3444	no	3
Warnings:					
Information:					
2		PA_68690952_1.pdf	80996 cc07768ec33a293d7e1ee7c7b5977327fa212ac5	yes	6

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Claims	2	5
Applicant Arguments/Remarks Made in an Amendment	6	6

Warnings:					
Information:					
3	Extension of Time	EXT___.pdf	187621 3299caac2551e19ee579a6637253babaf0372c34	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	39209 7cdd9b9f6b743c21e0e00fc63103d06fb20494d3	no	2
Warnings:					
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		Total Files Size (in bytes):	2007039		

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

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

New International Application Filed with the USPTO as a Receiving Office
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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/223,819	Filing Date 07/29/2016	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **11/14/2016**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

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

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

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/223,819	07/29/2016	2414	800	091172-1017552-102440US	20	3

CONFIRMATION NO. 3273

UPDATED FILING RECEIPT

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

OC000000087269178

Date Mailed: 11/18/2016

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Shawn Patrick Stapleton, Burnaby, CANADA;
Paul Lemson, Woodinvile, WA;
Bin Lin, Burnaby, CANADA;
Albert S. Lee, San Mateo, CA;

Applicant(s)

Dali Systems Co. Ltd., George Town, CAYMAN ISLANDS;

Power of Attorney: The patent practitioners associated with Customer Number 20350

Domestic Priority data as claimed by applicant

This application is a CON of 14/800,515 07/15/2015 PAT 9419837
which is a CON of 14/260,145 04/23/2014 PAT 9137078
which is a CON of 13/211,247 08/16/2011 PAT 8737300
which claims benefit of 61/439,940 02/07/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 08/11/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/223,819**

Projected Publication Date: 02/23/2017

Non-Publication Request: No

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

DISTRIBUTED ANTENNA SYSTEM

Preliminary Class

370

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

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/223,819

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	300		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*	x 210 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	730		TOTAL	

APPLICATION AS AMENDED - PART II

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

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

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2414
	Examiner Name	
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-5,880,863	A	03-09-1999	Rideout et al.	
	2.	US-6,353,600	B1	03-05-2002	Schwartz et al.	
	3.	US-6,393,007	B2	05-21-2005	Haartsen	
	4.	US-6,493,335	B1	12-10-2002	Darcie et al.	
	5.	US-6,625,429	B1	09-23-2003	Yamashita	
	6.	US-6,657,993	B1	12-02-2003	Casanova et al.	
	7.	US-6,724,737	B1	04-20-2004	Boyden et al.	
	8.	US-6,801,767	B1	10-05-2004	Schwartz et al.	
	9.	US-7,102,442	B2	09-05-2006	Anderson	
	10.	US-7,145,704	B1	12-05-2006	Islam	
	11.	US-7,283,519	B2	10-16-2007	Girard	
	12.	US-7,362,776	B2	04-22-2008	Meier et al.	
	13.	US-7,489,632	B2	02-10-2009	Lakkakorpi	
	14.	US-7,496,367	B1	02-24-2009	Ozturk et al.	
	15.	US-7,634,536	B2	12-15-2009	Halasz	
	16.	US-7,765,294	B2	07-27-2010	Edwards et al.	
	17.	US-7,801,038	B2	09-21-2010	Liao et al.	
	18.	US-7,826,369	B2	11-02-2010	Filsfils et al.	
	19.	US-7,855,977	B2	12-21-2010	Morrison et al.	
	20.	US-8,036,226	B1	10-11-2011	Ma et al.	
	21.	US-8,098,572	B2	01-17-2012	Zhou et al.	
	22.	US-8,139,492	B1	03-20-2012	Peterson et al.	
	23.	US-8,363,628	B2	01-29-2013	Chi et al.	
	24.	US-8,451,735	B2	05-28-2013	Li	
	25.	US-8,478,331	B1	07-02-2013	Rogers	
	26.	US-8,520,603	B2	08-27-2013	Kozisek et al.	
	27.	US-8,527,003	B2	09-03-2013	Gupta et al.	
	28.	US-8,682,338	B2	03-25-2014	Lemson et al.	
	29.	US-8,682,338	B2	03-25-2014	Lemson et al.	
	30.	US-8,737,300	B2	05-27-2014	Stapleton et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	31.	US-2001/0034223	A1	10-25-2001	Rieser et al.	
	32.	US-2002/0075906	A1	06-20-2002	Cole et al.	
	33.	US-2002/0086675	A1	07-04-2002	Mansour	
	34.	US-2002/0093926	A1	07-18-2002	Kilfoyle	
	35.	US-2003/0021263	A1	01-30-2003	Lee	
	36.	US-2003/0181221	A1	09-25-2003	Nguyen	
	37.	US-2004/0053624	A1	03-18-2004	Frank et al.	
	38.	US-2005/0152695	A1	7/14/2005	Sulzberger et al.	
	39.	US-2005/0181812	A1	08-18-2005	Scheck	

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	Art Unit	2414
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	Attorney Docket Number	091172-1017552-102440US

	40.	US-2005/0206564	A1	09-22-2005	Mao et al.	
	41.	US-2005/0220066	A1	10-06-2005	Wal et al.	
	42.	US-2006/0270366	A1	11-30-2006	Rozenblit et al.	
	43.	US-2007/0019598	A1	01-25-2007	Prehofer	
	44.	US-2007/0058742	A1	03-15-2007	Demarco et al.	
	45.	US-2007/0065078	A1	03-22-2007	Jiang	
	46.	US-2007/0116046	A1	05-24-2007	Liu et al.	
	47.	US-2007/0147488	A1	06-28-2007	Han	
	48.	US-2007/0177552	A1	08-02-2007	Wu et al.	
	49.	US-2008/0051129	A1	02-28-2008	Abe et al.	
	50.	US-2008/0146146	A1	06-19-2008	Binder et al.	
	51.	US-2008/0225816	A1	09-18-2008	Osterling et al.	
	52.	US-2008/0240036	A1	10-02-2008	Liu et al.	
	53.	US-2009/0274048	A1	11-05-2009	Sambhwani et al.	
	54.	US-2010/0087227	A1	04-08-2010	Francos et al.	
	55.	US-2010/0136998	A1	06-03-2010	Lott et al.	
	56.	US-2010/0202565	A1	08-12-2010	Abbasfar	
	57.	US-2010/0247105	A1	09-30-2010	Yu	
	58.	US-2010/0279704	A1	11-04-2010	Vachhani	
	59.	US-2010/0299173	A1	11-25-2010	Zampiello et al.	
	60.	US-2010/0311372	A1	12-09-2010	Bouyaud et al.	
	61.	US-2011/0103309	A1	05-05-2011	Wang et al.	
	62.	US-2012/0039254	A1	02-16-2012	Stapleton et al.	
	63.	US-2013/0272202	A1	10-17-2013	Stapleton et al.	
	64.	US-2014/0313884	A1	10-23-2014	Stapleton et al.	
	65.	US-2014-0286247	A1	09-25-2014	Lemson et al.	
	66.	US-2016/0014782	A1	01-14-2016	Stapleton et al.	
	67.	US-2016/0080082	A1	03-17-2016	Lemson et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	68.	103201958	CN	A	07-10-2013	Dali Systems Co. Ltd.		
	69.	2606576	EP	A0	06-26-2013	Dali Systems Co. Ltd.		
	70.	2008/154077	WO	A1	12-18-2008	Dali Systems Co. Ltd.		
	71.	2012/024343	WO	A1	02-23-2012	Dali Systems Co. Ltd.		
	72.	2012/024349	WO	A1	02-23-2012	Dali Systems Co. Ltd.		
	73.	101453799	CN	A	06-10-2009			
	74.	02/23956	WO	A2	03-21-2002	TELEDYNE LIGHTING AND DISPLAY PRODUCTS INC.		
	75.	02/47414	WO	A2	06-13-2002	SCIENCE APPLICATIONS INTERNATIONAL CORPORATION		

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	Attorney Docket Number	091172-1017552-102440US

	76.	101453799	CN	A	06-10-2009	Comba Telecom Sys China Co Ltd		
	77.	2008/146394	WO	A1	12-04-2008	Fujitsu Limited		
	78.	2007-235738	JP	A	09-13-2007	Sumitomo Electric Ind LTD		
	79.	2010-166531	JP	A2	07-29-2010	Hitachi Kokusai Electric Inc		
	80.	2008-516503	JP	A	05-15-2008	Jinquan Dai		
	81.	2008-099137	JP	A2	04-24-2008	Fujitsu Limited		
	82.	2007-529926	JP	A	10-25-2007	Wensheng He		
	83.	2007-523577	JP	A	08-16-2007	Telefonaktiebolaget Lm Ericssson		
	84.	2004-147009	JP	A2	05-20-2004	Hitachi Kokusai Electric Inc		
	85.	101521893	CN	A	09-02-2009	Comba Telecom System Holdings		
	86.	2009-296335	JP	A2	12-17-2009	Nippon Telegraph & Telephone		
	87.	101453799 (dupe)	CN	A	06-10-2009	Comba Telecom Sys China Co Ltd		
	88.	10-2009-0088083	KR	A	08-19-2009	Samsung Electronics Co Ltd		
	89.	00/23956	WO	A1	04-27-2000	Univ Maryland		
	90.	101453699	CN	A	06-10-2009	Huawei Tech Co Ltd.		
	91.	2008-506322	JP	A	02-28-2008	Utstarcom Telecom Co., Ltd.		
	92.	2010/087031	WO	A1	08-05-2010	Hitachi Ltd		

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	93.	U.S. Patent Application No. 15/205,820 filed on July 8,2016 by Lemson et al. (Unpublished. Copy available via USPTO's IFW System)	
	94.	Notification Of Transmittal Of The International Search Report And The Written Opinion Of The International Searching Authority, Or The Declaration and International Search Report and Written Opinion Of The International Searching Authority for International Application No. PCT/US2011/048004 mailed on January 5, 2012, 6 pages.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2414
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	Attorney Docket Number	091172-1017552-102440US

	95.	Notification Of Transmittal Of The International Search Report And The Written Opinion Of The International Searching Authority, Or The Declaration and International Search Report and Written Opinion Of The International Searching Authority for International Application No. PCT/US2011/047995 mailed on December 22, 2011, 7 pages.	
	96.	International Search Report and Written Opinion of the International Searching Authority for International Application No. PCT/US2011/047999 mailed on Dec. 19, 2011, 7 pages.	
	97.	Non-Final Office Action for U.S. Patent Application No. 13/211,247 mailed on October 10, 2012, 6 pages.	
	98.	Notice of Allowance for U.S. Patent Application No. 13/211,247 mailed on March 13, 2013, 11 pages.	
	99.	Non-Final Office Action for U.S. Patent Application No. 13/211,247 mailed on July 22, 2013, 11 pages.	
	100.	Final Office Action for U.S. Patent Application No. 13/211,247 mailed on November 26, 2013, 13 pages.	
	101.	Notice of Allowance for U.S. Patent Application No. 13/211,247 mailed on March 11, 2014, 10 pages.	
	102.	First Office Action for Chinese Patent Application No. 20118005066.6 mailed on August 4, 2014,	
	103.	Non-Final Office Action for U.S. Patent Application No. 13/913,207 mailed on November 20, 2014, 22 pages.	
	104.	Non-Final Office Action for U.S. Patent Application No. 14/260,145 mailed on January 27, 2015, 10 pages	
	105.	Second Office Action for Chinese Patent Application No. 20118005066.6 mailed on April 13, 2015, 7 pages.	
	106.	Final Office Action for U.S. Patent Application No. 13/913,207 mailed on April 15, 2015, 15 pages	
	107.	Notice of Allowance of May 8, 2015 for U.S. Patent Application No. 14/260,145 13 pages. (copy available via PAIR)	

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	Attorney Docket Number	091172-1017552-102440US

	108.	Notice of Allowance of May 26, 2015 for U.S. Patent Application No. 13/913,207, 11 pages. (copy available via PAIR)	
	109.	Third Office Action for Chinese Patent Application No. 20118005066.6 mailed on January 4, 2015, 6 pages.	
	110.	Notice of Allowance for U.S. Application No. 14/800,515, mailed May 20, 2016, 13 pages.	

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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

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

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	Art Unit	2414
	Examiner Name	
	Attorney Docket Number	091172-1017552-102440US

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2016-11-16
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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

Espacenet

Bibliographic data: JP2008506322 (A) — 2008-02-28

Packet Transmission Method for Wireless Signals in a Wireless Base Station System

Inventor(s):

Applicant(s):

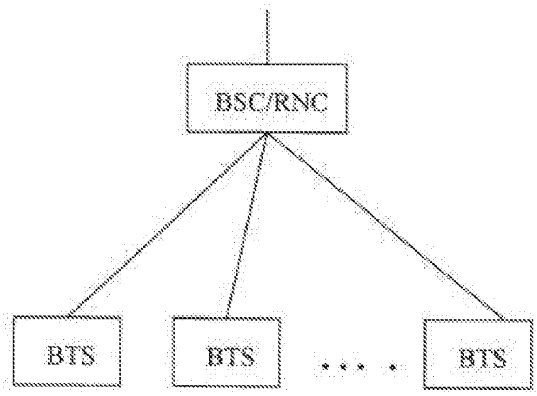
Classification: **- international:** ***H04L12/66; H04L12/865; H04L12/875; H04L12/885; H04L12/951; H04W24/06; H04W88/08; H04W92/00***
- cooperative: **H04L69/326**; **H04W24/06**

Application number: JP20070520645 20040713

Priority number(s): WO2004CN00801 20040713

Also published as: JP4611383 (B2) US2008069032 (A1) US7773578 (B2) CN1973559 (A) CN100502531 (C) more

Abstract not available for JP2008506322 (A)
Abstract of corresponding document: US2008069032 (A1)



a method of transmitting one or more branches of wireless signals between a channel processing unit and a remote radio frequency unit in a centralized base station, or between base stations through a packet network, each of said branches of wireless signals being a signal flow having a wireless frame period, the method comprising steps: obtaining a sample data stream of wireless signal of each branch in said wireless signals; dividing said sample data stream into consecutive data segments of fixed length; encapsulating said data segments into application protocol packets according to a predetermined protocol, each application protocol packet further including first information indicating the sequence of the data segment of the packet in all the data segments of the branch to which the data segment belongs; second information indicating payload type of the branch; third information indicating whether the data segment of the packet contains a data sample corresponding to the start of a wireless frame period; and fourth information indicating the position of the data sample in the

data segment if the third information indicates that the data sample corresponding to the start of the wireless frame period is contained; and encapsulating the generated application protocol packets into network protocol packets according to a network transport protocol and transmitting them to a specified target, wherein the network protocol packet further includes fifth information identifying one of said one or more branches to which the packet belongs, said fifth information and network transport source address and destination address uniquely distinguishing said branches.

(19)日本国特許庁(JP)　(12)公表特許公報(A)　(11)特許出願公表番号
特表2008-506322
(P2008-506322A)
(43)公表日　平成20年2月28日(2008.2.28)

(51)Int.Cl.		F I			テーマコード（参考）
H04L 12/56	(2006.01)	H04L	12/56	300Z	5K030
H04Q 7/36	(2006.01)	H04B	7/26	104A	5K067

審査請求 有　予備審査請求 未請求　（全 39 頁）

(21)出願番号　特願2007-520645 (P2007-520645)
(86)(22)出願日　平成16年7月13日 (2004.7.13)
(85)翻訳文提出日　平成19年3月8日 (2007.3.8)
(86)国際出願番号　PCT/CN2004/000801
(87)国際公開番号　WO2006/005229
(87)国際公開日　平成18年1月19日 (2006.1.19)

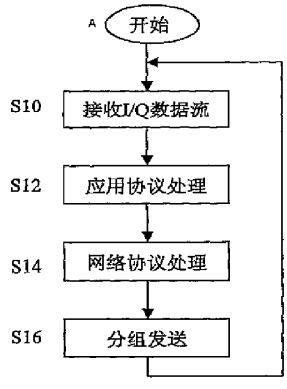
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(54)【発明の名称】無線基地局システムにおける無線信号のパケット伝送方式

(57)【要約】
無線信号群の１つ以上のブランチを、集中基地局内においてチャネル処理ユニット及び遠隔無線周波数ユニット間で、又はパケットネットワークを介して基地局間で伝送する方法であって、無線信号群の前記ブランチの各々はある無線フレーム周期を持つ信号フローである。

前記方法は、前記無線信号群中の各ブランチの無線信号のサンプルデータストリームを取得するステップと、前記サンプルデータストリームを固定長の連続データセグメントへと分割するステップと、前記データセグメントを所定プロトコルに準じてアプリケーションプロトコルパケットへとカプセル化するステップであって、各アプリケーションプロトコルパケットが更に、前記データセグメントが属する前記ブランチの全てのデータセグメントにおける、前記パケットの前記データセグメントの順番を表す第一の情報と、前記ブランチのペイロードタイプを表す第二の情報と、前記パケットの前記データセグメントが無線フレーム周期の開始に対応するデータサンプルを含んでいるか否かを表す第三の情報と、前記第三の情報が無線フレーム周期の開始に対応するデータサ



A　START
S10　RECEIVING I/Q DATA STREAM
S12　APPLICATION PROTOCOL PROCESS
S14　NETWORK PROTOCOL PROCESS
S16　TRANSMITTING PACKET

【特許請求の範囲】
【請求項1】
無線信号群の１つ以上のブランチを、集中基地局内においてチャネル処理ユニット及び遠隔無線周波数ユニット間で、又はパケットネットワークを介して基地局間で伝送する方法であって、無線信号群の前記ブランチの各々がある無線フレーム周期を持つ信号フローであり、
前記方法が、
前記無線信号群中の各ブランチの無線信号のサンプルデータストリームを取得するステップと、
前記サンプルデータストリームを固定長の連続データセグメントへと分割するステップと、
前記データセグメントを所定プロトコルに準じてアプリケーションプロトコルパケット中にカプセル化するステップであって、各アプリケーションプロトコルパケットが更に、前記データセグメントが属する前記ブランチの全データセグメント中における前記パケットの前記データセグメントのシーケンスを表示する第一の情報と、前記ブランチのペイロードタイプを表す第二の情報と、前記パケットの前記データセグメントが無線フレーム周期の開始に対応するデータサンプルを含んでいるか否かを表す第三の情報と、前記第三の情報が無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合に前記データセグメント中の前記データサンプルの位置を表す第四の情報と、を含むステップと、
生成された前記アプリケーションプロトコルパケットを、ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化し、それらを所定のあて先へと伝送するステップであって、前記ネットワークプロトコルパケットが前記１つ以上のブランチのうち、前記パケットが属する１つを識別する第五の情報を更に含み、前記第五の情報とネットワーク伝送ソースアドレス及びあて先アドレスが前記ブランチを一意に識別するステップと、を含む方法。
【請求項2】
前記ブランチの各々が、同じ機能ノード、同じセル、同じ搬送周波数、同じ無線インターフェース規格及びシステムに属する無線信号データストリームを含む請求項１に記載の方法。
【請求項3】
少なくとも１つのブランチが複数の並列チャネルの無線信号を含み、前記少なくとも１つのブランチのサンプルデータが、前記複数の並列チャネルの無線信号の同時サンプルデータである請求項２に記載の方法。
【請求項4】
ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化する前記ステップが、
ユーザーデータグラムプロトコル（ＵＤＰ）に準じて前記アプリケーションプロトコルパケットを固定長のＵＤＰパケットへとカプセル化することであって、ＵＤＰパケットヘッダが前記第五の情報を構成するソースポート番号及びあて先ポート番号を含むカプセル化と、
ＩＰｖ４又はＩＰｖ６プロトコルに準じて前記ＵＤＰパケットをネットワークプロトコルパケットへとカプセル化することと、を含む請求項１に記載の方法。
【請求項5】
ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化する前記ステップが、マルチプロトコルラベルスイッチ（ＭＰＬＳ）プロトコルに準じて前記アプリケーションプロトコルパケットを固定長のＭＰＬＳパケットへとカプセル化することであって、ＭＰＬＳ仮想回路ラベルが前記第五の情報として働き、ＭＰＬＳトンネルラベルが前記ネットワーク伝送ソースアドレス及び前記あて先アドレス間の接続を識別するように働くカプセル化を含む請求項１に記載の方法。

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【請求項6】
ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化する前記ステップが、
マルチプロトコルラベルスイッチ（ＭＰＬＳ）プロトコルに準じて前記アプリケーションプロトコルパケットを固定長のＭＰＬＳパケットへとカプセル化することであって、ＭＰＬＳ仮想回路ラベルが前記第五の情報として働き、ＭＰＬＳトンネルラベルが前記ネットワーク伝送ソースアドレス及び前記あて先アドレス間の接続を識別するように働くカプセル化と、
ＩＰｖ４又はＩＰｖ６プロトコルに準じて前記ＭＰＬＳパケットをネットワークプロトコルパケットへとカプセル化することと、を含む請求項１に記載の方法。
【請求項7】
所定プロトコルに準じてカプセル化する前記ステップが、
前記データセグメントを固定長のデータパケットへとカプセル化することであって、前記データパケットヘッダが前記第四の情報を含むカプセル化と、
リアルタイム伝送プロトコル（ＲＴＰ）に準じて前記データパケットを固定長のＲＴＰパケットへと、前記アプリケーションプロトコルパケットとしてカプセル化することであって、前記ＲＴＰパケットヘッダが前記第一の情報、第二の情報及び第三の情報を含み、同じブランチに属するＲＴＰパケットが同じ同期ソース識別子を持つカプセル化と、を含む請求項１に記載の方法。
【請求項8】
所定プロトコルに準じてカプセル化する前記ステップが、前記データセグメントを固定長のアプリケーションプロトコルパケットへとカプセル化することであって、前記アプリケーションプロトコルパケットヘッダが前記第一の情報、第二の情報、第三の情報及び第四の情報を含むカプセル化を含む請求項１に記載の方法。
【請求項9】
前記データセグメントの長さが、前記伝送待ち時間が所定の条件に合致するように選択される請求項１に記載の方法。
【請求項10】
前記データセグメントの長さが、前記伝送待ち時間が所定の条件に合致するように、前記伝送待ち時間の実際の計測値に基づいて動的に変えられる請求項１に記載の方法。
【請求項11】
前記伝送待ち時間及び待ち時間ジッタを低減する為の、現在の伝送のソース及びあて先に基づいたパケットネットワーク内の伝送経路及び転送ポリシーの調整を更に含む請求項１、５又は６に記載の方法。
【請求項12】
前記パケットネットワークがサービス品質制御機構を有しており、前記方法が、前記ネットワークプロトコルパケットの前記サービス品質制御機構におけるサービス品質レベルを可能な限り高く設定することを更に含む請求項１に記載の方法。
【請求項13】
前記ネットワークプロトコルパケットが、他のパケットよりも優先的に伝送される請求項１に記載の方法。
【請求項14】
無線信号群の１つ以上のブランチを、集中基地局内においてチャネル処理ユニット及び遠隔無線周波数ユニット間で、又はパケットネットワークを介して基地局間で受信する方法であって、無線信号群の前記ブランチの各々がある無線フレーム周期を有する信号フローであり、前記方法が、
ネットワークを介して固定長のネットワークプロトコルパケットを受信するステップと、
固定長のアプリケーションプロトコルパケットと、１つ以上のブランチのうち、前記パケットが属する１つを識別する第五の情報を取得するために前記ネットワークプロトコル

パケットをネットワーク伝送プロトコルに準じてパースするステップであって、前記第五の情報とネットワーク伝送ソースアドレス及びあて先アドレスが前記ブランチを一意に識別するステップと、

データセグメント、そして前記データセグメントが属するブランチの全データセグメントにおける、前記パケットの前記データセグメントのシーケンスを表す第一の情報、前記ブランチのロードタイプを表す第二の情報、前記パケットの前記データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むか否かを表す第三の情報、及び前記第三の情報が無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合に前記データセグメント中の前記データサンプルの位置を表す第四の情報を取得するために、前記アプリケーションプロトコルパケットを所定プロトコルに準じてパースするステップと、

前記同じブランチに属するデータセグメントを、前記第五の情報に基づいて元の無線信号へと回復するステップであって、前記データセグメントは前記第一の情報に基づいて順序付けられることによりデジタル信号データストリームが形成され、前記デジタル信号データストリームがロードタイプを表す前記第二の情報に基づいて無線信号フローへと再生され、ここで前記第三の情報が、データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むことを表している場合、前記無線信号フローの再生時に前記データサンプルに対応する無線フレームタイミングが、前記第四の情報に表される位置に基づいて回復されるステップと、を含む方法。

【請求項15】

前記ブランチの各々が、同じ機能ノード、同じセル、同じ搬送周波数、同じ無線インターフェース規格及びシステムに属する無線信号データストリームを含む請求項１４に記載の方法。

【請求項16】

少なくとも１つのブランチが複数の並列チャネルの無線信号を含んでおり、前記少なくとも１つのブランチのサンプルデータが前記複数の並列チャネルの無線信号の同時サンプルデータであり、前記無線信号を回復するステップが、前記複数の並列チャネルの無線信号を同時に再生することを含む請求項１５に記載の方法。

【請求項17】

ネットワーク伝送プロトコルに準じて前記ネットワークプロトコルパケットをパースする前記ステップが、

ＩＰｖ４又はＩＰｖ６プロトコルに準じて前記ネットワークプロトコルパケットを固定長のユーザーデータグラムプロトコル（ＵＤＰ）パケットへとパースすることと、

前記ＵＤＰパケットをＵＤＰプロトコルに準じて固定長のアプリケーションプロトコルパケットへとパースし、前記第五の情報を構成するソースポート番号及びあて先ポート番号を取得することと、を含む請求項１４に記載の方法。

【請求項18】

ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットをパースする前記ステップが、

ＭＰＬＳトンネルラベル及びＭＰＬＳ仮想回路ラベルをマルチプロトコルラベルスイッチ（ＭＰＬＳ）プロトコルに準じて処理することと、

前記ＭＰＬＳパケットを前記ＭＰＬＳプロトコルに準じてアプリケーションプロトコルパケットへとパースし、前記第五の情報としてＭＰＬＳ仮想回路ラベルを取得することと、を含む請求項１４に記載の方法。

【請求項19】

ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットをパースする前記ステップが、

ＩＰｖ４又はＩＰｖ６プロトコルに準じて前記ネットワークプロトコルパケットをＭＰＬＳパケットへとパースすることと、

ＭＰＬＳトンネルラベル及びＭＰＬＳ仮想回路ラベルをマルチプロトコルラベルスイッ

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チ（ＭＰＬＳ）プロトコルに準じて処理することと、
　前記ＭＰＬＳパケットを前記ＭＰＬＳプロトコルに準じてアプリケーションプロトコルパケットへとパースし、前記第五の情報としてＭＰＬＳ仮想回路ラベルを取得することと、を含む請求項１４に記載の方法。
【請求項20】
　所定プロトコルに準じてパースする前記ステップが、
　固定長のＲＴＰパケットを、前記アプリケーションプロトコルパケットとして、リアルタイム伝送プロトコルＲＴＰに準じて固定長のデータパケットへとパースし、前記第一の情報、第二の情報及び第三の情報を取得することと、
　前記固定長のデータパケットをデータセグメントへとパースし、前記第四の情報を取得することと、を含む請求項１４に記載の方法。
【請求項21】
　所定プロトコルに準じてパースする前記ステップが、前記固定長のアプリケーションプロトコルパケットをデータセグメントへとパースし、前記第一の情報、第二の情報、第三の情報及び第四の情報を取得することを含む請求項１４に記載の方法。
【請求項22】
　前記受信側が遠隔無線周波数ユニットである場合、周波数クロックを共通グローバルクロックから取得することを更に含む請求項１４に記載の方法。
【請求項23】
　前記共通グローバルクロックのソースがＧＰＳである請求項２２に記載の方法。
【請求項24】
　前記受信側が遠隔無線周波数ユニットである場合、前記デジタル信号データストリームに基づく適応型クロックリカバリ技術を用いて前記クロックを回復することを更に含む請求項１４に記載の方法。
【請求項25】
　前記適応型クロックリカバリ技術がＰＬＬである請求項２４に記載の方法。
【請求項26】
　前記無線フレームタイミングを回復するステップが、
　前記第三の情報がデータセグメントが無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合、前記データセグメントのサンプル長が前記第四の情報により表される位置値分減じられ、前記ダウンリンクサンプリング間隔により乗算されて前記データセグメントのパッキング待ち時間を取得することと、
　前記無線信号フローの再生時に、前記データサンプルに対応する無線フレームタイミングを回復する場合に前記パッキング待ち時間に修正を実施することと、を更に含む請求項１４に記載に方法。
【請求項27】
　前記無線フレームタイミングの回復が、前記無線フレームタイミングの周期性を利用して平滑化処理を実施することを更に含む請求項２６に記載の方法。
【請求項28】
　集中基地局内におけるチャネル処理ユニットと遠隔無線周波数ユニット間の無線信号ブランチの往復伝送待ち時間を計測する方法であって、前記伝送が所定の送信方法及び受信方法に基づいており、
　前記送信方法が、
　前記無線信号群における各ブランチの無線信号のサンプルデータストリームを取得するステップと、
　前記サンプルデータストリームを固定長の連続データセグメントへと分割するステップと、
　前記データセグメントを所定プロトコルに準じてアプリケーションプロトコルパケット中にカプセル化するステップであって、各アプリケーションプロトコルパケットが、前記データセグメントが属する前記ブランチの全データセグメントにおける前記パケットの前

記データセグメントのシーケンスを表す第一の情報と、前記ブランチのペイロードタイプを表す第二の情報と、前記パケットの前記データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むか否かを表す第三の情報と、そして前記第三の情報が前記無線フレーム周期の開始に対応する前記データサンプルを含むことを表す場合に前記データセグメント中の前記データサンプルの位置を表す第四の情報とを更に含むステップと、

前記生成されたアプリケーションプロトコルパケットを、ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化してそれらを所定ターゲットへと伝送するステップであって、前記ネットワークプロトコルパケットが前記１つ以上のブランチのうち前記パケットが属する１つを識別する第五の情報を更に含み、前記第五の情報とネットワーク伝送ソースアドレス及びあて先アドレスが前記ブランチを一意に識別するものであるステップと、を含み、

前記受信方法が、

ネットワークを介して前記固定長のネットワークプロトコルパケットを受信するステップと、

前記ネットワークプロトコルパケットをネットワーク伝送プロトコルに準じてパースすることにより、固定長のアプリケーションプロトコルパケットと１つ以上のブランチのうち前記パケットが属する１つを識別する第五の情報を取得するステップであって、前記第五の情報、ネットワーク伝送ソースアドレス及びあて先アドレスが前記ブランチを一意に識別するものであるステップと、

前記アプリケーションプロトコルパケットを所定プロトコルに準じてパースすることにより、データセグメント、そして前記データセグメントが属するブランチの全データセグメントにおける前記パケットの前記データセグメントのシーケンスを表す第一の情報、前記ブランチのロードタイプを表す第二の情報、前記パケットの前記データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むか否かを表す第三の情報、及び前記第三の情報が、無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合に前記データセグメント中の前記データサンプルの位置を表す第四の情報とを取得するステップと、

前記同じブランチに属するデータセグメントを、前記第四の情報に基づいて元の無線信号へと回復するステップであって、前記データセグメントが前記第一の情報に基づいて順序付けられることによりデジタル信号データストリームが形成され、前記デジタル信号データストリームがロードタイプを表す前記第二の情報に基づいて無線信号フローへと再生され、ここで前記第三の情報がデータセグメントが無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合に前記無線信号フローの再生時に前記データサンプルに対応する無線フレームタイミングが、前記第四の情報に表される位置に基づいて回復されるステップと、を含み、

前記計測する方法が、

第一のネットワークプロトコルパケットを前記チャネル処理ユニットにより前記遠隔無線周波数ユニットへと送信するステップであって、その中のデータセグメントが前記チャネル処理ユニット上の無線フレーム周期の開始に対応するデータサンプルを含むステップと、

前記遠隔無線周波数ユニットから伝送される第二のネットワークプロトコルパケットをチャネル処理ユニット上で受信するステップであって、その中のデータセグメントが前記遠隔無線周波数ユニット上の無線フレーム周期の開始に対応するデータサンプルを含み、前記無線フレーム周期が前記チャネル処理ユニット上の前記無線フレーム周期に対応するステップと、

前記送信ステップの開始から前記受信ステップの終了までの時間差を計算するステップと、

前記第一及び第二のネットワークプロトコルパケットのパッキング待ち時間をそれぞれに計算するステップであって、前記待ち時間が前記ネットワークプロトコルパケットの前記データセグメントの前記サンプル長から前記第四の情報により表される位置値分を減算

し、対応するサンプリング間隔を乗算したものと等しいステップと、
　前記２つのパッキング待ち時間を前記時間差から減算することにより、往復伝送待ち時間を取得するステップと、を含む方法。
【請求項29】
　前記往復伝送待ち時間が、前記チャネル処理ユニットから前記遠隔無線ユニットまでのダウンリンク伝送待ち時間を含み、前記ダウンリンク伝送待ち時間が、前記往復伝送待ち時間に所定の比例係数を乗算したものに等しい請求項２８に記載の方法。
【請求項30】
　前記所定の比例係数が０．５である請求項２９に記載の方法。
【請求項31】
　集中基地局において、遠隔無線周波数ユニットの無線フレームタイミングを、チャネル処理ユニット及び前記遠隔無線周波数ユニットとの間の無線信号ブランチ伝送を通じて調節する方法であって、前記伝送が所定の送信方法及び受信方法に基づくものであり、
　前記送信方法が、
　前記無線信号群における各ブランチの無線信号のサンプルデータストリームを取得するステップと、
　前記サンプルデータストリームを固定長の連続データセグメントへと分割するステップと、
　前記データセグメントを所定プロトコルに準じてアプリケーションプロトコルパケットへとカプセル化するステップであって、各アプリケーションプロトコルパケットが、前記データセグメントが属する前記ブランチの全データセグメント中における前記パケットの前記データセグメントのシーケンスを表す第一の情報と、前記ブランチのペイロードタイプを表す第二の情報と、前記パケットの前記データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むか否かを表す第三の情報と、そして前記第三の情報が無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合に前記データセグメント中の前記データサンプルの位置を表す第四の情報と、を更に含むステップと、
　前記生成されたアプリケーションプロトコルパケットをネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化してそれらを所定ターゲットへと伝送するステップであって、前記ネットワークプロトコルパケットが前記１つ以上のブランチのうち前記パケットが属する１つを識別する第五の情報を更に含み、前記第五の情報とネットワーク伝送ソースアドレス及びあて先アドレスが前記ブランチを一意に識別するステップと、を含み、
　前記受信方法が、
　ネットワークを介して前記固定長のネットワークプロトコルパケットを受信するステップと、
　前記ネットワークプロトコルパケットをネットワーク伝送プロトコルに準じてパースすることにより固定長のアプリケーションプロトコルパケットと、１つ以上のブランチのうち前記パケットが属する１つを識別する第五の情報を取得するステップであって、前記第五の情報、ネットワーク伝送ソースアドレス及びあて先アドレスが前記ブランチを一意に識別するステップと、
　前記アプリケーションプロトコルパケットを所定プロトコルに準じてパースすることにより、データセグメント、そして前記データセグメントが属するブランチの全データセグメントにおける前記パケットの前記データセグメントのシーケンスを表す第一の情報、前記ブランチのロードタイプを表す第二の情報、前記パケットの前記データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むか否かを表す第三の情報、及び前記第三の情報が、無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合、前記データセグメント中の前記データサンプルの位置を表す第四の情報を取得するステップと、
　前記同じブランチに属するデータセグメントを、前記第四の情報に基づいて元の無線信号へと回復するステップであって、前記データセグメントが前記第一の情報に基づいて順

序付けられることによりデジタル信号データストリームが形成され、前記デジタル信号データストリームがロードタイプを表す前記第二の情報に基づいて無線信号フローへと再生され、ここで前記第三の情報がデータセグメントが無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合に前記無線信号フローの再生時に前記データサンプルに対応する無線フレームタイミングが前記第四の情報に表される位置に基づいて回復されるステップと、を含み、

前記調節する方法が、

第一のネットワークプロトコルパケットを前記チャネル処理ユニットにより前記遠隔無線周波数ユニットへと送信するステップであって、その中のデータセグメントが前記チャネル処理ユニット上の無線フレーム周期の開始に対応するデータサンプルを含むステップと、

前記遠隔無線周波数ユニットから伝送される第二のネットワークプロトコルパケットをチャネル処理ユニット上で受信するステップであって、その中のデータセグメントが前記遠隔無線周波数ユニット上の無線フレーム周期の開始に対応するデータサンプルを含み、前記無線フレーム周期が前記チャネル処理ユニット上の前記無線フレーム周期に対応するステップと、

前記送信ステップの開始から前記受信ステップの終了までの時間差を計算するステップと、

前記第一及び第二のネットワークプロトコルパケットのパッキング待ち時間をそれぞれ計算するステップであって、前記待ち時間が、前記ネットワークプロトコルパケットの前記データセグメントの前記サンプル長から前記第四の情報により表される位置値分を減算し、対応するサンプリング間隔を乗算したものと等しいステップと、

前記２つのパッキング待ち時間を前記時間差から減算して往復伝送待ち時間を取得するステップと、

前記往復伝送待ち時間に所定の比例係数を乗算してダウンリンク伝送待ち時間を取得するステップと、

前記ブランチの送信時間を前記無線フレームタイミングに対して前記ダウンリンク伝送待ち時間分進めるステップと、を含む方法。

【請求項32】

前記所定の比例係数が０．５である請求項３１に記載の方法。

【請求項33】

前記受信法における前記回復するステップが、

前記第三の情報がデータセグメントが無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合に、前記データセグメントの前記サンプル長が前記第四の情報により表示される位置値分減算され、前記ダウンリンクサンプリング間隔で乗算されることにより前記データセグメントのパッキング待ち時間を取得することと、

前記無線信号フローの再生時に前記データサンプルに対応する無線フレームタイミングを回復する場合に、前記パッキング待ち時間に修正を実施することと、を更に含む請求項３１に記載の方法。

【請求項34】

前記無線フレームタイミングの回復が、前記無線フレームタイミングの周期性を利用することにより平滑化処理を実施することを更に含む請求項３３に記載の方法。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、移動通信システムにおける基地局技術に関し、より具体的には無線基地局システムにおける信号伝送方式及びシステムに関する。

【背景技術】

【0002】

１．遠隔無線周波数ユニットによる集中基地局技術

図１Ａに示されるように、移動通信システムにおいては、無線アクセスネットワークは

一般に基地局（ＢＴＳ）及びこれらの基地局を制御する為の基地局コントローラ（ＢＳＣ）又は無線ネットワークコントローラ（ＲＮＣ）から構成されている。図１Ｂに示されるように、１つの基地局は主にベースバンド処理サブシステム、無線周波数（ＲＦ）サブシステム、アンテナ等から構成されており、無線信号の送受信及び処理を実施するものである。基地局は複数のアンテナを介して異なるセルをカバーしている場合がある。

【0003】

この移動通信システムには、例えば高層ビルの屋内カバレージ、カバレージホール、又はシャドウゾーンのカバレージといった、従来のＢＴＳ技術では解決が困難な無線ネットワークカバレージ問題がある。遠隔無線周波数ユニットによる技術は、上述の問題を解決する為に提案されたものであり、より効果的な解決策である。遠隔無線周波数ユニットによる基地局システムにおいては、カバレージを要する領域内にメイン無線周波数ユニット及びアンテナが設置され、広帯域伝送線を通じてその基地局の他のユニットと接続される。

【0004】

この技術は、更に、遠隔無線周波数ユニットによる集中基地局技術に発展させることが出来る。従来の基地局と比較した場合、遠隔無線周波数ユニットによる集中基地局には以下の多数の利点がある。すなわち、従来基地局に基づく１つのマクロセルを複数のマイクロセルへと置き換えることが可能であり、これにより異なる無線環境に最適に対応し、システムの容量やカバレージ等の無線性能を増強することが出来る。中央集中化された構造によって、従来の基地局において、より穏やかな切り替わりによるソフトハンドオフの実施ができ、これにより更なる処理利得を得ることが出来る。中央集中化された構造により更に、高価なベースバンド信号処理リソースを複数セルにより共有するリソースプールとして利用することができるので、統計多重化及びシステムコストの削減という利益を得ることが出来る。特許文献１、特許文献２等に、この技術に関連する実施詳細が記載されている。

【0005】

図２に示されるように、遠隔無線周波数ユニットによる集中基地局システム１０は、中央に設置された中央チャネル処理メインユニット（ＭＵ）１１及び遠隔無線周波数ユニット（ＲＲＵ）１３から構成されており、これらが広帯域伝送リンク、即ちネットワーク１２を介して接続されている。中央チャネル処理メインユニット１１内のＢＳＣ／ＲＮＣインターフェースユニット１４は、ＢＴＳ及びＢＳＣ／ＲＮＣインターフェースのユーザプレーン及びシグナリングプレーン処理を実施するという役割を持つ。中央チャネル処理メインユニット１１は更にチャネル処理リソースプール１５、信号ルーティング分配ユニット１６等をも備えており、チャネル処理リソースプール１５は複数のチャネル処理ユニット１～Ｎを束にして構成されたものであり、ベースバンド信号処理のようなタスクを実施する。信号分配ユニット１６は異なるセルのトラヒックに応じて動的にチャネル処理リソースを割り当てることにより、複数セル間において処理リソースの効果的な共有を実現するものである。信号ルーティング分配ユニット１６は、図２に示したＭＵ内部への実装の他に、ＭＵ外部に別個のデバイスとして実現してもよい。遠隔アンテナ素子は主に、伝送チャネルの無線周波電力増幅器、受信チャネルの低ノイズ増幅器、デュプレクサ及びアンテナ等の機能ユニットにより構成される。中央チャネル処理サブシステム及び遠隔アンテナ素子間のリンクには、光ファイバ、同軸ケーブル、マイクロ波等のような伝送媒体を採用することが出来る。信号伝送は、サンプリング後のデジタル信号、又は変調後のアナログ信号という形式で実施することが出来る。信号はベースバンド信号、中間周波信号又は無線周波信号であってよい。

【0006】

遠隔無線周波数ユニットによる上記二種類の基地局システムにおいては、ＲＲＵ及びＭＵ間において無線信号伝送を実現することが重要となる。通常、アナログ中間周波信号ソリューション、又はアナログ無線周波信号ソリューションが利用される。アナログ信号伝送を採用する方が簡単ではあるが、アナログ線は確実にノイズ等の干渉要素を取り込んで

しまい、伝送中における信号変調も非線形ひずみを取り込んでしまう。更に、アナログ伝送は伝送線利用率を低下させ、大容量多重化技術アプリケーションにとっては不都合なものである。従ってアナログ伝送ソリューションで大規模ネットワークを構成することは困難である。

【0007】

その為に、特許文献３、特許文献４等は、デジタル信号伝送を用いたソリューションを提案している。要求される伝送帯域幅を可能な限り小さくする為には、デジタルベースバンド信号伝送ソリューションを通常採用する。特許文献３のみが、光ファイバを用いることによりＲＲＵ及びメイン基地局間においてデジタルＩ／Ｑ（同相／直角位相）ベースバンド信号を伝送するという単純な方法を開示しており、これは即ち、デジタルＩ／Ｑベースバンド信号が、伝送側においてパラレル・シリアル変換を経てシリアルデータストリームとなり、光送信器を通じて受信側へと送信され、そして受信側において受信後にシリアル・パラレル変換を経ることによりデジタルＩ／Ｑベースバンド信号へと回復されるというものである。特許文献４では、イーサネットＭＡＣ（メディアアクセス制御）フレームを利用せずに、特別に定義された連続ビットストリームフォーマットを持つ伝送技術を利用して物理層上でイーサネットを使う技術を提案されている。現在、ＣＰＲＩ（Ｃｏｍｍｏｎ　Ｐｕｂｌｉｃ　Ｒａｄｉｏ　Ｉｎｔｅｒｆａｃｅ）という協力団体も、ＲＲＵ及びメイン基地局間におけるデジタルベースバンド伝送の標準化に向けて活動しており、この団体の技術規格はウェブサイト（http://cpri.info/spec.html）からダウンロードすることが出来る。この規格は特許文献４等に類似した技術を採用しており、物理インターフェースがギガイーサネット又は１０ＧＢイーサネット標準規格を、そして上位層が自己定義された連続ビットストリームフォーマットを採用しているものであるが、しかしＣＰＲＩはポイントツーポイントリンクしかサポートしていない。上記既存技術はトランスポート層技術において高度な伝送技術を利用することなく専用プロトコル規格を採用したものであることから、実際のシステム中で多くの潜在的な技術問題を検証しなければならず、技術開発及び製品開発サイクルが長くなり、ネットワーク構築コストが高くなってしまう。このことは大規模ネットワークのアプリケーションにとっては欠点であり、またオペレータの既存投資を守る上でも欠点となる。

【0008】

２．無線基地局システムにおける負荷分散技術

中国特許庁に２００４年３月４日に出願された「無線基地局における負荷分散方式およびシステム（“Ｌｏａｄ－ｓｈａｒｉｎｇ　ｍｅｔｈｏｄ　ａｎｄ　ｓｙｓｔｅｍ　ｉｎ　ａ　ｗｉｒｅｌｅｓｓ　ｂａｓｅ　ｓｔａｔｉｏｎ”）」という名称の特許出願においては、同発明者が無線基地局間において負荷分散をチャネル処理する方法を提案しており、ここでは基地局が広帯域リンクで接続されて分散型無線基地局システムが構築され、一基地局が取り扱うセルのトラヒック量が過多となった場合、又は一部又は全てのチャネル処理ユニットが不具合を生じた場合、基地局間の広帯域リンクを介してその基地局が取り扱う一部又は全てのセルに対応する無線信号を、それに接続する１つ以上の他の遠隔側基地局へとルーティングする、即ち切り替えること、そしてその基地局の処理負荷の一部又は全てを他の遠隔側基地局に分散させることが可能であり、これにより不適切なリソースによる基地局システム全体の呼損を低減し、リソース利用率と基地局システム全体の信頼性を高めるというものである。

【0009】

無線信号を基地局間で伝送する為の広帯域リンクは、上述した遠隔無線周波数ユニットによる基地局システムにおけるＲＲＵ及びＭＵ間のものと類似した特性を持っていることから、遠隔無線周波数ユニットによる基地局システムにおけるＲＲＵ及びＭＵ間の無線信号伝送技術もまた、負荷分散構造を持つ無線基地局間の無線信号伝送に適用することが出来るものである。

【0010】

【特許文献1】米国特許第５，６５７，３７４号

【特許文献2】

米国特許第６，３２４，３９１号
【特許文献3】中国特許出願第１，４６４，６６６号
【特許文献4】中国特許出願第１，４７１，３３１号
【発明の開示】
【発明が解決しようとする課題】
【0011】
３．発明の起源
つまり、無線基地局システムにおけるＭＵ及びＲＲＵ間、そしてＢＴＳ間の無線信号伝送の必要性が存在する。しかしながら、従来技術には未だ幾つかの問題が存在しているが、一方ではＩＰ　ｏｖｅｒ　ＳＤＨ（Ｓｙｎｃｈｒｏｎｏｕｓ　ｄｉｇｉｔ　ｓｅｑｕｅｎｃｅ）、ＩＰ　ｏｖｅｒ　ＤＷＤＭ（高密度波長分割多重）等のワイドエリアネットワーク上で大容量ＩＰパケットを伝送する為の技術が成長しており、広く利用されている。ＩＥＥＥ８０２．３ａｂギガイーサネット（ＧＥ）、ＩＥＥＥ８０２．３ａｅ１０ギガイーサネット（１０ＧＥ）等の広帯域技術が開発されるに従い、ローカルエリアネットワーク（ＬＡＮ）の範囲においては従来の遠隔通信伝送ネットワークよりも高速で広帯域、そしてより安価なパケット交換ネットワークを構築することが可能となった。更には、ＳＤＨ、ＤＷＤＭ及びＣＷＤＭ（低密度波長分割多重）のような、イーサネットＭＡＣフレームを広帯域伝送ネットワーク上で直接的に搬送する為の技術、そして直接伝送ＳＤＨの１０ＧＥ～ＶＣ－４－６４ｃコンテナにおけるオプショナルワイドエリアネットワーク（ＷＡＮ）インターフェースサブレイヤーのサポートにより、イーサネットに基づく広帯域パケット交換ネットワークはローカルエリアネットワークアプリケーションからワイドエリアネットワークへと広がった。
【0012】
従って、遠隔無線周波数ユニットに基づく基地局システムにおけるＲＲＵ及びＭＵ間のデジタル無線信号を、比較的低コストかつ既存技術との互換性を持つ広帯域パケット交換ネットワークを用いて伝送することが出来れば、より低コストで高速、柔軟な大規模ネットワーク構築アプリケーションを実現する上で有益である。この為に本発明は、無線基地局システムにおける無線信号のパケット伝送法（Ｒａｄｉｏ　ｏｖｅｒ　Ｐａｃｋｅｔ）を提供するものである。
【0013】
本発明の目的は、無線信号の１つ以上のブランチを、集中基地局内においてチャネル処理ユニット及び遠隔無線周波数ユニット間で、又はパケットネットワークを介して基地局間で送信又は受信する為の方法を提供することにより、信号処理ユニット及び遠隔無線周波数ユニットを、パケットネットワークを通じて接続することが出来るようにすることにある。
【0014】
本発明の他の目的は、集中基地局におけるチャネル処理ユニット及び遠隔無線周波数ユニット間の無線信号ブランチの往復伝送待ち時間を計測する方法を提供することにより、システム性能の計測及び調節を助長することにある。
【0015】
本発明の他の目的は、集中基地局において、チャネル処理ユニット及び遠隔無線周波数ユニット間の無線信号ブランチ伝送を通じて遠隔無線周波数ユニットの無線フレームタイミングを調節する為の方法を提供することにより、無線周波数ユニットの無線フレームタイミングをチャネル処理ユニットと同期させることである。
【課題を解決するための手段】
【0016】
本発明の一態様によれば、無線信号の１つ以上のブランチを、集中基地局内においてチャネル処理ユニット及び遠隔無線周波数ユニット間で、又はパケットネットワークを介して基地局間で伝送する方法が提供されるものであり、前記無線信号のブランチの各々が無線フレーム周期を持つ信号フローであり、方法は、前記無線信号中の各ブランチの無線信

号のサンプルデータストリームを取得するステップと、前記サンプルデータストリームを固定長の連続データセグメントへと分割するステップと、前記データセグメントを所定プロトコルに準じてアプリケーションプロトコルパケットへとカプセル化するステップであって、各アプリケーションプロトコルパケットが、そのデータセグメントが属するブランチの全データセグメントにおける、そのパケットのデータセグメントのシーケンスを表す第一の情報と、そのブランチのペイロードタイプを表す第二の情報と、パケットのそのデータセグメントが無線フレーム周期の開始に対応するデータサンプルを含むか否かを表す第三の情報と、第三の情報が無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合にそのデータサンプルのデータセグメント中の位置を表す第四の情報を更に含むステップと、生成されたアプリケーションプロトコルパケットをネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化してそれらを所定のあて先へと伝送するステップであって、ネットワークプロトコルパケットが前記１つ以上のブランチのうちの、そのパケットが属する１つを識別する第五の情報を含み、前記第五の情報及びネットワーク伝送ソースアドレス及びあて先アドレスがそのブランチを一意に識別するステップとを含んでいる。

【0017】

一実施例によれば、前記ブランチの各々は同じ機能ノード、同じセル、同じ搬送周波数、同じ無線インターフェース規格及びシステムに属する無線信号データストリームを含んでいる。

【0018】

他の実施例によれば、少なくとも１つのブランチは、複数の並列チャネルの無線信号を含んでおり、この少なくとも１つのブランチのサンプルデータはその複数の並列チャネルの無線信号の同時サンプルデータである。

【0019】

他の実施例によれば、ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化するというステップは、アプリケーションプロトコルパケットを、ユーザーデータグラムプロトコル（ＵＤＰ）に準じて固定長のＵＤＰパケットへとカプセル化するステップであって、このＵＤＰパケットヘッダが第五の情報を構成するソースポート番号及びあて先ポート番号を含むステップと、そしてＵＤＰパケットをＩＰｖ４又はＩＰｖ６プロトコルに基づいてネットワークプロトコルパケットへとカプセル化するステップとを含む。

【0020】

他の実施例によれば、ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化するというステップは、アプリケーションプロトコルパケットを、マルチプロトコルラベルスイッチ（ＭＰＬＳ）プロトコルに準じて固定長のＭＰＬＳパケットへとカプセル化するステップであって、ＭＰＬＳ仮想回路ラベルが前記第五の情報として作用し、ＭＰＬＳトンネルラベルがネットワーク伝送ソースアドレス及びあて先アドレス間の接続を識別するように作用するステップを含む。

【0021】

他の実施例によれば、ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化するステップは、アプリケーションプロトコルパケットを、マルチプロトコルラベルスイッチ（ＭＰＬＳ）プロトコルに準じて固定長のＭＰＬＳパケットへとカプセル化するステップであって、ＭＰＬＳ仮想回路ラベルが前記第五の情報として作用し、ＭＰＬＳトンネルラベルがネットワーク伝送ソースアドレス及びあて先アドレス間の接続を識別するように作用するステップと、そしてＭＰＬＳパケットをＩＰｖ４又はＩＰｖ６プロトコルに基づいてネットワークプロトコルパケットへとカプセル化するステップとを含む。

【0022】

他の実施例によれば、所定プロトコルに準じてカプセル化するというステップは、データセグメントを固定長のデータパケットへとカプセル化するステップであって、データパ

ケットヘッダが前記第四の情報を含むステップと、そしてデータパケットを、アプリケーションプロトコルパケットとしてリアルタイム伝送プロトコル（ＲＴＰ）に準じて固定長のＲＴＰパケットへとカプセル化するステップであって、ＲＴＰパケットヘッダが前記第一の情報、第二の情報及び第三の情報を含み、同じブランチに属するＲＴＰパケットが同じ同期ソース識別子を持つステップとを含む。

【0023】

他の実施例によれば、所定プロトコルに準じてカプセル化するというステップは、データセグメントを固定長のアプリケーションプロトコルパケットへとカプセル化するステップであって、アプリケーションプロトコルパケットヘッダが前記第一の情報、第二の情報、第三の情報及び第四の情報を含むステップを含む。

【0024】

他の実施例によれば、データセグメントの長さは、伝送待ち時間が所定の条件に適合することになるように選択される。

【0025】

他の実施例によれば、データセグメントの長さは、伝送待ち時間が所定の条件に適合することになるように、伝送待ち時間の実際の測定値に基づいて動的に変更される。

【0026】

他の実施例によれば、前記方法は、現在の通信のソース及びあて先に応じてパケットネットワークにおける伝送経路及び転送ポリシーを調節することにより伝送待ち時間及び待ち時間ジッタを低減するステップを更に含む。

【0027】

他の実施例によれば、前記パケットネットワークはサービス品質制御機構を含み、前記方法は、前記サービス品質制御機構において前記ネットワークプロトコルパケットのサービス品質レベルを可能な限り高く設定するステップを更に含む。

【0028】

他の実施例によれば、前記ネットワークプロトコルパケットは、他のパケットよりも優先して伝送される。

【0029】

本発明の他の態様によれば、基地局間で無線信号の１つ以上のブランチを、集中基地局内においてチャネル処理ユニット及び遠隔無線周波数ユニット間で、又はパケットネットワークを介して受信する為の方法が提供されるものであり、前記無線信号のブランチの各々は無線フレーム周期を持つ信号フローであり、前記方法は、固定長のネットワークプロトコルパケットを、ネットワークを介して受信するステップと、ネットワークプロトコルパケットをネットワーク伝送プロトコルに準じてパースすることにより固定長のアプリケーションプロトコルパケットと、前記１つ以上のブランチのうち、そのパケットが属する１つを識別する第五の情報とを取得するステップであって、前記第五の情報及びネットワーク伝送ソースアドレス及びあて先アドレスが、それらのブランチを一意に識別するものであるステップと、アプリケーションプロトコルパケットを、所定のプロトコルに準じてパースすることにより、データセグメント、そしてそのデータセグメントが属するブランチの全データセグメントにおける、そのパケットのデータセグメントのシーケンスを表す第一の情報、ブランチのロードタイプを表す第二の情報、パケットのそのデータセグメントが無線フレーム周期の開始に対応するデータサンプルを含んでいるか否かを表す第三の情報、及びその第三の情報が無線フレーム周期の開始に対応するデータサンプルを含むことを表す場合にデータセグメント中のそのデータサンプル位置を表す第四の情報を取得するステップと、第四の情報に基づき、同じブランチに属するデータセグメントを元の無線信号として回復するステップであって、データセグメントが第一の情報に基づいて順序付けされてデジタル信号データストリームが形成されるステップと、ロードタイプを表す第二の情報に基づいてデジタル信号データストリームを無線信号フローへと再生するステップであって、データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むことを第三の情報が表す場合、無線信号フローが再生される時点でそのデータサンプル

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に対応する無線フレームタイミングが第四の情報により表される位置に基づいて回復される。

【0030】

他の実施例によれば、少なくとも１つのブランチは複数の並列チャネルの無線信号を含み、少なくとも１つのブランチのサンプルデータは、その複数の並列チャネルの無線信号の同時サンプルデータであり、無線信号を回復する前記ステップが、その複数の並列チャネルの無線信号を、同じ無線フレームタイミングに基づいて同時に再生することを含む。

【0031】

他の実施例によれば、ネットワークプロトコルパケットをネットワーク伝送プロトコルに準じてパースする前記ステップが、ネットワークプロトコルパケットを、ＩＰｖ４又はＩＰｖ６プロトコルに準じて固定長のユーザーデータグラムプロトコル（ＵＤＰ）パケットへとパースするステップと、そしてＵＤＰパケットを、ＵＤＰプロトコルに準じて固定長のアプリケーションプロトコルパケットへとパースするステップとを含む。

【0032】

他の実施例によれば、ネットワークプロトコルパケットをネットワーク伝送プロトコルに準じてパースする前記ステップが、ＭＰＬＳトンネルラベル及びＭＰＬＳ仮想回路ラベルをマルチプロトコルラベルスイッチ（ＭＰＬＳ）プロトコルに準じて処理するステップと、ＭＰＬＳパケットをＭＰＬＳプロトコルに準じてアプリケーションプロトコルパケットへとパースし、ＭＰＬＳ仮想回路ラベルを前記第五の情報として取得するステップとを含む。

【0033】

他の実施例によれば、ネットワークプロトコルパケットをネットワーク伝送プロトコルに準じてパースする前記ステップが、ネットワークプロトコルパケットをＩＰｖ４又はＩＰｖ６プロトコルに準じてＭＰＬＳパケットへとパースするステップと、ＭＰＬＳトンネルラベル及びＭＰＬＳ仮想回路ラベルをマルチプロトコルラベルスイッチ（ＭＰＬＳ）プロトコルに準じて処理するステップと、そしてＭＰＬＳパケットをＭＰＬＳプロトコルに準じてアプリケーションプロトコルパケットへとパースし、ＭＰＬＳ仮想回路ラベルを前記第五の情報として取得するステップとを含む。

【0034】

他の実施例によれば、所定のプロトコルに準じてパースする前記ステップが、固定長のＲＴＰパケットをアプリケーションプロトコルパケットとしてリアルタイム伝送プロトコル（ＲＴＰ）に準じて固定長のデータパケットへとパースし、前記第一の情報、第二の情報及び第三の情報を取得するステップと、そして固定長のデータパケットをデータセグメントへとパースし、前記第四の情報を取得するステップとを含む。

【0035】

他の実施例によれば、所定のプロトコルに準じてパースする前記ステップが、固定長のアプリケーションプロトコルパケットをデータセグメントへとパースし、前記第一の情報、第二の情報、第三の情報及び第四の情報を取得するステップを含む。

【0036】

他の実施例によれば、受信側が遠隔無線周波数ユニットであった場合、前記方法は共通グローバルクロックから基準クロックを取得することを更に含む。

【0037】

他の実施例によれば、前記共通グローバルクロックのソースはＧＰＳである。

【0038】

他の実施例によれば、受信側が遠隔無線周波数ユニットであった場合、前記方法はデジタル信号データストリームに基づいて適応型クロックリカバリ技術を使うことによりクロックを回復することを更に含む。

【0039】

他の実施例によれば、前記適応型クロックリカバリ技術とはＰＬＬである。

【0040】

他の実施例によれば、前記回復するステップが、データセグメントが無線フレーム周期の開始に対応するデータサンプルを含むことを第三の情報が表した場合、データセグメントのサンプル長が、第四の情報により表される位置値分減算され、ダウンリンクサンプリング間隔で乗算され、そのデータセグメントのパッキング待ち時間が取得されるステップと、そして無線信号フローが再生される時にそのデータサンプルに対応する無線フレームタイミングが回復されると、パッキング待ち時間に修正が実施されるステップとを更に含む。

【0041】

他の実施例によれば、無線フレームタイミングを回復する前記ステップが、無線フレームタイミングの周期性を用いて平滑化処理を実施するステップを更に含む。

【0042】

本発明の他の態様によれば、無線信号ブランチの、集中基地局におけるチャネル処理ユニット及び遠隔無線周波数ユニット間の伝送待ち時間を計測する為の方法が提供されるものであり、前記伝送が上述した伝送及び受信方法に基づくものであり、前記計測する為の方法が、チャネル処理ユニットにより第一のネットワークプロトコルパケットを遠隔無線周波数ユニットへと伝送するステップであって、その中のデータセグメントがチャネル処理ユニット上の無線フレーム周期の開始に対応するデータサンプルを含んでいるステップと、遠隔無線周波数ユニットから伝送される第二のネットワークプロトコルパケットをチャネル処理ユニットで受信するステップであって、その中のデータセグメントが遠隔無線周波数ユニット上の無線フレーム周期の開始に対応するデータサンプルを含んでおり、その無線フレーム周期が前記チャネル処理ユニット上の無線フレーム周期に対応するものであるステップと、上記伝送するステップの開始から上記受信するステップの終了までの時間の差を計算するステップと、前記第一及び第二のネットワークプロトコルパケットのパッキング待ち時間をそれぞれに計算するステップであって、その待ち時間が、第四の情報に表される位置値を減算し、対応するサンプリング間隔で乗算したネットワークプロトコルパケット中のデータセグメントのサンプル長に等しいステップと、前記二つのパッキング待ち時間を前記時間の差から減算して往復伝送待ち時間を取得するステップとを含む。

【0043】

一実施例によれば、前記往復伝送待ち時間はチャネル処理ユニットから遠隔無線周波数ユニットまでのダウンリンク伝送待ち時間を含み、このダウンリンク伝送待ち時間は所定の比例係数により乗算された前記往復伝送待ち時間に等しい。

【0044】

他の実施例によれば、前記所定の比例係数とは０．５である。

【0045】

本発明の他の態様によれば、集中基地局において、遠隔無線周波数ユニットの無線フレームタイミングを、チャネル処理ユニット及び無線周波数ユニット間における無線信号ブランチ伝送を通じて調節する為の方法が提供されるものであり、前記伝送が上述した送信法及び受信法に基づくものであり、前記調節法は、上述した計測法により往復伝送待ち時間を取得するステップと、前記往復伝送待ち時間を、所定の比例係数により乗算し、ダウンリンク伝送待ち時間を取得するステップと、そしてそのブランチの伝送時間を、無線フレームタイミングに対し、前記ダウンリンク伝送待ち時間に等しい時間量だけ進めるステップとを含む。

【0046】

本発明の上述及び他の態様、特徴及び／又は利点は、添付図を参照しつつ以下の説明を読むことにより更に明らかとなる。

【発明を実施するための最良の形態】

【0047】

図１３ａは、本発明の一実施例に基づく無線信号パケット送信システム２０を説明する為の概略ブロック図である。システム２０はアプリケーションプロトコル送信処理部２７と、ネットワークプロトコル送信処理部２８、及び送信スケジューリングユニット２６を

含む。

【0048】

同じ機能ノード（遠隔無線周波数ユニットに基づく基地局システム中のＲＲＵ、遠隔無線周波数ユニットに基づく基地局システム中のＭＵ、負荷分散構造に基づく無線基地局等を含む）中の異なるセルの無線信号、搬送周波数及び無線インターフェース規格は、それぞれ異なる送信ブランチに対応し、ここで各ブランチは、単一又は複数並列チャネルの無線信号（代表的には多重アンテナシステムにおけるそれぞれのアンテナ信号）のサンプルデータストリーム（代表的にはＩ／Ｑサンプルデータストリーム等）を伝送する役割を担っている。

【0049】

図１４ａのフローチャートはシステム２０の送信処理を示している。システム２０の送信処理についての説明は、以下においては１つのブランチに関するものとする。実際には、システム２０は１つ以上のブランチの無線信号を同時に処理する場合がある。

【0050】

ステップＳ１０においては、システム２０はある伝送ブランチのＩ／Ｑサンプルデータストリームを受ける。

【0051】

次にステップＳ１２において、Ｉ／Ｑサンプルデータストリームは、アプリケーションプロトコル送信処理部２７によりアプリケーションプロトコルパケットへと処理される。

【0052】

一実施例においては、アプリケーションプロトコル送信処理部２７は、Ｉ／Ｑデータセグメント化ユニット２１、ペイロードカプセル化ユニット２２及びＲＴＰカプセル化ユニット２３を含む。

【0053】

Ｉ／Ｑデータセグメント化ユニット２１は、Ｉ／Ｑサンプルデータストリームにセグメント化処理を実施してＩ／Ｑデータペイロード部を形成する。１つのＩ／Ｑデータペイロード部は、Ｉ／Ｑベースバンド無線信号データストリームの１セグメントに対応する。図１０は、２アンテナシステムにおけるＩ／Ｑデータペイロード部のフォーマットを示すものであり、ここで$I_{j,k,l}$とは、ｊ番目のアンテナのＩ／Ｑベースバンド信号同相成分のｋ番目のサンプリングポイントの１番目のビットのことであり、$Q_{j,k,l}$とは、ｊ番目のアンテナのＩ／Ｑベースバンド信号直交成分のｋ番目のサンプリングポイントの１番目のビットのことであり、Ｗはサンプリングビット幅で、その代表的な値は４～２０である。図からわかるように、Ｉ／Ｑデータペイロード部は、サンプリング時間で昇順に配列されている。多重アンテナ技術を利用する場合、それぞれのアンテナからのＩ／Ｑベースバンド信号は同じサンプリング時間で順番に配列されるもので、ここではそれぞれのアンテナのＩ／Ｑベースバンド信号のサンプリング値の配列順序は、アンテナアレイ、又はアンテナグループの空間位置配列順序と同じであり、同じアンテナのＩ／Ｑベースバンド信号のサンプリング値は、直交成分のサンプリング値及び同相成分のサンプリング値の順序に配列される。従って、アンテナの数がＤであり、Ｉ／Ｑデータペイロードカプセル化のサンプリングポイントの数がＳであった場合、１サンプリングポイントは２ＷＤビットに相当し、１パケットのＩ／Ｑデータペイロードの総ビット数Ｎは次のようになる。

【0054】

【数1】

$$N = 2W \cdot D \cdot S \qquad (1)$$

【0055】

特定のシステムの場合、アンテナ数Ｄ及びサンプリングビット幅Ｗは特定されており、１パケット中のＩ／Ｑデータペイロードのサンプリングポイント数Ｓは無線信号データストリームを搬送する各パケットの長さに依存する。無線信号データストリームを搬送する為のパケット長がＬバイトであった場合、そしてＩ／Ｑデータペイロード以外のヘッダオ

ーバーヘッドがHバイトであった場合、そのＩ／Ｑデータペイロードのサンプリングポイント数Ｓは以下のように表される。

【0056】

【数2】

$$S = \frac{4(L-H)}{WD} \qquad (2)$$

【0057】

ここでパケット長Ｌは、上記式の右側部分が整数となるように選択されることにより、Ｉ／Ｑデータペイロード部がパディングビットのないバイトで揃えられるのである。

【0058】

次にペイロードカプセル化ユニット２２はＩ／Ｑデータペイロード部をカプセル化し、ここでペイロードヘッダが生成される。ＲＴＰカプセル化ユニット２３は更なるカプセル化を実施し、ここでＲＴＰヘッダが生成される。

【0059】

ペイロードカプセル化及びＲＴＰカプセル化は、異なる方法で実施することが出来る。

【0060】

例えば、現在の実施例においては、ペイロードヘッダ及びＲＴＰヘッダは、それぞれに（例えば異なる層で）生成される。ペイロードヘッダは当該技術において既知のコンテンツ以外にも、ポインタフィールド及びオプションの同期外れリンク表示ビット（Ｒ）を更に含んでいる。同期外れリンク表示ビットは、このパケットが同期外れであることをピアエンドに通知する為に使われるもので、例えば、正常受信の場合にＲ＝０となり、ピアエンドの搬送する無線信号データストリームとの同期が崩れた場合にＲ＝１となる。受信側において、所定数のパケットの喪失が連続して発生した場合、それらのパケットは同期外れであると判断される。この時、受信側はパケットの同期外れが発生したことを、逆リンクのペイロードヘッダのリンク同期外れ表示ビットを通じてピアエンドへと通知し、ピアエンドがリンクの再初期化等の処理を実施することで、受信側がパケット同期を再度得られるようにする。ポインタフィールドは、無線フレームと往復伝送待ち時間（ＲＴＴ）の計測との同期を得る為に利用されるもので、これについては後に詳細を説明する。

【0061】

ＲＴＰヘッダの構造は、図７の通りである。ＲＴＰ層のＲａｄｉｏ　Ｏｖｅｒ　Ｐａｃｋｅｔ（無線信号のパケット伝送）における主な機能は、リアルタイム無線信号データストリームを搬送することである。上述したように、同じ機能ノード中における異なるセル、異なる搬送周波数、異なる無線インターフェース規格及びシステムの無線信号データストリームは、異なるブランチにより区別されなければならない。しかしながら、同じ機能ノード中における同じセル、同じ搬送周波数、同じ無線インターフェース規格及びシステムの無線信号データストリームであっても、複数の並列チャネルからの無線信号で構成される場合があり、代表的な例には多重アンテナ技術のアプリケーションがある。実際の無線基地局システムにおいて、代表的には送信ダイバーシチ、受信ダイバーシチ、多重アンテナ送受信（ＭＩＭＯ）及びスマートアンテナ又はアレイアンテナ等のような多重アンテナ技術は、無線性能を強化する為に益々採用が広がっている。多重アンテナ技術を採用したこれらの無線基地局システムにおいては、アンテナ信号間に厳密な時間及び位相関係があり、送信処理におけるアンテナ信号の伝送待ち時間は厳密に等しくなければならない。よって多重アンテナ技術の場合、同じアンテナグループ又はアレイの全アンテナに対応する、同じ機能ノードにおける同じセル、同じ搬送周波数、同じ無線インターフェース規格及びシステムの中の無線信号データストリームは、同じＲＴＰストリーム上で搬送することが出来る。

【0062】

図７に示したＲＴＰヘッダのフィールドの基本的な定義は、ＩＥＴＦ仕様“ＲＦＣ１８８９，ＲＴＰ：リアルタイムアプリケーションのためのトランスポートプロトコル（Ａ Ｔｒａｎｓｐｏｒｔ Ｐｒｏｔｏｃｏｌ ｆｏｒ Ｒｅａｌ－Ｔｉｍｅ Ａｐｐｌｉｃａｔｉｏｎｓ）”に準拠したものであり、本実施例における具体的な用法は以下の通りである。

【0063】

Ｖ（バージョン番号）：現在のＲＴＰバージョン番号で２と設定される。

【0064】

Ｐ（パディング表示ビット）：例えばパディングが無い等の場合、０と設定される。

【0065】

Ｘ（ヘッダ拡張表示ビット）：例えばヘッダ拡張が無い場合、０と設定される。

【0066】

ＣＣ（ＣＳＲＣカウント）：例えばＣＳＲＣ（貢献ソース）が無い場合、０と設定される。

【0067】

Ｍ（識別ビット）：このビット及びペイロードヘッダのポインタフィールドは共に、後に詳細を説明する無線フレームの同期及び往復伝送待ち時間（ＲＴＴ）の計測用に利用される。

【0068】

ＰＴ（ペイロードタイプ）：このフィールドは異なるペイロードフォーマットを表示するもので、ペイロードフォーマットに影響を与える因子としては、サンプリングレート、サンプリング値のビット幅及び並列チャネル数（アンテナ数）が含まれる。サンプリングレートはコードセルの倍数又は対応する無線インターフェースの物理チャネルのシンボルレートであり、その代表的な値は１～８である。例えば、ＣＤＭＡ（符号分割多重接続）システムにおいては、サンプリングレートはチップレートの倍数となり、ＴＤＭＡ（時分割多重接続）システムにおいては、サンプリングレートはシンボルレートの倍数となる。サンプリング値ビット幅は採用されたＡＤＣ／ＤＡＣ（アナログ－デジタル変換／デジタル－アナログ変換）のビット数に対応し、代表的な値は４～２０である。並列チャネル数はアンテナの数であり、代表的な値は１～１６である。ＰＴフィールドには７ビットしか無く、最大で１２８種類のペイロードフォーマットしか表示できない為、特定の無線基地局システムの場合、その特定のケースに応じて更なる定義を作らなければならない。

【0069】

シーケンス番号：ＩＰ／ＵＤＰ層はパケットの連続伝送を管理していない為、受信側により、パケット喪失の検出及びパケットシーケンス回復の為にシーケンス番号が利用される。その具体的な用法は、ＩＥＴＦ仕様書ＲＦＣ１８８９の関連箇所に準拠するものである。

【0070】

タイムスタンプ：タイムスタンプはペイロード部の第一のサンプリング値のサンプリング時間を表示するものである（ペイロードが、例えば複数アンテナの無線信号である等、複数の並列チャネルで構成されている場合、並列チャネルは全て同期してサンプリングされることから、アンテナ信号のサンプリング時間は同じである）。上述したように、サンプリングレートはコードセルの倍数、又は対応する無線インターフェースの物理チャネルのシンボルレートである。無線信号のパケット伝送（Ｒａｄｉｏ Ｏｖｅｒ Ｐａｃｋｅｔ）のアプリケーションにおいては、待ち時間ジッタの計測にはタイムスタンプを利用することが出来る。タイムスタンプの利用法は、ＩＥＴＦ仕様書ＲＦＣ１８８９の関連箇所に準拠するものである。

【0071】

ＳＳＲＣ（同期ソース識別）：ＲＦＣ１８８９の関連仕様によれば、ＲＴＰセッション（例えばＩＰアドレス及びＵＤＰポートの組み合わせのような、トランスポート層アドレスにより識別される）は、異なるソースからの複数のＲＴＰストリームを含む場合があり

、ここでは各ＲＴＰストリームは異なるＳＳＲＣ値により識別され、独立したＳＳＲＣ値及びシーケンス番号空間を持つ。本発明においては、異なるセル（セクタを持つ）、異なる搬送周波数及び異なる無線インターフェース規格及びシステムのアップリンク及びダウンリンク無線信号は、異なるトランスポート層アドレスを採用している為、各セッションは、１つのＲＴＰストリーム（例えば、たった１つの同期ソース）しか持たない。

【0072】

ＲＴＣＰ（ＲＴＰ制御プロトコル）はオプションであり、無線信号のパケット伝送（Ｒａｄｉｏ　Ｏｖｅｒ　Ｐａｃｋｅｔ）アプリケーションにおいては、パケット喪失率や待ち時間ジッタ、往復伝送待ち時間（ＲＴＴ）といった、伝送品質に関するフィードバック情報を提供する為に利用することが出来る。関連する用法はＩＥＴＦ仕様書“ＲＦＣ１８８９，ＲＴＰ：リアルタイムアプリケーションのためのトランスポートプロトコル（ＡＴｒａｎｓｐｏｒｔ　Ｐｒｏｔｏｃｏｌ　ｆｏｒ　Ｒｅａｌ－Ｔｉｍｅ　Ａｐｐｌｉｃａｔｉｏｎ）”に準拠するものである。

【0073】

本実施例におけるペイロードカプセル化及びＲＴＰカプセル化下位層の、無線信号ネットワーク（例えばＩＰ）送信カプセル化構造は図３ａに示した通りである。

【0074】

上述した例のＲＴＰヘッダ及びペイロードヘッダの場合、ペイロードタイプ、パケットシーケンス番号、無線信号パケット伝送リンク同期外れ表示（オプション）、無線フレーム同期表示及び対応無線フレーム開始位置ポインタに関わる情報が、本発明の目的に関わるものであり、他のフィールドは本発明の範囲には関わりがない。加えて、上述した特定のフォーマット及び値は、例示したに過ぎず、本発明を制約するものではない。当業者であれば、本願の説明に基づく他のフォーマット及び限界値を得ることが出来るであろう。

【0075】

他の実施例においては、図９に示される推奨ペイロードヘッダ構造が採用されており、ここではペイロードヘッダが識別ビット（Ｍ）、シーケンス番号、ペイロードタイプ（ＰＴ）等のＲＴＰヘッダと同じ機能を持つ重要なフィールドを提供しており、これによってＲＴＰ層ではなく、アプリケーションプロトコルの下位のプロトコル（例えばネットワークプロトコル）を利用して無線信号データストリームが直接的に搬送されており、ＲＴＰ層の処理オーバーヘッド及びＲＴＰヘッダの伝送帯域オーバーヘッドが低減されている。無線信号データストリームを、ＲＴＰ層以外の例えばネットワークプロトコルにより直接的に搬送する為の、無線信号ネットワーク（例えばＩＰ）送信カプセル化構造体は、図３ｂに示される通りである。実際のところ、各無線信号データストリームは１つの同期ソースしか持っていないことから、ＲＴＰ層を使用しない場合、同期ソース識別フィールドは必要とされない。無線信号は等しい間隔でサンプリングされ、サンプリングの順番に伝送されることから、搬送される無線信号データストリーム各々のネットワークプロトコルパケット（例えばＩＰパケット）は等しい長さを持ち、従ってＲＴＰ層を使用しない場合、タイムスタンプフィールドは必要とされない。この場合、ＲＴＰカプセル化ユニットは省かれ、ＲＴＰプロトコルの主要機能はペイロードカプセル化ユニット２３へと統合化される。

【0076】

図９に示したように、ＲＴＰヘッダと同じ機能を持つ識別ビット、シーケンス番号及びペイロードタイプのフィールドを提供するという他に、ペイロードヘッダ中にはリンク同期外れ表示ビット（Ｒ）及びポインタフィールドが定義されている。リンク同期外れ表示ビットは、パケットが同期外れを生じていることをピアエンドに通知する（例えば通常受信の場合にＲ＝０、そのピアエンドが搬送する無線信号データストリームパケットとの同期が崩れた場合にＲ＝１）為に利用される。所定数のパケット喪失が連続して生じた場合、それらのパケットは同期外れを生じたものと判断される。この時、受信側はピアエンドへとパケット同期外れの発生を、逆リンクのペイロードヘッダのリンク同期外れ表示ビットにより通知しなければならず、するとピアエンドは受信側にパケット同期を再度取らせ

る為にリンクの再初期化等を実施することが出来る。ポインタフィールド及び識別ビット（Ｍ）は共に、後により詳細を説明する無線フレームの同期及び往復伝送待ち時間（ＲＴＴ）の計測に利用される。

【0077】

図１４ａに戻るが、ステップＳ１４においては、ネットワークプロトコル送信処理部２８がアプリケーションプロトコル送信処理部２７により生成されたアプリケーションプロトコルパケットに処理を実施する。

【0078】

一実施例においては、ネットワークプロトコル送信処理部２８はＵＤＰカプセル化ユニット２４及びＩＰカプセル化ユニット２５を含む。本実施例の処理法は、図３ａ及び図３ｂに示した通りである。図３ａ及び図３ｂは、ＩＰネットワーク中にＲＴＰ層を含む無線信号ＩＰ伝送（Ｒａｄｉｏ　Ｏｖｅｒ　ＩＰ）用のネットワークプロトコルカプセル化法、及びＩＰネットワーク中にＲＴＰ層を含まない無線信号ＩＰ伝送（Ｒａｄｉｏ　Ｏｖｅｒ　ＩＰ）用のネットワークプロトコルカプセル化法を、それぞれ示したものである。図３ａに示したもののような無線信号ＩＰ送信カプセル化構造においては、最上層はＩ／Ｑデータペイロード、そして以下、ペイロードヘッダ、ＲＴＰ（リアルタイム伝送プロトコル）ヘッダ、ＵＤＰ（ユーザーデータグラムプロトコル）ヘッダ及びＩＰｖ４又はＩＰｖ６ヘッドの各層へと続く。

【0079】

ＩＰ層のソースアドレス及びあて先アドレスとは、それぞれ送信側及び受信側のＩＰアドレスのことである。本発明の送信側及び受信側とは、遠隔無線周波数ユニットに基づく基地局システムにおけるＲＲＵ、遠隔無線周波数ユニットに基づく基地局システムにおけるＭＵ、負荷分散構造を持つ無線基地局等の機能ノードである可能性がある。加えて、以下に説明するように、搬送される各無線信号データストリームのＩＰパケットペイロード部は同じサイズを持っている為、各搬送無線信号データストリームのＩＰパケットは、等しい長さを持つ。

【0080】

ＵＤＰヘッダの構造は、図６に示す通りである。無線信号ＩＰ伝送（Ｒａｄｉｏ　Ｏｖｅｒ　ＩＰ）におけるＵＤＰ層の主な機能は、多重化である。同じ機能ノードに異なるセル（セクタを含む）の無線信号があったり、同じセル内に異なる搬送周波数の無線信号があったり、同じ機能ノードに異なる無線インターフェース規格やシステムの無線信号があったり等、同じ機能ノードには複数の異なる無線信号が存在し得る。同じ機能ノード中のそれぞれの無線信号は、それぞれにアドレスを指定され、異なる処理が実施されなければならない。例えば、アップリンク方向においては、異なるモジュール又はユニットにより、異なるセル（セクタを含む）、異なる搬送周波数及び異なる無線インターフェース規格及びシステムのアップリンク信号にチャネル処理を実施しなければならず、ダウンリンク方向においては、異なる無線周波数チャネルにより、異なるセル（セクタを含む）、異なる搬送周波数及び異なる無線インターフェース規格及びシステムのダウンリンク信号を伝送しなければならない。従ってトランスポート層は、対応する処理が実施されるように差別化する為の異なるアドレスを提供しなければならない。よって異なるセル（セクタを含む）、異なる搬送周波数及び異なる無線インターフェース規格及びシステムのアップリンク及びダウンリンク信号は、差別化され、ＩＰアドレス及びＵＤＰポートの組み合わせによりアドレス指定されるのである。ＵＤＰヘッダ中の他のフィールドの用法は、ＩＥＴＦ仕様書“ＲＦＣ７６８，ユーザデータグラムプロトコル（Ｕｓｅｒ　Ｄａｔａｇｒａｍ　Ｐｒｏｔｏｃｏｌ）”に準拠する。

【0081】

他の実施例においては、ネットワークプロトコル送信処理部は、ＭＰＬＳ仮想回路ラベルをマーキングする為のＭＰＬＳ仮想回路ラベルマーキングユニットと、ＭＰＬＳトンネルラベルをマーキングする為のＭＰＬＳトンネルラベルマーキングユニットとを含んでいる。

【0082】
ＭＰＬＳ（マルチプロトコルラベルスイッチ）技術は、その高速スイッチング能力、スケーラビリティ、ＱｏＳ（クォリティオブサービス）管理及びトラヒックエンジニアリング実現の容易性から、大規模広帯域パケットネットワークの構築に向けた効果的なソリューションとなっている。その関連する技術に関しては、ＩＥＴＦのＲＦＣ３０３１、ＲＦＣ３０３２、ＲＦＣ３０３６等といった関連仕様書を見ることが出来る。図４ａ及び図４ｂは、ＭＰＬＳネットワーク中にＲＴＰ層を含む無線信号パケット伝送（Ｒａｄｉｏ　Ｏｖｅｒ　ＭＰＬＳ）と、ＭＰＬＳネットワーク中にＲＴＰ層を含まない無線信号パケット伝送（Ｒａｄｉｏ　Ｏｖｅｒ　ＭＰＬＳ）とを、それぞれに示している。図４ａに示したように、送信側（例えばＭＵ）及び受信側（例えばＲＲＵ）がいずれもＭＰＬＳのラベル配布プロトコル（ＬＤＰ）をサポートしている場合、又はＭＰＬＳのラベルスイッチ経路（ＬＳＰ）を静的に構成することにより、ＲＴＰをＭＰＬＳ上で直接的に搬送することが可能である。図４ａに示すもののような無線信号ＭＰＬＳ送信カプセル化構造におけるそれぞれの層とは、最上層から最下層の順に、Ｉ／Ｑデータペイロード、ペイロードヘッダ、ＲＴＰヘッダ、１つ以上のラベルを順番に含むＭＰＬＳ仮想回路ラベル及びＭＰＬＳトンネルラベルである。ＩＰ伝送と同様、図４ｂはＲＴＰ層を使わずに、しかし無線信号データストリームをＭＰＬＳ上で直接的に搬送するカプセル化構造を示している。
【0083】
ＭＰＬＳのラベルは、１つ以上のラベルから成るラベルスタックである。図８は、一般的なＭＰＬＳラベルスタックの１ラベルエントリの構造を示すものである。それぞれのフィールドに関する定義については、ＩＥＴＦ仕様書、“ＲＦＣ３０３２，ＭＰＬＳ　ラベルスタックエンコーディング（Ｌａｂｅｌ　Ｓｔａｃｋ　Ｅｎｃｏｄｉｎｇ）”を参照されたい。図４ａ及び図４ｂにおいては、ＭＰＬＳトンネルラベルは遠隔無線周波数ユニットに基づく基地局システム中のＭＵ及びそれぞれのＲＲＵ間、及び負荷分散構造を持つ無線基地局間の接続を識別する為に利用されており、そしてＭＰＬＳ仮想回路ラベルは多重化機能を持っており、同じ接続における異なるセル（セクタを含む）異なる搬送周波数及び異なる無線インターフェース規格及びシステムのアップリンク及びダウンリンク無線信号の差別化の為に利用される。
【0084】
他の実施例においては、図５ａ及び図５ｂに示すように、ＭＰＬＳ－ｉｎ－ＩＰ混合無線信号パケット送信カプセル化構造を用いることにより、ＭＰＬＳ及びＩＰの混合ネットワークを介した無線信号パケット送信を実施するアプリケーションにそのようなカプセル化構造を適用することが出来る。本実施例においては、ネットワークプロトコル送信処理部は、ＭＰＬＳ仮想回路ラベルをマーキングする為のＭＰＳＬ仮想回路ラベルマーキングユニット、ＭＰＬＳトンネルラベルをマーキングする為のＭＰＬＳトンネルラベルマーキングユニット、及びＩＰプロトコルカプセル化を実施する為のユニットを含んでいる。本カプセル化構造においては、ＭＰＬＳトンネルラベルの下のＩＰ層のソースアドレス及びあて先アドレスは、送信側及び受信側それぞれのＩＰアドレスにも対応している。送信側及び受信側とは、遠隔無線周波数ユニットに基づく基地局システムにおけるＲＲＵ、遠隔無線周波数ユニットに基づく基地局システムにおけるＭＵ、負荷分散構造を持つ無線基地局等の機能ノードである可能性がある。ＭＰＬＳ－ｉｎ－ＩＰに関するより詳細な説明については、ＩＥＴＦ　ＲＦＣ“ＩＰのＭＰＬＳラベルスタックカプセル化、ドラフト－ワースター－ｍｐｌｓ－イン－ＩＰ－０５、２００１年７月（ＭＰＬＳ　Ｌａｂｅｌ　Ｓｔａｃｋ　ｅｎｃａｐｓｕｌａｔｉｏｎ　ｉｎ　ＩＰ，　ｄｒａｆｔ－ｗｏｒｓｔｅｒ－ｍｐｌｓ－ｉｎ－ｉｐ－０５，Ｊｕｌｙ　２００１）”を参照することが出来る。
【0085】
留意すべきは、前記機能ノード中にある異なるセル、搬送周波数及び無線インターフェース規格に対応する異なる無線信号ブランチには、異なるＵＤＰポート（又はＭＰＬＳ仮想回路ラベル）が使われる。
【0086】

最後に無線信号を搬送する為のそれぞれのブランチのＩＰ（又はＭＰＬＳ）パケット、及び管理制御クラス情報を搬送する為のＩＰ（又はＭＰＬＳ）パケットは、送信スケジューリングユニット２６を介して伝送されるもので、ここで送信スケジューリングユニット２６は、無線信号を搬送する為のそれぞれのブランチのＩＰ（又はＭＰＬＳ）パケットには、例えば循環スケジューリングのような同じ優先順位に基づいてスケジューリングを適用し、管理制御クラス情報を搬送する為のＩＰ（又はＭＰＬＳ）パケットにはより低い伝送優先順位を適用する。

【0087】

図１４ａに戻ると、ステップＳ１６においては、最終パケットが送信ポートから送信される。その後ステップＳ１０に戻る。

【0088】

図１３ｂは、本発明の一実施例に基づく無線信号パケット受信システム３０を描いた概略ブロック図である。システム３０は、ネットワークプロトコル受信処理部３６及びアプリケーションプロトコル受信処理部３７を含んでいる。

【0089】

図１４ｂのフローチャートは、システム３０の受信処理を示すものである。図１４ｂに示されるように、ステップＳ２０において、システム３０はネットワークプロトコル（例えばＩＰ又はＭＰＬＳ）パケットを受信ポートから受ける。ネットワークプロトコルパケットは、上述したシステム２０により処理された後に生成されるものである。

【0090】

次にステップＳ２２において、ネットワークプロトコル受信処理部３６は受信したネットワークプロトコル（例えばＩＰ又はＭＰＬＳ）パケットに処理を実施してその中にあるアプリケーションプロトコルパケットを取得する。本実施例においては、受信されたネットワークプロトコルパケットは、図３ａ及び図３ｂにおいて示したようにプロトコルカプセル化後はＩＰパケットである。ネットワークプロトコル受信処理部３６は、ＩＰヘッダを処理してＵＤＰパケットを抽出するＩＰパースユニット３１、ＵＤＰヘッダを処理してアプリケーションプロトコルパケットを抽出するＵＤＰパースユニット３２を含む。ステップＳ２２はステップＳ１４を逆に処理するものである為、重複部に関しては特に説明はしないものとする。他の実施例においては、受信されたネットワークプロトコルパケットは、図４ａ及び図４ｂに示したようにプロトコルカプセル化されたネットワークプロトコルパケットである。ネットワークプロトコル受信処理部３６は、対応するようにＭＰＬＳトンネルラベルを処理する為のユニット及びＭＰＬＳ仮想回路ラベルを処理する為のユニットを含んでいる。他の実施例においては、受信されたネットワークプロトコルパケットは、図５ａ及び図５ｂに示したようにプロトコルカプセル化されたネットワークプロトコルパケットである。ネットワークプロトコル受信処理部３６は、対応するようにＩＰヘッダを処理してＭＰＬＳパケットを抽出する為のユニット、ＭＰＬＳトンネルラベルを処理する為のユニット及びＭＰＬＳ仮想回路ラベルを処理する為のユニットを含んでいる。ステップＳ２２においては、異なる機能ノードにより受信されたネットワークプロトコルパケットがネットワークプロトコル受信処理部３６中の対応するユニットにより処理され、上述した管理制御クラス情報を搬送するパケットが異なるトランスポート層プロトコル又はトランスポート層アドレスに基づいて識別され、そして残りのパケットが、同じ機能ノード内の異なるセル、搬送周波数及び無線インターフェース規格に対応する異なる無線信号ブランチについて、ＵＤＰポート又はＭＰＬＳ仮想回路ラベルに基づいて逆多重化される（例えばそのブランチのパケットデータストリームを分離し、アプリケーションプロトコル受信処理部３７中の対応する受信経路へと出力する）。

【0091】

次にステップＳ２４において、それぞれのブランチのパケットが、アプリケーションプロトコル受信処理部３７内の対応する処理経路において更に処理される。一実施例においては、アプリケーションプロトコル受信処理部３７の処理経路は、ＲＴＰ処理ユニット３３、ペイロード処理ユニット３４及びＩ／Ｑデータ再構築ユニット３５を含んでおり、こ

こでアプリケーションプロトコルパケットはステップＳ１２においてＲＴＰ層を含む方式に基づいて生成されたアプリケーションプロトコルパケットに対応するものであり、ＲＴＰ処理ユニット３３及びペイロード処理ユニット３４の処理は、ＲＴＰカプセル化ユニット２３及びペイロードカプセル化ユニット２２の処理を逆に実施するものである。ＲＴＰ処理ユニット３３の処理においては、ＲＴＰヘッダフィールド及びペイロードヘッダフィールドにより搬送される情報を使って対応する処理が同時に実施されるものであり、ここでは受信されたパケットは受信側におけるパケットシーケンス番号を使って再ソートされ、これと同時に、パケットネットワーク中間ノード又は受信側によりタイムアウトで破棄されたパケットは、パディングデータにより埋められ（一般に、対応するＩ／Ｑサンプリング信号に０が埋められる）、これによりＩ／Ｑ無線信号の順次伝送が保証される。加えて送信側及び受信側は、無線フレーム同期、ＲＴＴ推定、ＲＲＵ待ち時間修正、無線信号パケット伝送リンク同期外れ検出等を含む先に説明した機能を、無線信号パケット伝送リンク同期外れ表示、無線フレーム同期表示、対応無線フレーム開始位置ポインタ等の、上述した対応するＲＴＰヘッダフィールド及びペイロードヘッダフィールドが搬送する情報を使って実施する。最後にＲＴＰ処理ユニット３３及びペイロード処理ユニット３４がアプリケーションプロトコルパケットを処理してＩ／Ｑデータペイロードセグメントを取得し、Ｉ／Ｑデータ再構築ユニット３５へと出力する。Ｉ／Ｑデータ再構築ユニット３５はＩ／Ｑデータストリームを回復及び再構築するもので、ここで多重アンテナシステムに複数の並列チャネルがある等の場合でも、並列チャネルそれぞれの無線信号Ｉ／Ｑサンプルデータストリームを正しく分離することが可能である。

【0092】

他の実施例においては、ＲＴＰ処理ユニット３３は省くことが出来る。この場合、アプリケーションプロトコルパケットは、ＲＴＰヘッダは含まないが、図９に示すようにペイロードヘッダを含んでいる。ペイロード処理ユニット３４はＲＴＰ処理ユニット３３の主な機能を含んでいる。

【0093】

送信側がＭＵであり、受信側がＲＲＵである場合、又は送信側が基地局であり、受信側が他の基地局である場合、ステップＳ２４において、受信されたデータストリームに基づき、無線フレームタイミング回復機能も実施される。上述したように、ＲＴＰヘッダ及びペイロードヘッダの識別ビット、及びペイロードヘッダポインタフィールドは、無線フレームの同期及び往復伝送待ち時間（ＲＴＴ）の測定用に共に用いられるもので、その原理は図１１に示した。

【0094】

遠隔無線周波数ユニットに基づく基地局システムを例に挙げると、ＭＵ側の無線フレームタイミングは、それに接続する全ＲＲＵのタイミング基準である。ダウンリンク方向において、ＭＵは固定ペイロード長でダウンリンクＩ／Ｑベースバンド信号サンプリングシーケンスを分割し、これらを固定長のパケットにカプセル化してそれぞれのＲＲＵへと伝送する（説明の便宜上、パケットペイロード長及び無線フレーム長は、いずれもサンプリング時間間隔の倍数で表現されるものとする）。パケットペイロード部へとカプセル化されたダウンリンクＩ／Ｑベースバンド信号サンプリングシーケンスにおけるサンプリングポイントのサンプリング時間が無線フレームの開始時間と等しい場合、パケットペイロードヘッダ（ＲＴＰを用いた場合はＲＴＰヘッダを含む）の識別ビットはＭ＝１である。これと同時に、パケットペイロードヘッダのポインタフィールドは、無線フレーム開始時間と同じサンプリング時間を持つ前記サンプリングポイントのサンプリング位置を指し示すもので、例えばポインタフィールドの値は、パケットペイロード部中の最初のサンプリングポイントからそのサンプリングポイントまでの間におけるサンプリングポイント数である。無線フレーム長は、必ずしもパケットペイロード長の整数倍であるとは限らないことから、無線フレームの開始位置が対応するパケットペイロード位置は変化する。容易にわかるように、上述した処理は、Ｉ／Ｑベースバンド信号サンプリングシーケンス自体を時間軸として使うことにより、実際に無線フレームのタイミングをマーキングするものであ

る。

【0095】

例えば、ＲＲＵがダウンリンクＩ／Ｑベースバンド信号サンプリングシーケンスのセグメントを搬送するパケットをＭＵから受けると同時にそのＩ／Ｑベースバンド信号サンプリングシーケンスを順次再構築した後、上述した識別ビット及びポインタフィールドを用いることにより無線フレームタイミングを回復することが可能である。

【0096】

ステップＳ２４の後、取得されたＩ／Ｑデータストリームはステップ Ｓ２６にて出力され、その後処理はステップＳ２０へと戻る。

【0097】

上述した送受信実施例に基づき、ＲＴＴ及びＲＲＵ待ち時間修正の推定が提供される。ＭＵ側における無線フレームタイミングと比較すると、ＲＲＵ側において回復された無線フレームタイミングは一定の遅延を持っている。この遅延は、無線フレーム開始位置をマーキングする為のパケットのパッキング待ち時間及びそのダウンリンク伝送待ち時間を含んでおり、ここでパッキング待ち時間とは、無線フレーム開始時間からパケットペイロード部中の最後のサンプリングポイントのサンプリング時間までの、ＭＵにおける時間である。少なくともパケットをカプセル化して送出することが出来るまでの時間周期は待たなければならないこと、そしてこのパッキング待ち時間は既知であることから、ポインタフィールドの値及びパケットペイロード長を使ってパッキング待ち時間を計算することが出来る。無線フレーム開始位置をマーキングする為のパケットのペイロード部ポインタフィールドの値をP^{DL}、ダウンリンク方向のＩ／Ｑデータペイロードカプセル化におけるサンプリングポイント数をS^{DL}、そしてダウンリンク方向のサンプリング時間間隔をT_s^{DL}とした場合、ダウンリンク方向のパッキング待ち時間は以下の通りである。

【0098】

【数3】

$$\tau_p^{DL} = \left(S^{DL} - P^{DL}\right) \cdot T_s^{DL} \qquad (3)$$

【0099】

上述した変更後のパッキング待ち時間に対する修正の実施、及び無線フレームタイミングの周期性（ダウンリンク無線フレームが周期的再現性を持っている場合、ほとんどの無線アクセス技術がこの特性を持つ）を用いた平滑化処理の実施により、精度の高い無線フレームタイミングをＲＲＵ側で取得することが可能である。

【0100】

アップリンク方向において、ＲＲＵも固定ペイロード長でアップリンクＩ／Ｑベースバンドサンプリングシーケンスを分割し、それらを固定長のパケットへとカプセル化してＭＵへと送信する。パケットペイロード部中にカプセル化されたアップリンクＩ／Ｑベースバンドサンプリングシーケンスのセグメント中のサンプリングポイントのサンプリング時間が、ＲＲＵの取得した無線フレームタイミングのフレーム開始時間と等しい場合、パケットペイロードヘッダ（ＲＴＰを用いている場合、ＲＴＰヘッダを含む）の識別ビットはＭ＝１である。これと同時に、パケットペイロードヘッダのポインタフィールドは、無線フレーム開始時間と同じサンプリング時間を持つそのサンプリングポイントのサンプリング位置を指し示すもので、例えばポインタフィールドの値は、パケットペイロード部中の最初のサンプリングポイントからそのサンプリングポイントまでの間におけるサンプリングポイント数である。また、無線フレーム長は、必ずしもパケットペイロード長の整数倍であるとは限らないことから、無線フレームの開始位置が対応するパケットペイロード位置は変化する。

【0101】

ＭＵがアップリンクＩ／Ｑベースバンド信号サンプリングシーケンスのセグメントを搬送するパケットをＲＲＵから受信すると同時にそのＩ／Ｑベースバンド信号サンプリング

シーケンスを順次再構築した後、上述した識別ビット及びポインタフィールドを用いることによりＲＲＵによりフィードバックされる無線フレーム開始位置の時間を決定することが出来る。更に、その時間はＲＲＵにおける無線フレーム開始位置の時間と比較して特定の遅延を持っている。この遅延は、無線フレーム開始位置をマーキングする為のパケットのパッキング待ち時間と、そのアップリンク伝送待ち時間を含み、そのパッキング待ち時間とは無線フレーム開始時間からパケットペイロード部中の最後のサンプリングポイントのサンプリング時間までのＲＲＵにおける時間である。無線フレームスタート位置をマーキングする為のパケットのペイロード部ポインタフィールド値をＰ^{ＵＬ}、ダウンリンク方向のＩ／Ｑデータペイロードカプセル化におけるサンプリングポイント数をＳ^{ＵＬ}、そしてダウンリンク方向のサンプリング時間間隔をＴｓ^{ＵＬ}とした場合、アップリンク方向のパッキング待ち時間は以下の式の通り算出することが出来る。

【0102】

【数4】

$$\tau_p^{UL} = \left(S^{UL} - P^{UL}\right) \cdot T_s^{UL} \qquad (4)$$

【0103】

よってＭＵにおいて、ＲＲＵによりフィードバックされた無線フレーム開始位置の時間と、その元の無線フレームタイミング開始位置の時間との間の差τ_{Σ}を、式（３）及び式（４）と共に使うことにより、往復伝送待ち時間（ＲＴＴ）の推定値を取得することが可能である。

【0104】

【数5】

$$RTT = \tau_d^{DL} + \tau_d^{UL} = \tau_{\Sigma} - \tau_p^{DL} - \tau_p^{UL} \qquad (5)$$

【0105】

ここで$\tau_{d}^{ＤＬ}$及び$\tau_{d}^{ＵＬ}$は、それぞれダウンリンク方向伝送待ち時間及びアップリンク方向伝送待ち時間である。

【0106】

ＲＴＣＰを用いた計測と比較すると、上述した技術を使ってＲＴＴを計測した場合、ＲＴＣＰ処理の複雑性を回避することが出来、また、これはＲＴＰ層を利用しない場合においても適用可能である。同時に、周期的計測を実施するものであることから、ＲＴＴのリアルタイムでの変化を追跡することが可能であり、周期性を用いた平滑化処理を実施することでより高い精度のＲＴＴ計測結果を得ることが出来る。

【0107】

ＲＲＵが無線フレームタイミングを取得する理由とは、ＲＲＵの無線周波数モジュール（無線周波数電力増幅器、周波数合成器等）がしばしば無線フレームタイミングを時間基準として使う周期的制御信号を必要とすること、そしてＴＤＤ（時分割二重）システム中の無線周波数モジュール、モードスイッチ、送受信スイッチ等に関わるオンオフ制御に対して厳しいタイミング条件を持っていることから、取得したフレームタイミングをＲＲＵが局所的及び周期的に利用して上述した信号を生成することが出来るようにする為である（それぞれの制御信号の開始及び停止時間は、パラメータ設定し、制御プレーン信号により変更することが出来る）。

【0108】

ＴＤＤモードの無線インターフェース技術においては、それぞれのＲＲＵが厳密な同期のもとにアップリンク受信及びダウンリンク送信を実施するものであることを保証しなければならない。ＴＤＤシステムにおけるそれぞれのセルのアップリンク及びダウンリンク送受信タイミングの同期外れは、異なるセルの送受信スロット間に相互干渉を生じ、ハンドオフにおいて進むタイミングの調整に影響を与えることから、それぞれのＲＲＵ無線フ

レームタイミングの同期を保証する必要があるのである。ＴＤＤモードにおけるセルの同期問題に関する考察については、３ＧＰＰ（第三世代協力プロジェクト（Ｔｈｉｒｄ　Ｇｅｎｅｒａｔｉｏｎ　Ｃｏｏｐｅｒａｔｉｏｎ　Ｐｒｏｊｅｃｔ））の“ＴＲ２５，８３６，ＴＤＤのノードＢ同期（ＮｏｄｅＢ　Ｓｙｎｃｈｒｏｎｉｚａｔｉｏｎ　ｆｏｒ　ＴＤＤ）”という文献を参照されたい。ＦＤＤ（周波数分割二重）モードの無線インターフェース技術については、それぞれのセルの無線フレームに厳密な同期が要求されない場合はＲＲＵ待ち時間修正処理は実施されなくても良く、要求される場合はＲＲＵ待ち時間修正が更に実施される。

【0109】

上述したように、上述の方法でそれぞれのＲＲＵにより取得された無線フレームタイミングは異なっており、この差は異なる伝送待ち時間により生じたものである。この為、本発明によれば、ＭＵは取得したそれぞれのＲＲＵのＲＴＴ計測値を用いることで、それぞれのＲＲＵへと送り出す無線フレームタイミングを相対的に進める又は遅らせることが出来ることにより（例えばパケット中のペイロード部ポインタフィールドの値を相対的に増やす又は減じることによりダウンリンク方向における無線フレーム開始位置をマーキングする等）、それぞれのＲＲＵの無線フレームタイミングが等しくなる傾向となり、これによってそれぞれのＲＲＵのＲＴＴ変化が追跡され、それぞれのＲＲＵの無線フレームタイミングの同期が維持されるのである。

【0110】

図１２ａ及び図１２ｂは、ＲＴＴ計測に基づく待ち時間修正の概略図である。図に示されるように、中間はＲＲＵにおける待ち時間修正前のタイミングであり、そして一番下はＲＲＵにおける待ち時間修正後のタイミングである。図に示されるように、左側矢印はそれぞれのＲＲＵに対応するＭＵ側におけるフレーム開始時間を示しており、中間矢印はＲＲＵ側で受信されたフレーム開始時間を示しており、右側矢印はＲＲＵからＭＵへとフィードバックされたフレーム開始時間を示している。基準タイミングの往復伝送待ち時間はＲＴＴ０であり、ＲＲＵの往復伝送待ち時間はＲＴＴ１である。図１２ａにおいては、ＲＲＵのＲＴＴ１は基準タイミングＲＴＴ０よりも$\Delta RTT = RTT_1 - RTT_2 > 0$分大きく、従ってＭＵはＲＲＵへと向けられるフレーム開始時間を１／２ΔＲＴＴ進めることによりＲＲＵ側で受信されるフレーム開始時間が基準タイミングと一致するようにしなければならない。対照的に、図１２ｂにおいては、ＲＲＵのＲＴＴ１は基準タイミングＲＴＴ０よりも$\Delta RTT = RTT_1 - RTT_2 > 0$分小さく、従ってＭＵはＲＲＵへと向けられるフレーム開始時間を１／２ΔＲＴＴ遅らせることによりＲＲＵ側で受信されるフレーム開始時間が基準タイミングと一致するようにしなければならない。

【0111】

実際のところ、上述した待ち時間修正処理においては、アップリンク及びダウンリンク伝送待ち時間が等しいことを前提としており、これはほとんどのアプリケーションに適用可能である。特定のアプリケーションのアップリンク及びダウンリンク伝送待ち時間が等しくない場合、それぞれのＲＲＵへと送られる無線フレームタイミングを進める又は遅らせる量をある修正率で増大させることが可能である（例えば$1/2(1+\gamma)\Delta RTT$の修正、ここで$-1<\gamma<1$）。修正率は実際の計測を通じて取得した実験値により決定することが出来る。加えて、上記待ち時間修正処理における基準タイミングは、全ＲＲＵが待ち時間修正を実施する為の基準であるが、しかしその値の選択はそれぞれのＲＲＵの相対的なタイミング同期に影響を及ぼすものではなく、それぞれのＲＲＵに対応するＭＵ側の平均フレーム開始時間に影響を及ぼすものである。よって上記基準タイミングは、それぞれのＲＲＵに対応するＭＵ側の平均フレーム開始時間により決定される。

【0112】

待ち時間計測及び修正方法を、ＭＵを送信側、そしてＲＲＵを受信側とした例において説明して来たが、当業者には明らかなように、このような方法は必要に応じて本発明の送受信法を採用するいずれの送信側及び受信側にも適用可能であり、同期目的及び同期条件の特定の定義に基づいて相応にタイミング調整を送ることが可能である。

【0113】
伝送待ち時間、待ち時間ジッタ、パケット喪失等といった、無線信号パケット伝送におけるＱｏＳ（クウォリティオブサービス（Ｑｕａｌｉｔｙ　ｏｆ　Ｓｅｒｖｉｃｅ））性能パラメータの中でも、伝送待ち時間は無線信号パケットの伝送品質に影響を与える重要な要素である。無線インターフェース技術は物理層において、高速クローズドループパワー制御、クローズドループ送信ダイバーシチ、ＡＲＱ（自動再送要求（Ａｕｔｏｍａｔｉｃ　Ｒｅｔｒａｎｓｍｉｓｓｉｏｎ　Ｒｅｑｕｅｓｔ））等のフィードバック制御技術の採用を益々進めていることから、フィードバック制御性能を高める為に可能な限りフィードバック制御ループに固有の待ち時間を低減することが必要であり、従って無線信号パケット伝送におけるアップリンク及びダウンリンク伝送待ち時間は出来る限り低減しなければならない。

【0114】
パケット伝送の伝送待ち時間は、主にパケットパッキング待ち時間及びネットワーク伝送待ち時間から成るもので、ここでパケットパッキング待ち時間はパケット長により決まり、ネットワーク伝送待ち時間は主にネットワーク中のスイッチ／ルーティングノードのパケット転送待ち時間により決まる。加えて、受信側は待ち時間ジッタを廃除する為にパケットをバッファしなければならず、待ち時間ジッタが大きければ大きい程、受信バッファにより生じる待ち時間も長くなることから、待ち時間ジッタも総待ち時間に影響を与えるものである。本発明によれば、伝送待ち時間や待ち時間ジッタ等を低減する（ＱｏＳ性能の改善）為に、以下の方法を採用することが出来る。

【0115】
１）伝送効率の向上と、伝送待ち時間の低減との間のトレードオフにより、最も好適なパケット長を選択する（例えばパケットペイロード部の無線信号データストリームのセグメント長とする等）。統計的にパケット長を設定することの他に、実際に計測された伝送待ち時間又はＲＴＴに基づいてパケット長を動的に変化させることにより、特定の伝送待ち時間条件に合わせることが出来る。

【0116】
２）無線信号パケット伝送におけるアップリンク及びダウンリンクデータストリームの量は比較的に固定されており、周知でもある為、ネットワーク構築及びネットワーク設定においてトラヒックの伝送経路及びスイッチ／ルーティングノードのパケット転送ポリシーの計画及び最適化を実施することにより、伝送待ち時間及び待ち時間ジッタを可能な限り低減することが出来る。この対策は、ＭＰＬＳに基づく伝送方式に、特に適用可能である。

【0117】
３）ネットワーク中の無線信号パケット伝送に関わるトラヒック以外にも、他のトラヒック（少なくとも無線信号パケット伝送自体のリンク制御管理パケットが含まれる）が存在することから、ＱｏＳの制御機構、代表的にはディフサーブ（ＤｉｆｆＳｅｒｖ）の分割機構（サービスの差別化）、ＭＰＬＳにおけるＦＥＣ（フォワードエキバレントクラス（Ｆｏｒｗａｒｄ　Ｅｑｕｉｖａｌｅｎｔ　Ｃｌａｓｓ））等を使って無線信号データストリームを搬送するパケットをなるべく高いＱｏＳレベルに設定することにより、そのＱｏＳ性能を保証する。

【0118】
４）無線信号パケット伝送においては、無線信号データストリームを搬送する為のパケットの他にも、無線信号のパケット伝送（Ｒａｄｉｏ　Ｏｖｅｒ　Ｐａｃｋｅｔ）リンク制御及び管理、ＲＴＣＰ、ＬＤＰ、ＲＲＵ処理メンテナンス等といった様々な管理制御パケットを含む他のパケットが存在する。無線信号データストリーム伝送のＱｏＳ性能を保証する為には、無線信号のパケット伝送（Ｒａｄｉｏ　Ｏｖｅｒ　Ｐａｃｋｅｔ）リンク伝送パケットの送信側がパケットを伝送する場合、優先順位に基づくパケットスケジューリングを実施することにより、無線信号データストリームを搬送するパケットが最も高い優先順位で送られなければならない。

【0119】
先に説明したように、ペイロードヘッダ及びＲＴＰヘッダの関連フィールド、ＲＴＣＰ等を使って伝送待ち時間（同等にＲＴＴ）、待ち時間ジッタ、パケット喪失等のＱｏＳ性能をリアルタイムで監視することは可能である。異常があった場合、対応する異常処理及び適応処理を実施し、無線信号パケット伝送のＱｏＳ性能を保証することが出来る。
【0120】
移動通信システムにおいては、基地局内の無線周波数ユニットの周波数安定性条件は高く、時に０．０５ｐｐｍの精度を要求される。従って、ＲＲＵは高い安定性を持つ周波数基準を取得しなければならない。これと同時に、デジタル無線信号データストリームは無線信号パケット伝送におけるパケットを通じて受信側へと伝送されることから、元のビットタイミング情報はパケット伝送後に失われる。受信側にて無線信号データストリームを再構築するには、デジタル無線信号データストリームのビットタイミング情報を回復、又は取得する必要がある。また、無線基地局を支持する負荷分散構造においては、基地局は既存技術を通じて高い安定性を持つ同期クロック信号を取得することが出来る為、通常はクロックの回復を実施する必要がない。
【0121】
遠隔無線周波数ユニットに基づく基地局システムにおいては、ＭＵは常に高い安定性を持つ周波数基準を取得することが出来、ＲＲＵはそれに同期した、高い安定性を持つクロックを回復又は取得する必要がある。一方で、必要とされる周波数基準が無線周波数部へと提供される一方、ダウンリンクデジタル無線信号データストリームが再構築され、アップリンク方向の無線信号データストリームの生成の為に利用される。この為には、ＲＲＵが必要とするデジタル無線信号データストリームのビットタイミング及び高い安定性を持つ周波数基準を取得する為の、可能な二つの異なる方法を採用することが出来る。一つは、共通グローバルクロックを採用することである。代表的な実施方法は、ＭＵ及びそれぞれのＲＲＵが全てＧＰＳ（グローバルポジショニングシステム（Ｇｌｏｂａｌ　Ｐｏｓｉｔｉｏｎｉｎｇ　Ｓｙｓｔｅｍ））から高い安定性を持つ周波数基準を取得し、それをデジタル無線信号データストリームのサンプリングクロックソースとするというものである。他方は、伝送された連続データストリームの固定ビットレートの特徴を利用することにより、位相ロックループ（ＰＬＬ）を通じて一定したデータストリームのクロックを回復する適応型クロックリカバリ技術を採用することである。米国特許第６，７３１，６４９号、“ＴＤＭ　ｏｖｅｒ　ＩＰ（ＩＰ回線エミュレーションサービス（ＩＰ　Ｃｉｒｃｕｉｔ　Ｅｍｕｌａｔｉｏｎ　Ｓｅｒｖｉｃｅ））”は、そのような技術を採用している。
【0122】
遠隔無線周波数ユニットに基づく基地局システムにおいては、ＲＲＵ及びＭＵ間にはデジタル無線信号データストリームの他に対応する管理制御クラス情報があり、これがパケットネットワークにより伝送される。
【0123】
１）無線信号のパケット伝送（Ｒａｄｉｏ　Ｏｖｅｒ　Ｐａｃｋｅｔ）リンク制御、管理及びメンテナンス信号送信：リンク確立、変更及び削除、処理モードネゴシエーション、レートネゴシエーション、ペイロードフォーマットネゴシエーション、リンク監視等を含む。
【0124】
２）ＲＲＵのそれぞれの無線周波数モジュールのパラメータ設定、状態監視、警告等。
【0125】
３）ＲＲＵの処理メンテナンス情報：ソフトウェア／ファームウェアのアップグレードやコンフィギュレーション管理等。
【0126】
４）パケット伝送技術に関するプロトコル：ＲＴＣＰ、ＬＤＰ、ＩＧＭＰ（インターネットグループ管理プロトコル）、ＱｏＳに関連する制御プロトコル等。
【0127】

無線信号のパケット伝送（Ｒａｄｉｏ　Ｏｖｅｒ　Ｐａｃｋｅｔ）リンク制御、管理及びメンテナンス信号送信及びＲＲＵの処理メンテナンス情報は、代表的にはＴＣＰ（伝送制御プロトコル）／ＩＰ上の専用制御プロトコル中で搬送することが出来るもので、また、これはＵＤＰ／ＩＰ上のＳＮＭＰ（簡易ネットワーク管理プロトコル）においても搬送し、対応するＭＩＢ（管理情報ベース）を定義することが可能であり、ＲＲＵの処理メンテナンス情報は代表的にはＵＤＰ／ＩＰ上のＳＮＭＰ中で搬送することが出来る。

【0128】

当業者には周知のように、上述した具体的フォーマット、値及び実施例は単に例示したに過ぎず、本発明を限定するものではない。当業者であれば、本明細書の説明に基づいて他の変更を加えた実施例や変化形態を得ることができる。

【図面の簡単な説明】

【0129】

【図1a】無線アクセスネットワークの構造を示す概略図である。

【図1b】従来の基地局の構造を示す概略図である。

【図2】遠隔無線周波数ユニットに基づく集中基地局システムの構造を示すブロック図である。

【図3a】本発明の一実施例に基づく、ＲＴＰ層を含むＩＰ送信カプセル化構造を示す図である。

【図3b】本発明の一実施例に基づく、ＲＴＰ層を含まないＩＰ送信カプセル化構造を示す図である。

【図4a】本発明の一実施例に基づく、ＲＴＰ層を含むＭＰＬＳ送信カプセル化構造を示す図である。

【図4b】本発明の一実施例に基づく、ＲＴＰ層を含まないＭＰＬＳ送信カプセル化構造を示す図である。

【図5a】本発明の一実施例に基づく、ＲＴＰ層を含むＭＰＬＳ－ｉｎ－ＩＰ送信カプセル化構造を示す図である。

【図5b】本発明の一実施例に基づく、ＲＴＰ層を含まないＭＰＬＳ－ｉｎ－ＩＰ送信カプセル化構造を示す図である。

【図6】本発明の一実施例において利用されるＵＤＰヘッダ構造を示す図である。

【図7】本発明の一実施例において利用されるＲＴＰヘッダ構造を示す図である。

【図8】本発明の一実施例において利用されるＭＰＬＳラベルエントリ構造を示す図である。

【図9】本発明の推奨される実施例において利用されるペイロードヘッダ構造を示す図である。

【図10】本発明の推奨される実施例において利用されるＩ／Ｑデータペイロードのカプセル化構造を示す図である。

【図11】無線フレームタイミング及びＲＴＴの計測を示す概略図である。

【図12a】ＲＲＵ待ち時間修正の概略図である。

【図12b】ＲＲＵ待ち時間修正の概略図である。

【図13a】本発明の一実施例に基づく無線信号パケット送信システムを描いた概略ブロック図である。

【図13b】本発明の一実施例に基づく無線信号パケット受信システムを描いた概略ブロック図である。

【図14a】本発明の一実施例に基づく無線信号パケット送受信それぞれのフローチャートである

【図14b】本発明の一実施例に基づく無線信号パケット送受信それぞれのフローチャートである

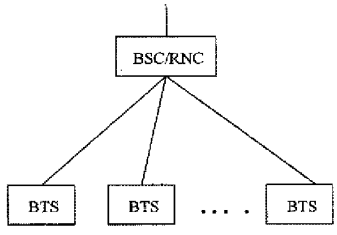
【符号の説明】

【0130】

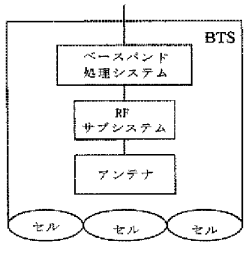
１０　集中基地局

１１　チャネル処理ユニット
１３　遠隔無線周波数ユニット

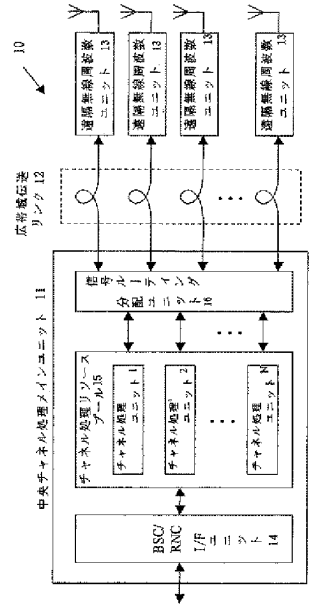
【図1a】



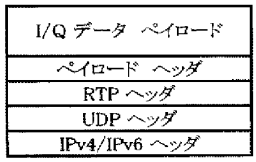
【図1b】



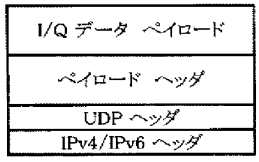
【図2】



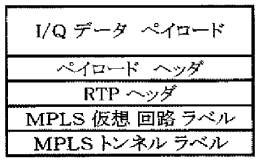
【図3a】



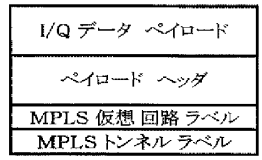
【図3b】



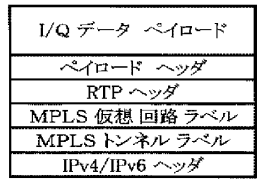
【図4a】



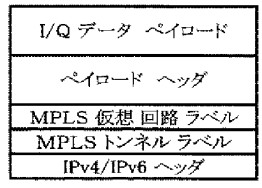
【図4b】



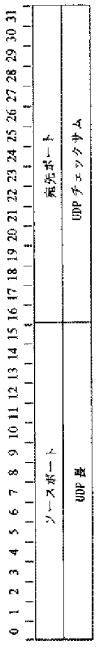
【図5a】



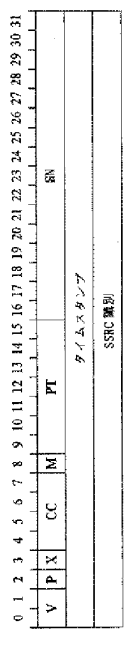
【図5b】



【図6】

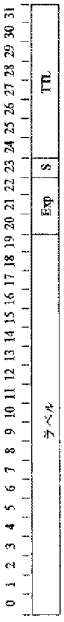


【図7】

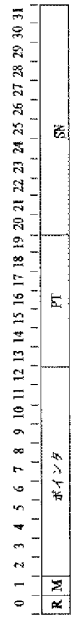


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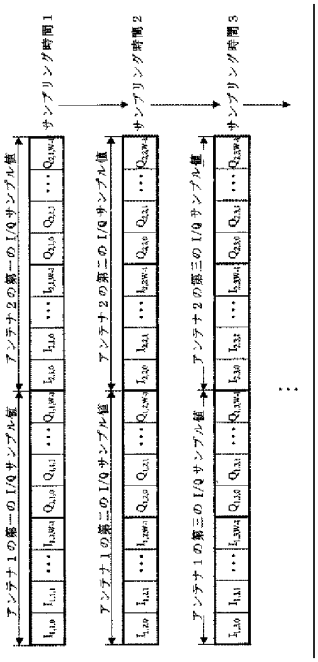
【図８】


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ラベル
Exp
S
TTL

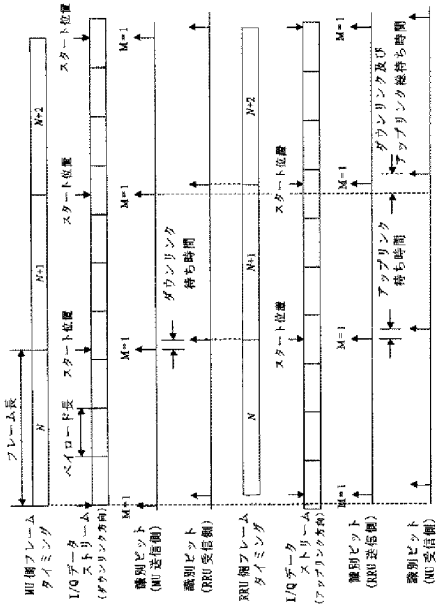
【図９】


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R
M
ポインタ
PT
SN

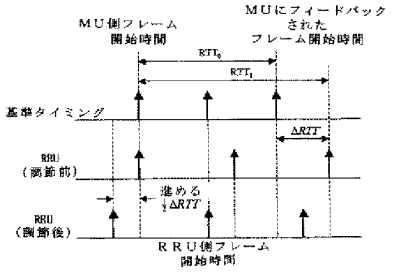
【図１０】


アンテナ１の第一のI/Qサンプル値
アンテナ２の第一のI/Qサンプル値
サンプリング時間１
アンテナ１の第二のI/Qサンプル値
アンテナ２の第二のI/Qサンプル値
サンプリング時間２
アンテナ１の第三のI/Qサンプル値
アンテナ２の第三のI/Qサンプル値
サンプリング時間３

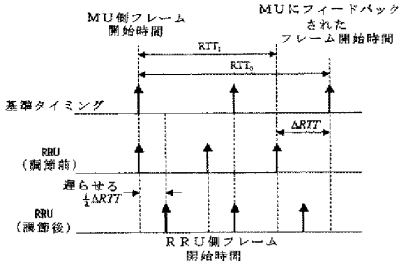
【図１１】


MU側フレーム タイミング
I/Qデータ ストリーム (ダウンリンク方向)
識別ビット (MU送信側)
識別ビット (RRU受信側)
RRU側フレーム タイミング
I/Qデータ ストリーム (アップリンク方向)
識別ビット (RRU送信側)
識別ビット (MU受信側)
フレーム長
N
ペイロード長
スタート位置
M=1
M=2
ダウンリンク 待ち時間
アップリンク 待ち時間
ダウンリンク及び アップリンク維持ち時間

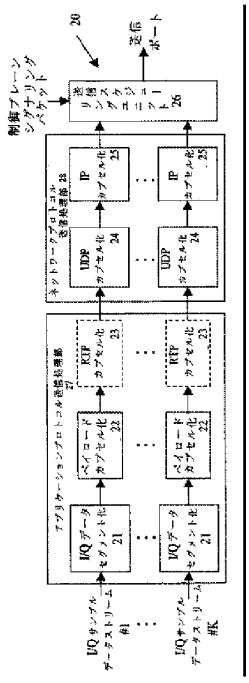
【図12a】



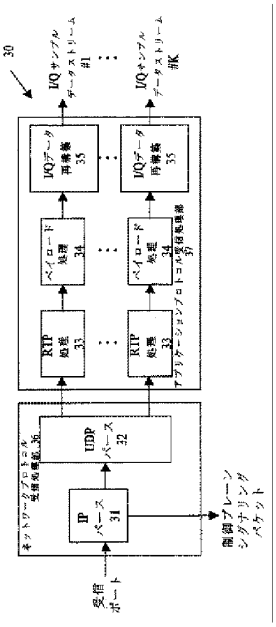
【図12b】



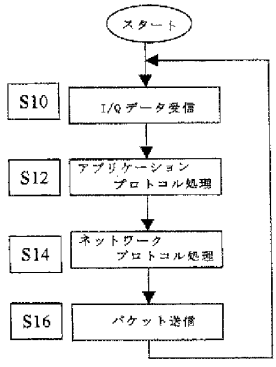
【図13a】



【図13b】

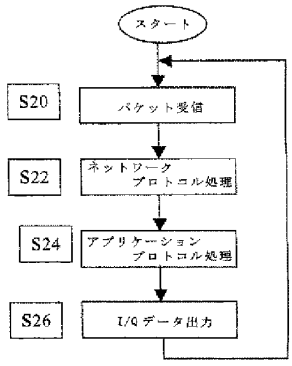


【図14a】



T-Mobile Ex. 1037

【図14b】


スタート
S20
パケット受信
S22
ネットワーク
プロトコル処理
S24
アプリケーション
プロトコル処理
S26
I/Oデータ出力

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2004/000801

A. CLASSIFICATION OF SUBJECT MATTER

IPC7:H04Q7/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7:H04Q

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

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

CNPAT,WPI,EPODOC,PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1288628 A (NOKIA NETWORKS LIMTED.CO) 21.Mar.2001(21.03.2001) full document.	1-34
A	US6594496 B1(LGC WIRELESS INC) 15.Jul.2003(15.07.2003) full document	1-34

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

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 Mar. 2005 (30.03.2005)	21 · APR 2005 (21 · 04 · 2005)
Name and mailing address of the ISA/ 6 Xitucheng Rd., Jimen Bridge, Haidian District, 100088 Beijing, China Facsimile No. 86-10-62019451	Authorized officer Wu Xingqiang Telephone No. 86-10-62084574

Form PCT/ISA /210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2004/000801

Patent document Cited in search report	Publication date	Patent family member(s)	Publication date
CN1288628 A	2001.03.21	JP2002501333T	2002.01.15
		WO9935800 A2	1999.07.15
		FI9800024 A	1999.07.08
		AU1880099 A	1999.07.26
		NO200003480 A	2000.07.06
		EP1058989 A2	2000.12.13
		US6292891 B1	2001.09.18
US6594496 B2	2003.07.15	US2002037730 A1	2002.03.28
		AU200139934 A	2001.11.12
		WO0184865 A1	2001.11.08

Form PCT/ISA /210 (patent family annex) (January 2004)

国际检索报告	国际申请号 PCT/CN2004/000801

A. 主题的分类

IPC7:H04Q7/00

按照国际专利分类表(IPC)或者同时按照国家分类和 IPC 两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC7:H04Q

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词（如使用）)

CNPAT,WPI,EPODOC,PAJ

C. 相关文件

类　型*	引用文件，必要时，指明相关段落	相关的权利要求
A	CN1288628 A (诺基亚网络有限公司) 21.3 月 2001(21.03.2001)，全文	1—34
A	US6594496 B2 ▲ (LGC 无线公司) 15.7 月 2003(15.07.2003)， 全文	1—34

☐ 其余文件在 C 栏的续页中列出。　　☒ 见同族专利附件。

* 引用文件的具体类型：
"A" 认为不特别相关的表示了现有技术一般状态的文件
"E" 在国际申请日的当天或之后公布的在先申请或专利
"L" 可能对优先权要求构成怀疑的文件，为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件
"O" 涉及口头公开、使用、展览或其他方式公开的文件
"P" 公布日先于国际申请日但迟于所要求的优先权日的文件
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"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性
"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性
"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
30. 3 月 2005（30. 03. 2005）	21·4月 2005 (21·04·2005)
中华人民共和国国家知识产权局(ISA/CN) 中国北京市海淀区蓟门桥西土城路 6 号 100088 传真号：　(86-10)62019451	授权官员 吴兴福 电话号码：(86-10)62084574

PCT/ISA/210 表(第 2 页)(2004 年 1 月)

国际检索报告
关于同族专利的信息

国际申请号
PCT/CN2004/000801

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN1288628 A	2001.03.21	JP2002501333T	2002.01.15
		WO9935800 A2	1999.07.15
		FI9800024 A	1999.07.08
		AU1880099 A	1999.07.26
		NO200003480 A	2000.07.06
		EP1058989 A2	2000.12.13
		US6292891 B1	2001.09.18
US6594496 B2	2003.07.15	WO0184865 A1	2001.11.08
		AU200139934 A	2001.11.12
		US2002037730 A1	2002.03.28

PCT/ISA/210 表(同族专利附件)(2004 年 1 月)

(81)指定国　　AP(BW,GH,GM,KE,LS,MW,MZ,NA,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),
EP(AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,HU,IE,IT,LU,MC,NL,PL,PT,RO,SE,SI,SK,TR),OA(BF,BJ,CF,CG,
CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BW,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,
DE,DK,DM,DZ,EC,EE,EG,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,M
A,MD,MG,MK,MN,MW,MX,MZ,NA,NI,NO,NZ,OM,PG,PH,PL,PT,RO,RU,SC,SD,SE,SG,SK,SL,SY,TJ,TM,TN,TR,TT,TZ,UA,UG
,US,UZ,VC,VN,YU,ZA,ZM,ZW

（特許庁注：以下のものは登録商標）
１．イーサネット

(72)発明者　リゥ　シュン
中華人民共和国　５１８０５７，グァンドンシャン　シェンジェンシュ　ナンシャンチュ　ガオシ
ンジシュチャンイェユアン　リェンシャンダシャサンロウ

Ｆターム(参考) 5K030 HB11　HB25　HB28　HC01　HC09　JA05　JL01　JL08
5K067 BB01　BB21　CC08　EE10　EE16　HH21

【要約の続き】
ンプルを含むことを表す場合に、前記データセグメント中の前記データサンプルの位置を表す第四の情報と、を含むステップと、生成された前記アプリケーションプロトコルパケットを、ネットワーク伝送プロトコルに準じてネットワークプロトコルパケットへとカプセル化し、それらを所定のあて先へと伝送するステップと、を含む。
前記ネットワークプロトコルパケットは更に、前記１つ以上のブランチのうちの前記パケットが属する１つを識別する第五の情報を含み、前記第五の情報とネットワーク伝送ソースアドレス及びあて先アドレスが前記ブランチを一意に識別する。

(12) 特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2010 年 8 月 5 日(05.08.2010)

PCT

(10) 国際公開番号
WO 2010/087031 A1

(51) 国際特許分類:
H04W 16/28 (2009.01) *H04W 88/02* (2009.01)

(21) 国際出願番号: PCT/JP2009/052008

(22) 国際出願日: 2009 年 1 月 30 日(30.01.2009)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(71) 出願人 (米国を除く全ての指定国について): 株式会社日立製作所 (HITACHI, LTD.) [JP/JP]; 〒1008280 東京都千代田区丸の内一丁目 6 番 6 号 Tokyo (JP).

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(75) 発明者/出願人 (米国についてのみ): 小野豪 (ONO, Go) [JP/JP]; 〒1858601 東京都国分寺市東恋ヶ窪一丁目 280 番地 株式会社日立製作所中央研究所内 Tokyo (JP). 藤嶋堅三郎(FUJISHIMA, Kenzaburo) [JP/JP]; 〒1858601 東京都国分寺市東恋ヶ窪一丁目 280 番地 株式会社日立製作所中央研究所内 Tokyo (JP). 高田芽衣(TAKADA, May) [JP/JP]; 〒1858601 東京都国分寺市東恋ヶ窪一丁目 280 番地 株式会社日立製作所中央研究所内 Tokyo (JP). 上野幸樹 (UWANO, Koki) [JP/JP]; 〒2448567 神奈川県横浜市戸塚区戸塚町 216 番地 株式会社日立コミュニケーションテクノロジー キャリアネットワーク事業部内 Kanagawa (JP).

(74) 代理人: 後藤政喜(GOTO, Masaki); 〒1000013 東京都千代田区霞が関三丁目 3 番 1 号 尚友会館 Tokyo (JP).

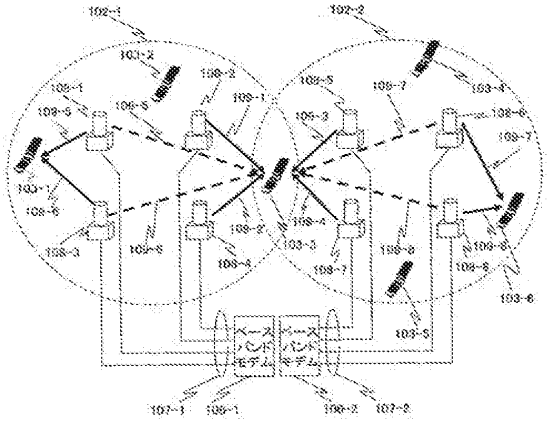
(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[続葉有]

(54) Title: WIRELESS COMMUNICATION SYSTEM AND COMMUNICATION CONTROL METHOD

(54) 発明の名称 : 無線通信システム及び通信制御方法

図2



(57) **Abstract:** In a wireless communication system, a plurality of base stations each comprise a plurality of cells and a terminal communicates with the base stations. Each of the base stations is equipped with one or a plurality of antennas. The base stations transmit first reference signals that do not overlap with at least those of neighborhood base stations and are unique to the antennas. The terminal receives the first reference signals, estimates the reception powers of the first reference signals transmitted from the respective antennas, selects, based on the estimation results of the reception powers, a plurality of the antennas suitable for communication, and transmits the antenna selection results to the base stations. The base stations refer to the antenna selection results transmitted from the terminal to assign the antennas belonging to the different cells to the terminal and notify the terminal of the results of assigning the antennas.

(57) 要約: 複数の基地局が各々複数のセルを構成し、１台の端末が前記複数の基地局と通信する無線通信システムであって、前記各基地局は、１又は複数のアンテナを備え、前記基地局は、少なくとも近傍の基地局間では重複しないアンテナ固有の第１の参照信号を送信し、前記端末は、前記第１の参照信号を受信して、前記アンテナ毎の前記第１の参照信号の受信電力を推定し、前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、前記アンテナの選択結果を前記基地局に送信し、前記基地局は、前記端末から送信された前記アンテナの選択結果を参照して、異なるセルに属する前記複数のアンテナを前記端末に割り当て、前記アンテナの割当結果を前記端末に通知する。

WO 2010/087031 A1

(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), ヨーロッパ (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:

— 国際調査報告（条約第 21 条(3)）

明　細　書

発明の名称

無線通信システム及び通信制御方法

技術分野

本発明は、無線通信システムに関し、特に、端末が複数の基地局と通信する無線通信システムに関する。

背景技術

図３１は、従来のセルラシステムを説明する図である。

二つの基地局（１０１－１、１０１－２）が、各々、セル（１０２－１、１０２－２）を形成する。セル１０２－１内の３台の端末（１０３－１、１０３－２、１０３－３）は、基地局１０１－１と通信し、セル１０２－２内の３台の端末（１０３－４、１０３－５、１０３－６）は、基地局１０１－２と通信する。

各基地局及び各端末は、複数のアンテナを備える。各基地局は、ある瞬間において、その基地局によって形成されるセルに所属する１台の端末とＭＩＭＯ（Ｍｕｌｔｉｐｌｅ　Ｉｎｐｕｔ　Ｍｕｌｔｉｐｌｅ　Ｏｕｔｐｕｔ）通信をする。なお、ＯＦＤＭＡ（Ｏｒｔｈｇｏｎａｌ　Ｆｒｅｑｕｅｎｃｙ　Ｄｉｖｉｓｉｏｎ　Ｍｕｌｔｉｐｌｅ　Ａｃｃｅｓｓ）等のマルチキャリア通信システムでは、各キャリアが互いに直交性を持っているため、キャリア毎に異なる端末とＭＩＭＯ通信をすることができるが、ここでは簡単のため、シングルキャリアの通信システムを仮定して説明する。

図３１は、ある時刻におけるスナップショットを示しており、基地局１０１－１は端末１０３－３と、信号１０４－１を所望信号として、シングルユーザＭＩＭＯ通信をし、基地局１０１－２は端末１０３－４と、信号１０４－２を所望信号として、シングルユーザＭＩＭＯ通信をしている。このシングルユーザＭＩＭ

○通信は、いわゆる第３．９世代のセルラシステムで採用が決まっており、そのプロトコルは、"Physical layer procedures (Release 8)", 3GPP TSG RAN, 3GPP TS36.213 ver8.4.0, pp.18-43, 2008/9に開示されている。

ただし、無線信号は他の端末にも到達するので、無線信号の漏れ込みによる干渉が発生する。具体的には、基地局１０１－２から端末１０１－３に対する干渉１０５－１、及び、基地局１０１－１から端末１０３－４に対する干渉１０５－２が発生する。

端末１０３－４のように、所望信号１０４－２の伝搬距離と干渉信号１０５－２の伝搬距離とに大きな差がある状態では、干渉信号１０５－２の伝搬減衰によって、干渉は問題にならない。しかし、端末１０３－３のように所望信号１０４－１の伝搬距離と干渉信号１０５－１の伝搬距離とに差が小さい状態では、所望信号１０４－１と干渉信号１０５－１との間の伝搬減衰量は同程度なので、所望信号１０４－１の電界強度と干渉信号１０５－１の電界強度との差が小さい。従って、セル間干渉が深刻な問題となる。

図３２は、近年注目されているセルラシステムを説明する図である。図３２に示すシステムは、前述したセル間干渉の問題を解決する無線通信システムとして、"Inter-cell Radio Resource Management for Heterogeneous Network", NTT DoCoMo, 3GPP TSG RAN WG1, R1-083019, 2008/8に開示されている。

従来、基地局に設置されていたベースバンドモデム（１０６－１、１０６－２）をセル（１０２－１、１０２－２）とは別の場所に設置し、セルにはシンプルな無線送受信機であるＲＲＵ（Ｒｅｍｏｔｅ　Ｒａｄｉｏ　Ｕｎｉｔ）が配置される。

この構成の第１の特徴は、ベースバンドモデム（１０６－１、１０６－２）を集中化することによってセル間で連携した信号処理ができるため、セル間干渉を低減することができる。また、第２の特徴は、ＲＲＵ（１０８－１～１０８－８）はセルカバレッジを確保するために面状に分散して配置される。さらに、第３の特徴は、ベースバンドモデム１０６とＲＲＵ１０８とは光ファイバ（１０７

－１、１０７－２）によって接続され、ベースバンドモデム１０６とＲＲＵ１０８との間は、ＣＰＲＩ（Ｃｏｍｍｏｎ　Ｐｕｂｌｉｃ　Ｒａｄｉｏ　Ｉｎｔｅｒｆａｃｅ）規格に従ってベースバンド信号が伝送される。なお、このシステムにおいて、セル１０２－１は、ベースバンドモデム１０６－１が管理する４台のＲＲＵ（１０８－１、１０８－２、１０８－３、１０８－４）によって形成される。セル１０２－２も同様に、ベースバンドモデム１０６－２が管理する４台のＲＲＵ（１０８－５、１０８－６、１０８－７、１０８－８）によって形成される。

すなわち、図３２に示すシステムでは、ベースバンドモデム１０６を集中化することによって、セル１０２間のベースバンド信号の処理連携が容易となり、端末が複数の基地局と通信するＮｅｔｗｏｒｋ　ＭＩＭＯを容易に実現することができる。

発明の概要

以上説明したように、端末にとって望ましい（端末への伝搬距離が短い）アンテナを選択することがセル間干渉低減に有効であることから、Ｎｅｔｗｏｒｋ　ＭＩＭＯはセル間干渉を低減して、通信品質を向上させる効果がある。すなわち、セル境界の端末１０３－３のセル間干渉を低減するためには、伝搬距離が短いＲＲＵ（１０８－２、１０８－４、１０８－５、１０８－７）と通信することが望ましい。しかし、選択された４台のＲＲＵのうち、２台のＲＲＵ（１０８－２、１０８－４）はベースバンドモデム１０６－１によって管理され、他の２台のＲＲＵ（１０８－５、１０８－７）はベースバンドモデム１０６－２によって管理されている。従来のプロトコルでは、端末は１つのセルをサービングセルとして、セル内のアンテナのみを使用して（１台のベースバンドモデムによって制御されるＲＲＵと）通信することができるのみで、複数セルに跨ってアンテナを選択することができなかった。

しかし、Ｎｅｔｗｏｒｋ　ＭＩＭＯを実現するために、複数セルに跨ってアンテナを選択するための具体的な通信手順は提案されていなかった。特に、セルの

枠に囚われずに、端末にとって最適なアンテナを選択することが、Ｎｅｔｗｏｒｋ　ＭＩＭＯの効果を生じるために重要であるが、このアンテナ選択に関する具体的な方法は提案されていなかった。すなわち、従来は、セル境界付近の端末に複数基地局のアンテナを割り当てることによって、セル境界付近の端末の通信品質を向上するための具体的手順は提案されていなかった。

本発明は、無線通信システムにおいて通信品質の劣化を招くセル間干渉を低減するため、セルの枠組みに囚われず、端末にとって最適な基地局アンテナを割り当てるための具体的手順を提案することを目的とする。

本発明の代表的な一例を示せば以下の通りである。すなわち、複数の基地局が各々複数のセルを構成し、１台の端末が前記複数の基地局と通信する無線通信システムであって、前記各基地局は、１又は複数のアンテナを備え、前記基地局は、少なくとも近傍の基地局間では重複しないアンテナ固有の第１の参照信号を送信し、前記端末は、前記第１の参照信号を受信して、前記アンテナ毎の前記第１の参照信号の受信電力を推定し、前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、前記アンテナの選択結果を前記基地局に送信し、前記基地局は、前記端末から送信された前記アンテナの選択結果を参照して、異なるセルに属する前記複数のアンテナを前記端末に割り当て、前記アンテナの割当結果を前記端末に通知することを特徴とする。

本発明の別な一形態では、複数の基地局が各々複数のセルを構成し、１台の端末が前記複数の基地局と通信する無線通信システムにおいて、前記各基地局は、１又は複数のアンテナを備え、前記端末は、端末固有の第２の参照信号を送信し、前記基地局は、前記第２の参照信号を受信して、前記アンテナ毎に前記第２の参照信号の受信電力を推定し、前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、前記アンテナの選択結果を参照して、異なるセルに属する複数の前記アンテナを前記端末に割り当て、前記アンテナの割当結果を前記端末に通知することを特徴とする。

本発明の実施の形態によると、セル間干渉を低減することができる。このため、

セル境界付近の端末の通信品質を向上することができる。すなわち、セル境界における周波数利用効率を改善し、端末間で提供されるサービス品質の差を小さくすることができる。

図面の簡単な説明

図１は、本発明の第１の実施の形態の無線通信システムのネットワーク構成を示す図である。

図２は、本発明の第１の実施の形態の無線通信システムの構成を示す図である。

図３Ａは、本発明の第１の実施の形態のベースバンドモデムとＲＲＵとの間を光ファイバで接続した場合の構成を示ブロック図である。

図３Ｂは、本発明の第１の実施の形態のベースバンドモデムとＲＲＵとの間を同軸ケーブルで接続した場合の構成を示すブロック図である。

図３Ｃは、本発明の第１の実施の形態のベースバンドモデムとＲＲＵとの間を無線リンクで接続した場合の構成を示すブロック図である。

図４は、本発明の第１の実施の形態の無線通信システムにおける下り通信時の各ノードの動作を示すシーケンス図である。

図５は、本発明の第１の実施の形態の無線通信システムにおける上り通信時の各ノードの動作を示すシーケンス図である。

図６は、本発明の第１の実施の形態のベースバンドモデム及びその周辺の構成を示すブロック図である。

図７は、本発明の第１の実施の形態のベースバンド信号生成部の構成を示すブロック図である。

図８は、本発明の第１の実施の形態のデータ・制御信号分離の構成を示すブロック図である。

図９は、本発明の第１の実施の形態の長区間平均電力推定部の構成を示すブロック図である。

図１０は、本発明の第１の実施の形態のモデム制御部の構成を示すブロック図

である。

図１１は、本発明の第１の実施の形態のＰＡＩバッファに格納された内容を示す説明図である。

図１２は、本発明の第１の実施の形態の電力推定結果バッファに格納された内容を示す説明図である。

図１３は、本発明の第１の実施の形態の端末の構成を示すブロック図である。

図１４Ａは、本発明の第１の実施の形態の基地局側から端末へ通知されるＲＲＵアサイン情報を示す説明図である。

図１４Ｂは、本発明の第１の実施の形態の基地局側から端末へ通知されるＲＲＵアサイン情報を示す説明図である。

図１５は、本発明の第１の実施の形態の下りＲＲＵマッピング部及び上りＲＲＵマッピング部の共通の処理を示すフローチャートである。

図１６は、本発明の第１の実施の形態のＲＲＵ割当結果を説明する図である。

図１７は、本発明の第１の実施の形態の下りＲＲＵマッピング部及び上りＲＲＵマッピング部の共通の処理の変形例を示すフローチャートである。

図１８は、本発明の第１の実施の形態のＲＲＵ割当結果を説明する図である。

図１９Ａは、本発明の第１の実施の形態のＰＡＩフィードバックの内容を示す説明図である。

図１９Ｂは、本発明の第１の実施の形態のＰＡＩフィードバックの内容を示す説明図である。

図１９Ｃは、本発明の第１の実施の形態のＰＡＩフィードバックの内容を示す説明図である。

図２０Ａは、本発明の第１の実施の形態のＲＲＵ個別参照信号の挿入例を示す説明図である。

図２０Ｂは、本発明の第１の実施の形態のＲＲＵ個別参照信号の別の挿入例を示す説明図である。

図２０Ｃは、本発明の第１の実施の形態のＲＲＵ個別参照信号の別の挿入例を

示す説明図である。

図２１Ａは、本発明の本発明の第１の実施の形態の効果を説明する図である。

図２１Ｂは、本発明の本発明の第１の実施の形態の効果を説明する図である。

図２２は、本発明の第２の実施の形態の無線通信システムのネットワーク構成を示す図である。

図２３は、本発明の第２の実施の形態の無線通信システムにおける下り通信時の各ノードの動作を示すシーケンス図である。

図２４は、本発明の第２の実施の形態の無線通信システムにおける上り通信時の各ノードの動作を示すシーケンス図である。

図２５は、本発明の第２の実施の形態のベースバンドモデム及びその周辺の構成を示すブロック図である。

図２６は、本発明の第２の実施の形態のベースバンド信号生成部の構成を示すブロック図である。

図２７は、本発明の第２の実施の形態のモデム－ＲＲＵ間スイッチの構成を示すブロック図である。

図２８は、本発明の第２の実施の形態のＲＲＵ割当結果を説明する図である。

図２９は、本発明の第２の実施の形態のＲＲＵ割当結果を説明する図である。

図３０は、本発明の第２の実施の形態のＲＲＵ割当結果を説明する図である。

図３１は、従来のセルラシステムを説明する図である。

図３２は、近年注目されているセルラシステムを説明する図である。

発明を実施するための形態

＜第１実施形態＞

図１は、第１の実施の形態の無線通信システムのネットワーク構成を示す図である。

第１の実施の形態の無線通信システムは、ゲートウェイ１１１、モデム制御手段１１２、ベースバンドモデム１０６－１、１０６－２、…（以下、ベースバン

ドモデムを区別する必要がない場合は、単に１０６と記載する）、及び、ＲＲＵ（Ｒｅｍｏｔｅ　Ｒａｄｉｏ　Ｕｎｉｔ）１０８－１、１０８－２、…（以下、ＲＲＵを区別する必要がない場合は、単に１０８と記載する）を備える。本実施の形態の無線通信システムは、複数のベースバンドモデム１０６を備えるが、１台のベースバンドモデム１０６を備えてもよい。また、本実施の形態の無線通信システムは、複数のＲＲＵ１０８を備えるが、複数のベースバンドモデム１０６を備える場合には、各々のベースバンドモデム１０６に対し１台のＲＲＵ１０８を備えてもよい。

ゲートウェイ１１１は、コアネットワーク１１０と無線アクセスネットワーク（ゲートウェイ１１１より下層）とを接続し、無線アクセスネットワークを終端するノードであり、ネットワーク間でプロトコルを変換する。

モデム制御手段１１２は、ゲートウェイ１１１とモデム１０６との間のデータフローを制御する。なお、適切なＲＲＵ１０８は端末１０３毎に異なるため、端末１０３毎にデータを転送するＲＲＵ１０８が管理される。この制御のために、プロセッサ（ＣＰＵ、ＤＳＰ等）、論理回路（ＡＳＩＣ、ＦＰＧＡ等）を用いるとよい。モデム制御手段１１２は、複数のベースバンドモデム（１０６－１、１０６－２、…）を管理する。

ベースバンドモデム１０６は、ＩＰパケットと無線ベースバンド信号との間のプロトコルを変換する装置である。このプロトコル変換のため、モデム制御手段１１２と同様に、プロセッサ及び／又は論理回路を用いるとよい。無線信号のプロトコルは、標準化団体で標準化された規格（例えば、前述した"Inter-cell Radio Resource Management for Heterogeneous Network"に記載されるＬＴＥ（Ｌｏｎｇ　Ｔｅｒｍ　Ｅｖｏｌｕｔｉｏｎ））に準拠する。

各ベースバンドモデム１０６は、複数のＲＲＵ１０８を管理する。ベースバンドモデム１０６とＲＲＵ１０８との間は光ファイバ又は同軸ケーブルで接続する。なお、ケーブル等を用いた有線による接続に代わって、ベースバンドモデム１０６及びＲＲＵ１０８の双方に無線通信機を備え、無線リンクによってベースバン

ドモデム１０６とＲＲＵ１０８との間を接続をしてもよい。ベースバンドモデム１０６とＲＲＵ１０８との間の接続は、図３Ａから図３Ｃを用いて後述する。ベースバンドモデム１０６とＲＲＵ１０８との間は、ＣＰＲＩ（Ｃｏｍｍｏｎ Ｐｕｂｌｉｃ Ｒａｄｉｏ Ｉｎｔｅｒｆａｃｅ）規格に従ってベースバンド信号が伝送される。

図２は、本発明の第１の実施の形態の無線通信システムの構成を示す図である。

複数のＲＲＵ（１０８－１、１０８－２、１０８－３、１０８－４）が、セル（１０２－１）を形成し、セル１０２－１内の端末と無線通信をする。すなわち、セル１０２－１内の３台の端末（１０３－１、１０３－２、１０３－３）は、ＲＲＵ（１０８－１、１０８－２、１０８－３、１０８－４）の一つ又は複数と通信する。

また、複数のＲＲＵ（１０８－５、１０８－６、１０８－７、１０８－８）が、セル（１０２－２）を形成し、セル１０２－２内の端末と無線通信をする。すなわち、セル１０２－２内の４台の端末（１０３－３、１０３－４、１０３－５、１０３－６）は、ＲＲＵ（１０８－５、１０８－６、１０８－７、１０８－８）の一つ又は複数と通信する。

各基地局及び各端末は、複数のアンテナを備える。各基地局は、ある瞬間において、その基地局によって形成されるセルに属する１台の端末とＭＩＭＯ（Ｍｕｌｔｉｐｌｅ Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ Ｏｕｔｐｕｔ）通信をする。なお、ＯＦＤＭＡ（Ｏｒｔｈｇｏｎａｌ Ｆｒｅｑｕｅｎｃｙ Ｄｉｖｉｓｉｏｎ Ｍｕｌｔｉｐｌｅ Ａｃｃｅｓｓ）等のマルチキャリア通信システムでは、各キャリアが互いに直交性を持っているため、キャリア毎に異なる端末とＭＩＭＯ通信をすることができるが、以下の説明では、説明を簡単にするため、シングルキャリアの通信システムについて説明する。なお、本発明はマルチキャリアの通信システムについても適用することができる。

ＲＲＵ（１０８－１～１０８－８）はセルカバレッジを確保するために面状に分散して配置される。

なお、図２に示すシステムにおいて、セル１０２－１は、ベースバンドモデム１０６－１が管理する４台のＲＲＵ（１０８－１、１０８－２、１０８－３、１０８－４）によって形成される。セル１０２－２も同様に、ベースバンドモデム１０６－２が管理する４台のＲＲＵ（１０８－５、１０８－６、１０８－７、１０８－８）によって形成される。

図３Ａから図３Ｃは、第１の実施の形態において、ベースバンドモデム１０６とＲＲＵ１０８との間を前述した各方法で接続した場合の、ベースバンドモデム１０６及びＲＲＵ１０８の構成を示すブロック図である。

図３Ａは、ベースバンドモデム１０６とＲＲＵ１０８との間を光ファイバで接続する場合の構成を示す。図３Ａに示すように、ＲＲＵ１０８は、ＤＡＣ９０１、ＡＤＣ９０２、アップコンバータ９０３、ダウンコンバータ９０４、パワーアンプ９０５、ローノイズアンプ９０６、デュプレクサ９０７及びアンテナ２０７を備える。

ＤＡＣ９０１は、アナログ信号をデジタル信号に変換する。ＡＤＣ９０２は、デジタル信号をアナログ信号に変換する。アップコンバータ９０３は、ベースバンド信号を無線周波数信号に変換する。ダウンコンバータ９０４は、無線周波数信号をベースバンド信号に変換する。パワーアンプ９０５は、送信信号を増幅する。ローノイズアンプ９０６は、受信信号を増幅する。デュプレクサ９０７は、下り信号と上り信号とを分離する。

図３Ｂは、ベースバンドモデム１０６とＲＲＵ１０８との間を同軸ケーブルで接続する場合の構成を示す。図３Ｂに示すように、ベースバンドモデム１０６は、ＤＡＣ９０１、ＡＤＣ９０２、アップコンバータ９０３及びダウンコンバータ９０４を備え、ＲＲＵ１０８は、パワーアンプ９０５、ローノイズアンプ９０６、デュプレクサ９０７及びアンテナ２０７を備える。ベースバンドモデム１０６及びＲＲＵ１０８に備わる各構成は、図３Ａを用いて説明した構成と同じである。

このように、ベースバンドモデム１０６とＲＲＵ１０８との間を同軸ケーブルで接続した場合は、両者を光ファイバで接続した場合と比較して、ＲＲＵ１０８

の構成は簡単になるため、システムを安価に構成できる。しかし、光ファイバにより接続した場合と比較して、同軸ケーブルによる信号のロスが大きいので、短距離の伝送に適している。

図３Ｃは、ベースバンドモデム１０６とＲＲＵ１０８との間を無線リンクによって接続する場合の構成を示す。図３Ｃに示すように、ベースバンドモデム１０６は、ＤＡＣ９０１、ＡＤＣ９０２、アップコンバータ９０３、ダウンコンバータ９０４、パワーアンプ９０５、ローノイズアンプ９０６、デュプレクサ９０７及びアンテナ２０７を備える。

ＲＲＵ１０８は、単純なリピータによって構成することができる。このようなＲＲＵ１０８は、特にＲｅｌａｙ　Ｎｏｄｅと呼ばれる。すなわち、ＲＲＵ１０８は、ベースバンドモデム側との無線通信で使用されるアンテナ２０７－１及びデュプレクサ９０７－１、端末側との無線通信で使用されるアンテナ２０７－２及びデュプレクサ９０７－２、上り通信及び下り通信の信号をそれぞれ増幅する二つのパワーアンプ９０５を備える。ベースバンドモデム側と端末側とで無線通信を中継する際に受信信号をデコードする場合は、ＲＲＵ１０８はベースバンドモデムを備える必要がある。

このように、ベースバンドモデム１０６とＲＲＵ１０８との間を無線リンクによって接続した場合、装置の構成は複雑であるが、ベースバンドモデム１０６とＲＲＵ１０８との間にケーブルを敷設しなくてもよい。

図１に示す構成例において、端末１０３とＲＲＵ１０８との間の伝搬距離を短くするためには、端末１０３はＲＲＵ１０８－３、１０８－４、１０８－５及び１０８－６を用いると、好都合である。これらのＲＲＵ１０８－３及び１０８－４は、ＲＲＵ１０８－５及び１０８－６と異なるベースバンドモデム１０６に接続されている。しかし、モデム制御手段１１２がデータフローを制御することによって、端末１０３にとって望ましいデータフロー１１４を生成する。データフロー１１４を生成する方法については後に詳述する。データフロー１１４は下り通信のデータフローを示しているが、上り通信においても同様のデータフローを

定義することができる。

次に、第１の実施の形態の無線通信システムの各ノードの動作について説明する。

図４は、第１の実施の形態の無線通信システムにおける下り通信時の各ノードの動作を示すシーケンス図である。

ベースバンドモデム１０６は、ＲＲＵ１０８を経由し、ＲＲＵ１０８固有の電力測定用参照信号を端末１０３に対し、無線によってブロードキャストによって送信する（２００１）。

端末１０３は、複数のＲＲＵ１０８から受信した電力測定用参照信号を使用し、ＲＲＵ１０８毎の電力測定用参照信号の受信電力を測定する（２００２）。端末１０３は、受信電力を推定する際、伝搬路の短区間変動（フェージング）による誤選択を防ぐため、ＲＲＵ１０８毎の長区間にわたる平均受信電力を測定する。すなわち、この受信電力を平均する時間（長区間）は、フェージングによるドップラー周波数の逆数の１０倍程度とすることが望ましい。

端末１０３は、受信電力の測定が完了した後、ＲＲＵ１０８間の受信電力測定結果を比較し、測定結果が高い順にＮ個のＲＲＵ１０８を選択する（２００３）。Ｎは任意の負でない整数である。

端末１０３は、電力測定用参照信号を用いて、選択されたＲＲＵ１０８毎又はその組合せによって確保できる通信品質（例えば、ＣＱ：Ｃｈａｎｎｅｌ　Ｑｕａｌｉｔｙ）を推定する（２００４）。

端末１０３は、選択されたＲＲＵ１０８、及び、選択されたＲＲＵ１０８（又は、選択されたＲＲＵ１０８の組み合せ）によって得られる推定通信品質を示す情報（例えば、ＣＱＩ：Ｃｈａｎｎｅｌ　Ｑｕａｌｉｔｙ　Ｉｎｄｉｃａｔｏｒ）を、上り制御信号（ＰＡＩ：Ｐｒｅｆｅｒｒｅｄ　Ａｎｔｅｎｎａ　Ｉｎｆｏｒｍａｔｉｏｎ）として、基地局側のベースバンドモデム１０６に送信する（２００５）。

ベースバンドモデム１０６は、端末１０３が送信した制御信号に含まれるＰＡ

Ｉを復号し（２００６）、復号結果をモデム制御手段１１２に送信する（２００７）。

モデム制御手段１１２は、１又は複数のベースバンドモデム１０６から送信される１又は複数の端末１０３のＰＡＩを集約し（２００８）、集約されたＰＡＩに基づいて各端末１０３にＲＲＵを割り当て（２００９）、ＲＲＵの割り当て結果に応じたデータ通信を１又は複数のベースバンドモデム１０６に指示する（２０１０）。

そして、モデム制御手段１１２は、端末へのＲＲＵの割当結果、及び、端末毎に割り当てられたＲＲＵで用いられるＭＣＳ（Ｍｏｄｕｌａｔｉｏｎ ａｎｄ Ｃｏｄｉｎｇ Ｓｃｈｅｍｅ）を示すRRU割当情報（ＡＡＩ：Ａｎｔｅｎｎａ Ａｓｓｉｇｎ Ｉｎｆｏｒｍａｔｉｏｎ）を送信する（２０１１）。

なお、下り通信の場合を図示したが、上り通信（Ｕｐｌｉｎｋ）の場合も同様である。この上り通信を示す場合は、”ＵＬ”を表示し、下り通信を示す場合は”ＤＬ”を表示する。

ベースバンドモデム１０６は、モデム制御手段１１２から送信された各端末宛のデータ２０１０及びＡＡＩ２０１１に基づいて、必要に応じて制御信号や参照信号を挿入することによってベースバンド信号を生成し（２０１２）、ＲＲＵ１０８は、生成されたベースバンド信号を無線周波数帯にアップコンバートし、アップコンバートされた信号を端末１０３宛にブロードキャストによって送信する（２０１３）。なお、ＲＲＵ１０８を選択するための電力測定用参照信号を、各端末宛のデータ及びＡＡＩと同時に送信してもよい。

端末１０３は、ブロードキャストされた信号を受信し、自端末宛の信号に含まれるデータを復号し（２０１４）、ＣＲＣチェック結果に応じてＡＣＫ又はＮＡＫの応答をベースバンドモデム１０６に送信する（２０１５）。

図５は、第１の実施の形態の無線通信システムにおける上り通信時の各ノードの動作を示すシーケンス図である。

ベースバンドモデム１０６は、ＲＲＵ１０８を経由し、端末１０３からの送信

データの有無にかかわらず、端末１０３から繰り返し送信される参照信号ＳＲＳ（Ｓｏｕｎｄｉｎｇ　Ｒｅｆｅｒｅｎｃｅ　Ｓｉｇｎａｌ）を受信し（２１０１）、受信した参照信号を電力測定用参照信号として使用し、ＲＲＵ１０８毎に端末１０３毎の長区間平均ＳＲＳ受信電力を測定する（２１０２）。受信電力の平均期間は、前述した下り通信時の動作（図４）と同様に、フェージングによるドップラー周波数に基づいて定めるとよい。ＳＲＳについては、"Physical Channels and Modulation (Release 8)", 3GPP TSG RAN, 3GPP TS36.211 ver8.4.0, pp.27-30, 2008/9 に開示されている。ベースバンドモデム１０６は、受信電力測定結果をモデム制御手段１１２に送信する（２１０３）。

モデム制御手段１１２は、端末１０３毎に、ＲＲＵ１０８間の受信電力測定結果を比較し、測定結果が高い順にＮ個のＲＲＵ１０８を選択する（２１０４）。選択されるＲＲＵ１０８の数Ｎは任意の負でない整数であり、下り通信時の動作（図４）と同様に定めるとよい。

モデム制御手段１１２は、ＲＲＵ１０８の選択が完了した後、端末毎ＲＲＵ毎の受信電力測定結果を用いて、選択されたＲＲＵ１０８毎又はその組合せによって確保できる通信品質（例えば、ＣＱ：Ｃｈａｎｎｅｌ　Ｑｕａｌｉｔｙ）を推定する（２１０５）。モデム制御手段１１２は、推定された通信品質に基づいて、各端末１０３にＲＲＵ１０８を割り当てる（２１０６）。

そして、モデム制御手段１１２は、端末１０３毎に選択されたＲＲＵ１０８、及び、選択されたＲＲＵ１０８（又は、選択されたＲＲＵ１０８の組み合せ）によって得られる推定通信品質から求められるＭＣＳを含んだ情報（ＡＡＩ）を、ベースバンドモデム１０６に送信する（２１０７）。

ベースバンドモデム１０６は、選択されたＲＲＵ１０８の情報によって、各ベースバンドモデム１０６によって管理される各ＲＲＵ１０８で受信する上り信号の送信元端末１０３を知ることができる。このため、ベースバンドモデム１０６によって管理される複数のＲＲＵ１０８で受信された同一端末１０３からの信号を集約することができる。端末１０３からの信号を集約するための処理の負荷を、

ベースバンドモデム１０６とモデム制御手段１１２とで分散することができる。

ベースバンドモデム１０６は、モデム制御手段１１２から受信したＡＡＩを下り制御信号に含め、この下り制御信号を無線周波数帯にアップコンバートした下り制御信号を生成する（２１０８）。そして、生成された下り制御信号を端末１０３宛にブロードキャストによって送信する（２１０９）。

端末１０３は、ブロードキャストされた信号を受信し、自端末宛の制御信号に含まれるＡＡＩを復号し、割り当てられたＲＲＵ１０８（アンテナ）の数及びＭＣＳに応じた上りデータ信号を生成し（２１１０）、生成された信号をベースバンドモデム１０６に送信する（２１１１）。なお、図５のフロー上では別々のタイミングに送信しているＲＲＵ１０８を選択するための電力測定用参照信号２１０１を、ベースバンドモデム１０６宛のデータ２１１１と同時に送信してもよい。

ベースバンドモデム１０６は、受信した信号を復号し（２１１２）、ＣＲＣチェック結果に応じてＡＣＫ／ＮＡＫの応答を端末１０３に送信する（２１１３）。また、ベースバンドモデム１０６は、受信に成功した（ＡＣＫを応答した）上りデータをモデム制御手段１１２に転送する（２１１４）。

次に、第１の実施の形態の無線通信システムの各ノードの構成について説明する。

図６は、第１の実施の形態のベースバンドモデム１０６及びその周辺の構成を示すブロック図である。

第１の実施の形態のベースバンドモデム１０６は、送信データバッファ２０１、ベースバンド信号生成部２０２、データ・制御信号分離２０３、ベースバンド信号解読部２０４及び長区間平均電力推定部２０５を備える。

送信データバッファ２０１は、メモリを備え、モデム制御手段１１２から送信された下りデータ信号を一時的に格納する。ベースバンド信号生成部２０２は、論理回路及び／又はプロセッサを備え、モデム制御手段１１２から送信されるＡＡＩからＲＲＵ割り当て情報及びＭＣＳを読み出し、１又は複数の端末１０３宛の空間多重ベースバンド信号を生成する。アンテナ毎のベースバンド信号は、ベ

ースバンドモデム１０６からＲＲＵ１０８に送信され、ＲＲＵ１０８内のＢＢ－ＲＦ変換部２０６で無線周波数帯のアナログ信号に変換され、変換された無線周波数帯の信号がＲＲＵ１０８のアンテナ２０７から端末１０３宛に放射される。

図１に示したように、ベースバンドモデム１０６とＲＲＵ１０８との間の接続（光ファイバ、同軸ケーブル、無線リンク）によって、ＢＢ－ＲＦ変換部２０６の構成が変わるので、ベースバンドモデム１０６に更にデバイスが実装される場合がある。

端末１０３によって送信された無線周波数帯の信号は、ＲＲＵ１０８のアンテナ２０７で受信され、ＢＢ－ＲＦ変換部２０６で無線周波数帯のアナログ信号からベースバンドデジタル信号に変換される。但し、前述したように、ベースバンドモデム１０６とＲＲＵ１０８との間の接続（光ファイバ、同軸ケーブル、無線リンク）によって、ベースバンドモデム１０６が、ベースバンドデジタル信号への変換処理の一部を行う。

ベースバンドモデム１０６は、アナログからデジタルに変換された信号に対しベースバンド信号処理を行う。このベースバンド処理の第１の目的は、受信信号に含まれるデータ信号及び制御信号を復号し、有為な情報（例えば、ＰＡＩ）を取り出すことである。もう１つの目的は、端末１０３によって送信される電力測定用の参照信号の受信電力を推定し、端末毎に最適なアンテナを選択することである。

ベースバンド信号解読部２０４は、論理回路及び／又はプロセッサを備え、受信信号のチャネルを推定し、及び、復調、復号を行って、データビット系列や制御ビット系列を出力する。

データ・制御信号分離２０３は、端末１０３によって送信されたデータ信号と制御信号（ＰＡＩ）とを分離し、分離された信号をモデム制御手段１１２に送信する。また、データ・制御信号分離２０３は、データ信号の復号結果を表すＡＣＫ／ＮＡＫを、端末１０３にフィードバックするために、ベースバンド信号生成部２０２に入力する。

長区間平均電力推定部２０５は、端末１０３から送信された電力推定に使用する参照信号の受信電力を推定する。長区間平均電力推定部２０５は、ＭＦ（Ｍａｔｃｈｅｄ　Ｆｉｌｔｅｒ）を備えた論理回路による構成が望ましいが、プロセッサによる処理も可能である。長区間平均電力推定部２０５は、ＲＲＵ１０８毎、端末１０３毎の参照信号受信電力を測定し、測定結果をモデム制御部１１２に送信する。

図７は、第１の実施の形態のベースバンド信号生成部２０２の構成を示すブロック図である。

第１の実施の形態のベースバンド信号生成部２０２は、データフローコントローラ４０１、符号化・変調器４０２、レイヤマッピング部４０３、プレコーディング部４０４、ＳＣＭＡＰ４０５、ＲＲＵ個別参照信号部４０６及びＩＦＦＴ部４０７を備える。

データフローコントローラ４０１は、モデム制御手段１１２からＲＲＵ割当情報（ＤＬ＿ＡＡＩ、ＵＬ＿ＡＡＩ）を受信する。受信したＲＲＵ制御情報は、制御情報として符号化・変調器４０２に入力され、下り制御信号として用いられる。また、符号化・変調器４０２は、受信したＤＬ＿ＡＡＩによって指定された送信データバッファ２０１へのアドレスポインタであって、端末宛のデータが格納されているアドレスと、ＭＣＳに応じたデータ長とに応じて、送信データバッファ２０１から端末１０３宛のデータを取得する。符号化・変調器４０２は、複数空間レイヤ分の一次変調シンボル系列を出力する。

レイヤマッピング部４０３は、符号化・変調器４０２から出力された一次変調シンボルデータが所定のＲＲＵ１０８に対して出力されるように、レイヤマッピングを行う。その後、必要であれば、プレコーディング部４０４はプレコーディングを行う。ＲＲＵ１０８の間隔が十分離れている場合には、プレコーディング行列は単位行列でよい。

ＳＣＭＡＰ４０５は、サブキャリアマッピングを行う。シングルキャリアシステムではＳＣＭＡＰ４０５は不要である。また、ＯＦＤＭＡでないマルチキャリ

アシステムでは、サブキャリアマッピングは各キャリアに対するマッピングである。ここではＯＦＤＭＡについて説明を続ける。

ＲＲＵ個別参照信号部４０６は、ＲＲＵ個別参照信号をサブキャリアマッピングされた信号の適切な位置に挿入する。ＲＲＵ個別参照信号の挿入の例は、図２０を用いて後述する。ＲＲＵ個別参照信号部４０６の機能は、電力推定参照信号挿入部２０８と類似しているが、電力推定参照信号挿入部２０８は時間領域で参照信号を重畳するのに対し、ＲＲＵ個別参照信号４０６は周波数領域で参照信号を重畳している点が異なる。

ＩＦＦＴ４０７は、参照信号が挿入された信号に逆フーリエ変換を行う。この信号がベースバンドモデム１０６のポートからＲＲＵ１０８へ出力される。

図８は、第１の実施の形態のデータ・制御信号分離２０３の構成を示すブロック図である。

第１の実施の形態のデータ・制御信号分離２０３は、セパレータ５０１及びデータバッファ５０２を備える。

セパレータ５０１は、ベースバンド信号解読部２０４から出力される上りデータ信号を受信し、受信した上りデータ信号をデータバッファ５０２に格納する。また、このデータ信号の受信が成功した場合、セパレータ５０１は、このデータ信号をモデム制御部１１２に転送し、このデータに関するＡＣＫをベースバンド信号生成部２０２に送信する。一方、このデータ信号の受信が失敗した場合、このデータ信号をデータバッファ５０２から削除し、このデータ信号に関するＮＡＫをベースバンド信号生成部２０２に送信する。

また、セパレータ５０１は、端末１０３がフィードバックするＰＡＩを受信し、受信したＰＡＩを、そのままモデム制御部１１２へ転送する。

図９は、第１の実施の形態の長区間平均電力推定部２０５の構成を示すブロック図である。

第１の実施の形態の長区間平均電力推定部２０５は、長区間平均電力推定コントローラ６０１、ＭＦパタン格納メモリ６０２、推定電力平均化部６０３及びマ

ッチトフィルタ６０４を備える。

ＭＦパタン格納メモリ６０２は、端末毎の電力推定用参照信号（例えば、ＳＲＳ）のパタンを格納する。長区間平均電力推定コントローラ６０１は、ＭＦパタン格納メモリ６０２に格納されている電力推定用参照信号のパタンをマッチトフィルタ６０４に設定する。

マッチトフィルタ６０４は、上り受信信号との相関演算によって、この参照信号の受信電力を推定する。推定が完了するたびに完了通知を長区間平均電力推定コントローラ６０１に送る。

長区間平均電力推定コントローラ６０１は、マッチトフィルタ６０４から完了通知を受けたことを契機として、ＭＦパタン格納メモリ６０２から別の電力推定用参照信号のパタン（別端末のパタン）を読み出し、読み出されたパタンをマッチトフィルタ６０４に設定し、演算開始を指示する。なお、通信プロトコルによっては電力推定用参照信号のパタンが時間的に変化する。この場合、通信プロトコルに従って、ＭＦパタン格納メモリ６０２の内容を変更する。

推定電力平均化部６０３は、マッチトフィルタ６０４からの出力を累積し、一定期間（例えば、１秒）毎に平均化した出力を、モデム制御手段１１２に出力する。そして、平均化した結果を出力した場合に累積結果を０に初期化する。

図１０は、第１の実施の形態のモデム制御部１１２の構成を示すブロック図である。

第１の実施の形態のモデム制御部１１２は、データバッファ３０１、下りＲＲＵマッピング部３０２、ＰＡＩバッファ３０３、上りＲＲＵマッピング部３０５、ＲＲＵ間電力比較部３０６、電力推定結果バッファ３０７及びネットワークインターフェース３０８を備える。なお、モデム制御部１１２は、図１０の右側において、１又は複数のベースバンドモデム１０６と接続されている。

ネットワークインターフェース３０８は、ゲートウェイ１１１と接続されており、ゲートウェイ１１１との間で上り及び下りのデータ通信をする。

ネットワークインターフェース３０８に入力された下り通信データは、一旦、

データバッファ３０１に格納された後、下りＲＲＵマッピング部３０２によって決定された端末とＲＲＵとのマッピング結果及び端末－ベースバンドモデム－ＲＲＵ間のルート情報（図１２参照）に従って、ベースバンドモデム１０６に転送される。

下りＲＲＵマッピング部３０２は、論理回路及び／又はプロセッサを備え、端末１０３からベースバンドモデム１０６経由で収集されたＰＡＩに従って、各端末１０３に使用可能なＲＲＵ１０８を割り当て、各端末１０３宛のデータを送信するＲＲＵ１０８と、各ＲＲＵ１０８って使用されるＭＣＳを各ベースバンドモデム１０６に通知する。

ＰＡＩバッファ３０３は、端末１０３からベースバンドモデム１０６経由で収集されたＰＡＩを一時的に格納するメモリである。ＰＡＩバッファ３０３に格納されたデータ（ＰＡＩ）は、下りＲＲＵマッピング部３０２によって参照される。

次に、上り通信について説明する。端末１０３から送信されたユーザデータは、ネットワークインターフェース３０８経由でゲートウェイ１１１に転送される。各ベースバンドモデム１０６によって推定されたＲＲＵ毎端末毎の上り電力測定用参照信号の受信電力推定結果は、電力推定結果バッファ３０７に格納される。なお、電力推定結果バッファ３０７は、上り電力測定用参照信号の受信電力推定結果を一時的に格納するメモリである。

ＲＲＵ間電力比較部３０６は、電力推定結果バッファ３０７に格納された受信電力推定結果を参照し、端末１０３毎にＲＲＵ１０８毎の受信電力推定結果を比較し、受信電力測定結果が高い順に１又は複数のＲＲＵ１０８を端末１０３毎に選択する。上りＲＲＵマッピング部３０５は、論理回路及び／又はプロセッサを備え、ＲＲＵ間電力比較部３０６による電力の比較結果に従って、各端末１０３が使用可能なＲＲＵ１０８を割り当てる。そして、上りＲＲＵマッピング部３０５は、各端末からのデータを受信するＲＲＵ１０８と、各ＲＲＵ１０８で使用されるＭＣＳを各ベースバンドモデム１０６に通知する。

なお、スイッチ制御部３０４は、第２の実施の形態で必要となる構成であり、

第１の実施の形態のモデム制御部１１２は備える必要がない。

図１１は、第１の実施の形態のＰＡＩバッファ３０３に格納された内容を示す説明図である。

ＰＡＩバッファ３０３は、前述したように、端末１０３からのＰＡＩのフィードバック結果を格納する。ＰＡＩバッファ３０３に格納されたＰＡＩのフィードバック結果は、端末の識別子１４０１、割当希望ＲＲＵ数１４０２、及び、割当希望のＲＲＵの識別子１４０３～１４０６を含む。ＰＡＩバッファ３０３に格納されたＰＡＩのフィードバック結果は、下りアンテナマッピング部３０２によって参照され、各端末１０３との通信で使用可能なＲＲＵ１０８を選別するために用いられる。

端末の識別子１４０１は、各端末１０３を一意に識別する識別子である。割当希望ＲＲＵ数１４０２は、この端末が割り当てを希望するＲＲＵ１０８の数である。割当希望ＲＲＵの識別子１４０３～１４０６は、この端末が割り当てを希望する複数（整数）のＲＲＵ１０８の識別子である。割当希望のＲＲＵの識別子１４０３～１４０６は、このＲＲＵが割り当てられた場合に通信可能なＭＣＳを含めるとよい。

図１２は、第１の実施の形態の電力推定結果バッファ３０７に格納された内容を示す説明図である。

電力推定結果バッファ３０７は、前述したように、ベースバンドモデム１０６によって推定された、ＲＲＵ毎端末毎の上り電力推定用参照信号の受信電力を一時的に格納する。

電力推定結果バッファ３０７には、ＲＲＵの識別子１５０１、ＲＲＵポートの識別子１５０２、ＲＲＵの識別子１５０３及び電力推定結果１５０４、１５０５が格納され、ＲＲＵの識別子（ＲＲＵ－ＩＤ）１５０３毎に、接続されているベースバンドモデム１０６の識別子１５０１と、ベースバンドモデム１０６に備わるＲＲＵポートの識別子１５０２との関係が保持されている。

なお、第１の実施の形態では、モデム－ＲＲＵ間スイッチ１１３が設けられて

いないので、図１２に示すようにＲＲＵ－ＩＤとモデムＩＤとＲＲＵポートとの間に整然とした関係を持たせることが可能である。しかし、後述する第２の実施の形態のように、ベースバンドモデム１０６とＲＲＵ１０８との間にモデム－ＲＲＵ間スイッチ１１３を設けた場合、ＲＲＵ－ＩＤとモデムＩＤとＲＲＵポートとの関係はダイナミックに変化する。

また、電力推定結果バッファ３０７には、ＲＲＵ－ＩＤ毎に端末毎の電力推定用参照信号の電力推定結果１５０４、１５０５が保持されている。

ＲＲＵ間電力比較部３０６は、電力推定結果バッファ３０７から、端末ＩＤ毎に電力推定結果が高い順にＲＲＵ－ＩＤを選択する。図１２に示す例では，丸で囲まれた電力が得られたＲＲＵ－ＩＤが、各端末のために選択される。電力推定結果バッファ３０７からＲＲＵ１０８が選択された結果は、推定受信電力からＭＣＳを定めることによって、ＰＡＩバッファ３０３に格納された内容（図１１）のように書き直すことができる。

図１３は、第１の実施の形態の端末１０３の構成を示すブロック図である。

第１の実施の形態の端末１０３は、アンテナ８０１、ＢＢ－ＲＦ変換部８０２、ベースバンド信号生成部８０３、データバッファ８０４、ベースバンド信号解読部８０５、データ・制御信号分離８０６、長区間平均電力推定部８０７、アンテナ選択部８０８及びユーザインターフェース８０９を備える、ベースバンドデジタル信号と無線周波数のアナログ信号との間を変換する。

ＢＢ－ＲＦ変換部８０２は、ＡＤコンバータ、ＤＡコンバータ、アップコンバータ、ダウンコンバータ、パワーアンプ、ローノイズアンプ及びデュプレクサを備える。ＡＤコンバータは、アナログ信号をデジタル信号に変換する。ＤＡコンバータは、デジタル信号をアナログ信号に変換する。アップコンバータは、ベースバンド信号を無線周波数の信号に変換する。ダウンコンバータは、無線周波数の信号をベースバンド信号に変換する。パワーアンプは、送信信号を増幅する。ローノイズアンプは、受信信号を増幅する。デュプレクサは、下り信号と上り信号とを分離する。

ベースバンド信号生成部８０３は、データバッファ８０４に格納されているデータ信号及び制御信号（ＰＡＩなど）を、プロトコルに従って、ベースバンド信号に変換する。ベースバンド信号解読部８０５は、プロトコルに従って、受信信号（ベースバンド信号）からデータ信号及び制御信号を抽出する。

データ・制御信号分離８０６は、ベースバンド信号解読部８０５で抽出されたデータ信号をユーザインターフェース８０９に転送する。また、データ・制御信号分離８０６は、物理層及びＭＡＣ層の制御情報（例えば、受信信号（データ信号）に対するＡＣＫ／ＮＡＫなど）をベースバンド信号生成部に入力する。

長区間平均電力推定部８０７は、基地局の長区間平均電力推定部２０５と同じ機能及び構成を有する。すなわち、長区間平均電力推定部８０７は、ＲＲＵ１０８毎固有の参照信号受信電力を測定し、測定結果をアンテナ選択部８０８に送信する。

アンテナ選択部８０８は、長区間平均電力推定部８０７で推定されたＲＲＵ１０８毎の電力測定用参照信号の受信電力を比較し、比較結果に基づいて１又は複数のＲＲＵ１０８を選択し、選択されたＲＲＵ１０８（又は、選択されたＲＲＵ１０８の組み合せ）によって得られる通信品質を推定し、推定通信品質を示す情報（例えば、ＣＱＩ：Ｃｈａｎｎｅｌ　Ｑｕａｌｉｔｙ　Ｉｎｄｉｃａｔｏｒ）を生成し、生成されたＣＱＩを、ＲＲＵ選択情報と共にＰＡＩとして上り伝送するために、ベースバンド信号生成部８０３に入力する。

ユーザインターフェース８０９は、受信データに基づいて、画像、音声及びデータを再生する。また、ユーザインターフェース８０９は、ユーザによるキー入力及び音声入力を受け付け、アプリケーションコマンドに応じた画像、音声及びデータ通信を提供する。

図１４Ａは、第１の実施の形態の基地局側から端末１０３へ通知されるＲＲＵアサイン情報を示す説明図である。

第１の実施の形態のＲＲＵアサイン情報（ＡＡＩ）は、端末ＩＤ２７０１、割り当てＲＲＵ数２７０２、割り当てＲＲＵ－ＩＤ２７０３及びＭＣＳ　ｆｏｒ

ＲＲＵ２７０４を含む。

端末ＩＤ２７０１は、ＲＲＵアサイン情報が通知される宛先となる端末１０３の識別子である。割り当てＲＲＵ数２７０２は、この端末に割り当てられたＲＲＵ１０８の数である。割り当てＲＲＵ－ＩＤ２７０３は、割り当てられたＲＲＵ１０８の識別子である。ＭＣＳ　ｆｏｒ　ＲＲＵ２７０４は、各ＲＲＵ１０８において使用されるＭＣＳである。

下り通信においては、この情報によってＲＲＵ１０８の識別子が分かるので、参照信号のパタンが分かり、チャネル推定をすることができる。また、ＭＣＳが分かるので、空間フィルタ処理後の各空間ストリームの変調方式及び符号化率が分かることから、復調及び復号が可能となる。よって、データ通信をすることができる。

一方、上り通信においては、ＲＲＵ１０８の識別子が分かることによって、基地局側が受信しようとしているストリームの数は分かるが、端末１０３がデータを送信すべきアンテナ及びＭＣＳが不明である。従って、図１４Ｂに示すように、上り通信のＲＲＵアサイン情報には、端末ＩＤ２７１１、割り当てＲＲＵ数２７１２及びＭＣＳ２７１３を含めるとよい。割り当てＲＲＵ数２７１２は、端末１０３が送信すべきストリーム数である。ＭＣＳ２７１３は、ストリーム間の平均のＭＣＳである。上り通信においては、これだけの情報があれば、端末１０３は送信方法を一意に決定でき、基地局側は通知した端末１０３の送信方法から、端末１０３から送信されたストリームの受信方法を知ることができ、データ通信をすることができる。

次に、第１の実施の形態の各装置の動作について説明する。

図１５は、第１の実施の形態の下りＲＲＵマッピング部３０２及び上りＲＲＵマッピング部３０５の共通の処理を示すフローチャートである。

最初に、全てのＲＲＵ１０８に割り当てられる端末１０３の数が上限を超えていないかを判定するために、ＲＲＵ１０８のカウンタを初期化する（Ｓ１００１）。

次に、ＰＡＩバッファ３０３に格納されたＰＡＩのフィードバック結果（図１１）に従って、カウンタが示すＲＲＵ１０８の使用を希望する端末１０３の数を計数する（Ｓ１００２）。

Ｓ１００２で計数された端末数と所定のしきい値とを比較する（Ｓ１００３）。このしきい値は、システムの管理ポリシーに依存して決定されるが、例えば、２０と設定することができる。

Ｓ１００３で比較した結果、計数された端末１０３の数が多いと判定された場合、このＲＲＵ１０８の使用を希望する端末の中で、このＲＲＵ１０８の希望順位を比較し、このＲＲＵ１０８の希望順位が低い端末から、このＲＲＵ１０８の使用を希望するという情報を削除する（Ｓ１００６）。その後、再度、端末１０３の数のカウント（Ｓ１００２）、端末数と所定のしきい値とを比較する（Ｓ１００３）。

一方、Ｓ１００３で比較した結果、計数された端末１０３の数が所定のしきい値より少ないと判定された場合、次の、ＲＲＵ１０８について端末１０３の数を判定するためにＲＲＵカウンタを更新する（Ｓ１００４）。

その後、全てのＲＲＵ１０８に関する判定が完了したか否かを判定する（Ｓ１００５）。判定の結果、一部のＲＲＵ１０８に関する判定が完了していない場合、Ｓ１００２に戻り、次のＲＲＵ１０８の処理を行う。一方、全てのＲＲＵ１０８に関する判定が完了している場合、処理を完了する。

図１６は、本発明の第１の実施の形態のＲＲＵ割当結果の説明図であり、特に、ＲＲＵマッピング処理（図１５）によって、ＰＡＩバッファ３０３に格納されたＰＡＩのフィードバック結果（図１１）が変化する様子を示す。なお、図１６においては、図１５のＳ１００３における端末１０３数のしきい値を２としている。

識別子が４のＲＲＵ１０８を三つの端末（端末ＩＤ＝１、２、５）が希望している。このため、Ｓ１００３において、端末数がしきい値である２を超えると判定された、識別子４のＲＲＵ１０８を希望する端末のうち、このＲＲＵ（ＩＤ＝４）の希望順位が低い端末（ＩＤ＝２）の識別子４のＲＲＵ１０８の情報を削除

している。

このように、図１５に示すＲＲＵマッピング処理では、ある特定のＲＲＵ１０８に負荷がかからないよう、各ＲＲＵ１０８に割り当てられる端末数に上限を設け、上限数を超えた場合には希望順位が低い端末の希望は受け入れないので、このＲＲＵ１０８しか希望しない端末に対しても最低限のスループットを与えることができる。

図１７は、第１の実施の形態の下りＲＲＵマッピング部３０２及び上りＲＲＵマッピング部３０５の共通の処理の変形例を示すフローチャートである。

図１５に示したＲＲＵマッピング部の処理はアドミッションコントロールに近い考え方に基づき、比較的長周期で制御される。一方、図１７に示す変形例はプロポーショナルフェアネスなど、無線チャネル状態を考慮したスケジューラに近い考え方に基づき、短周期で制御して、周波数利用効率を高めるものである。

図１７に示す変形例の処理の特徴は、端末１０３毎に選択されたＲＲＵ１０８と、ＲＲＵ１０８毎のＭＣＳとに応じて、各端末に適切なＲＲＵ１０８を割り当てることである。すなわち、図１７に示す変形例の処理の基本的な考え方は、各端末１０３が希望するＲＲＵの数－ｎ（ｎ＝０、１、２、…）のＲＲＵ１０８の割り当てを試み、全てのＲＲＵ１０８の割り当てが完了するか、又は、全ての端末１０３が希望するＲＲＵ１０８の数－ｎが０以下となるまで繰り返すものである。

まず、カウンタｎを０に初期化し（Ｓ１１０１）、端末１０３が希望するＲＲＵの数－ｎのＲＲＵ１０８の割り当てを開始する（Ｓ１１０２）。

そして、全ての端末１０３が希望するＲＲＵの数－ｎが０以下であるか否かを判定する（Ｓ１１０３）。判定の結果、全ての端末１０３が希望するＲＲＵの数－ｎが０以下である場合、いずれの端末１０３にもＲＲＵ１０８を割り当てることができない状態であるため、この処理を終了する。

一方、一部の端末１０３が希望するＲＲＵの数－ｎが０以下ではない場合、少なくとも一つのＲＲＵ１０８が割り当て可能な状態なので、希望するＲＲＵの数

－ｎが０以下の端末以外の全ての端末１０３に関し、プロポーショナルフェアネスの評価関数値を計算する（Ｓ１１０４）。プロポーショナルフェアネスでは、端末１０３毎の平均伝送レート及び瞬時伝送レートが必要となる。平均伝送レートは、当該端末１０３宛に通信に成功したビット数を時間平均して管理しておけばよい。瞬時伝送レートは、図１１に示すＭＣＳに基づいて、下位の希望順位のｎ個を除いた希望するＲＲＵ１０８を全て割り当てられた場合に期待されるデータ通信量を計算すればよい。

そして、プロポーショナルフェアネスの評価関数値が大きい順に端末１０３を並び替え、評価関数値の順位を示すインデックスを割り当てる（Ｓ１１０５）。次に、評価関数値の順位を計数するためのカウンタｍを初期化し（Ｓ１１０６）、実際の割り当ての可否を判定する（Ｓ１１０７）。

すなわち、評価関数値の順位ｍ番目の端末１０３が希望するＲＲＵ１０８を、希望するＲＲＵの数－ｎまで全て割り当てることができれば、この端末１０３に対しＲＲＵ１０８を全て割り当てる（Ｓ１１０８）。順位ｍ番目の端末１０３への割り当ての判定が完了したら、次の順位の端末１０３に関して判定をするため、カウンタｍを更新する（Ｓ１１０９）。

カウンタｍを更新した後、全ての端末１０３に関する判定が終了したか否かを判定する（Ｓ１１１０）。一部の端末１０３に関する判定が終了していない場合、Ｓ１１０７に戻り、次の端末１０３の割り当てを判定する。一方、全ての端末１０３に関する判定が終了している場合、Ｓ１１１１に進み、ＲＲＵの割り当てが完了したか否かを判定する。

その判定の結果、全てのＲＲＵ１０８が何れかの端末１０３に割り当てられている場合、ＲＲＵ１０８の割り当てが完了しているので、この処理を終了する。一方、一部のＲＲＵ１０８の割り当てが完了していない場合、カウンタｎを更新し、各端末１０３に割り当てるＲＲＵ１０８を一つ減らし（ｎを一つ大きくし）、Ｓ１１０２から再度この処理を実行する。

図１８は、本発明の第１の実施の形態のＲＲＵマッピング処理（図１７）によ

るＲＲＵ割当結果の説明図である。

図１１に示すＲＲＵ割当結果では各端末１０３が希望するＲＲＵ１０８の識別子が記載されていたが、図１８に示すＲＲＵ割当結果は、ＲＲＵ１０８が割り当てられた結果を示すので、ＲＲＵ１０８毎に１台の端末１０３が対応している点が特徴である。この割当結果が、ＲＲＵ割当情報（ＤＬ＿ＡＡＩ、ＵＬ＿ＡＡＩ）として、ベースバンドモデム１０６及び端末１０３に通知される。なお、ＯＦＤＭＡなどのマルチキャリア通信システムでは、図１８に示すような割当結果を、サブキャリア又はサブキャリアを複数束ねた周波数セグメント毎に生成してもよい。

図１９Ａ、図１９Ｂ及び図１９Ｃは、第１の実施の形態の端末１０３からのＰＡＩフィードバックの内容を示す説明図である。

図１９Ａに示すＰＡＩフィードバック情報には、送信元端末の識別子２８０１、この端末が割り当てを希望するＲＲＵの数２８０２、及び、割り当てを希望するＲＲＵの識別子２８０３が含まれる。モデム制御手段１１２は、この情報によって図１５に示す制御が可能となる。

図１９Ｂ及び図１９Ｃは、ＰＡＩフィードバック情報（図１９Ａ）に付加される情報を示す。

図１９Ｂは、ＲＲＵ１０８毎に異なるコードワードを使用するＭＣＷ（Ｍｕｌｔｉ　Ｃｏｄｅ　Ｗｏｒｄ）の場合の例である。ＭＣＷの場合は、ＲＲＵ－ＩＤ毎にＣＱＩ（２８０４）をフィードバックすればよい。

図１９Ｃは、複数のＲＲＵ１０８の間で一つのコードワードを使用するＳＣＷ（Ｓｉｎｇｌｅ　Ｃｏｄｅ　Ｗｏｒｄ）の場合の例である。ＳＣＷの場合は割り当てられたＲＲＵの組合せによって空間ストリーム間の平均通信品質が変化するため、割り当てられたＲＲＵ数に応じた平均の通信品質をＣＱＩ（２８０５）としてフィードバックすればよい。

また、通信品質を厳密に制御するために、図１９Ｃに示す付加情報を拡張し、割り当てられるＲＲＵ１０８の全ての組み合せに最適なＣＱＩをフィードバック

することが考えられる。しかし、ＲＲＵ１０８の数の増加に伴い、ＲＲＵ１０８の組み合せの数が増加するため、フィードバック情報が上り帯域を圧迫する。このような場合、図１９Ｂに示す情報をフィードバックし、モデム制御手段１１２において、割り当てられたＲＲＵ１０８の組み合せに応じてＣＱＩを平均化するとよい。

図２０Ａから図２０Ｃは、第１の実施の形態の下り通信におけるＲＲＵ個別参照信号の配置例を示す説明図である。

図２０Ａに示す例では、ＲＲＵ個別参照信号がサブキャリア方向に連続して配置されている。一方、図２０Ｂに示す例では、ＲＲＵ個別参照信号が時間方向に連続して配置されている。

ＲＲＵ１０８の間では、ＲＲＵ個別参照信号間が低い相関となるようにＺａｄｏｆｆ－Ｃｈｕ系列やＰＮ系列などを使用するとよい。ただし、相関区間でチャネル変動が発生すると系列間で直交性が崩れるため、チャネル変動が少ない方向に連続するよう参照信号を配置することが望ましい。例えば、伝搬路の遅延広がりが小さければサブキャリア方向の連続が望ましく、端末の移動速度が小さければ時間方向の連続が望ましい。一般的に、移動通信システムは、存在確率が高い低速移動端末に最適化するため、時間方向へ連続的にＲＲＵ個別参照信号を配置することが望ましい。ただし、端末１０３はこの参照信号を継続的に測定できることから、データ通信の効率を考慮して図２０Ｃに示すように、ＲＲＵ個別参照信号を離散的に配置してもよい。

以上、第１の実施の形態についてＭＩＭＯを例として説明したが、本発明はＭＩＭＯに限らず、複数基地局（アンテナ）が同一信号を送信するサイトダイバーシチなど、端末１０３が複数の基地局（アンテナ）と通信する無線通信システムに適用することができる。

以上説明したように、本発明の第１の実施の形態では、セル境界付近の端末に、セルを跨って複数のアンテナ（ＲＲＵ１０８）を割り当てることができ、セル間干渉を低減することによって、セル境界付近の端末の通信品質を向上することが

できる。

具体的には、第１の実施の形態では、図２に示すように、セルを跨って、伝搬距離が短いＲＲＵ（１０８－２、１０８－４、１０８－５、１０８－７）を端末１０３－３に割り当てることができる。この場合、選択されたＲＲＵと端末１０３とは、信号１０９－１、１０９－２、１０９－３、１０９－４によって通信がされる。他のＲＲＵ（１０８－１、１０８－３、１０８－６、１０８－８）は、それぞれ、別の端末（１０３－１、１０３－６）と通信している。このため、これらのＲＲＵから干渉信号（１０９－５、１０９－６、１０９－７、１０９－８）が端末１０３－３へ到達する。

しかし、所望信号（１０９－１、１０９－２、１０９－３、１０９－４）の伝搬距離より、干渉信号（１０９－５、１０９－６、１０９－７、１０９－８）の伝搬距離が長いため、干渉信号の減衰は所望信号の減衰より大きくなる。このため、干渉信号の電界強度が低下するため、図３１に示す従来の場合と比較して端末１０３－３の通信品質が改善し、干渉信号による通信品質劣化の問題が生じ難い。

図２１Ａ及び図２１Ｂは、本発明の第１の実施の形態の効果を説明する図である。

図２１Ａは、従来のように、端末毎にセルを跨ってアンテナを選択できない場合の周波数利用効率を示す。図２１Ｂは、第１の実施の形態による、端末毎にセルを跨ってアンテナを選択できる場合の周波数利用効率を示す。なお、各図において、白い部分が周波数利用効率が高く、黒い部分が周波数利用効率が低いことを示す。

図２１Ａ及び図２１Ｂにおいて、セルには４つの小型基地局（４本のアンテナ）が配置されており、各小型基地局には４本のアンテナが備わっている。アンテナは、図中、白丸で示す箇所に設置されている。

従来は、図２１Ａに示すように、端末は基地局を選択して、選択された基地局と４×４ＭＩＭＯ通信をする。この場合、各小型基地局のエリアの境界において、

図３１に示すようなセル間干渉が問題となり周波数利用効率が低くなっている。

一方、第１の実施の形態（図２１Ｂ）によると、端末はセルを跨って、端末からの距離が近い４本のアンテナを選択し、選択された４本のアンテナとの間で４×４ＭＩＭＯ通信をする。このように第１の実施の形態によると、図２に示したように、干渉電力を低くすることができ、従来（図２１Ａ）で周波数利用効率が低かった領域でも周波数利用効率を高くすることができる。

＜第２実施形態＞

図２２は、本発明の第２の実施の形態の無線通信システムのネットワーク構成を示す図である。

第２の実施の形態の無線通信システムは、ベースバンドモデム１０６とＲＲＵ１０８との間にモデム－ＲＲＵ間スイッチ１１３を備える点で、ベースバンドモデム１０６とＲＲＵ１０８とが所定の対応関係で接続されている第１の実施の形態の無線通信システムと異なる。なお、第２の実施の形態については、前述した第１の実施の形態との相違点のみを説明し、前述した第１の実施の形態と同じ構成及び処理については説明を省略する。

モデム－ＲＲＵ間スイッチ１１３は、モデム制御手段１１２からの指示に従って、スイッチを切り替え、ベースバンドモデム１０６の１又は複数のアンテナポートとＲＲＵ１０８との間の接続を切り替える。第２の実施の形態の無線通信システムは、１台の端末１０３との通信に使用されるベースバンドモデム１０６を１台に集約することができ、ベースバンドモデム１０６間での連携ベースバンド信号処理が不要な利点を有する。

図２３は、第２の実施の形態の無線通信システムにおける下り通信時の各ノードの動作を示すシーケンス図である。

ＲＲＵ１０８は、ベースバンドモデム１０６から送信される下りベースバンド信号に電力測定用参照信号を重畳し、電力測定用参照信号が重畳された信号を無線周波数帯にアップコンバートし、アップコンバートされた信号を端末１０３にブロードキャストによって送信する（２２０１）。具体的には、ＲＲＵ１０８の

メモリには参照信号パタンが保持されている。ＲＲＵ１０８は、適切なタイミングで、メモリから参照信号パタンを読み出し、ベースバンドモデム１０６から送信されたベースバンド信号に加算する。

端末１０３は、複数のＲＲＵ１０８から受信した電力測定用参照信号を使用し、ＲＲＵ１０８毎の電力測定用参照信号の受信電力を測定する（２２０２）。端末１０３は、受信電力を推定する際、伝搬路の短区間変動（フェージング）による誤選択を防ぐため、ＲＲＵ１０８毎の長区間にわたる平均受信電力を測定する。すなわち、この受信電力を平均する時間（長区間）は、フェージングによるドップラー周波数の逆数の１０倍程度とすることが望ましい。

端末１０３は、受信電力の測定が完了した後、ＲＵ１０８間の受信電力測定結果を比較し、測定結果が高い順にＮ個のＲＲＵ１０８を選択する（２２０３）。選択されるＲＲＵ１０８の数Ｎは任意の負でない整数であり、第１の実施の形態（図４）と同様に定めるとよい。

端末１０３は、電力測定用参照信号を用いて、選択されたＲＲＵ１０８（又は、選択されたＲＲＵ１０８の組合せ）によって得られる通信品質（例えば、ＣＱＩ：Ｃｈａｎｎｅｌ　Ｑｕａｌｉｔｙ）を推定する（２２０４）。

端末１０３は、選択されたＲＲＵ１０８、及び、選択されたＲＲＵ１０８（又は、選択されたＲＲＵ１０８の組み合せ）によって得られる推定通信品質を示す情報（例えば、ＣＱＩ：Ｃｈａｎｎｅｌ　Ｑｕａｌｉｔｙ　Ｉｎｄｉｃａｔｏｒ）を、上り制御信号（ＰＡＩ：Ｐｒｅｆｅｒｒｅｄ　Ａｎｔｅｎｎａ　Ｉｎｆｏｒｍａｔｉｏｎ）として、基地局側のベースバンドモデム１０６に送信する（２２０５）。

ＲＲＵ１０８は、受信した上り制御信号をダウンコンバートし、変換されたベースバンド信号をモデムーＲＲＵ間スイッチ１１３に送る。モデムーＲＲＵ間スイッチ１１３は、ベースバンド信号（ＰＡＩ）の経路を切り替え（２２０６）、ベースバンドモデム１０６に送る（２２０７）。

ベースバンドモデム１０６は、端末１０３によって送信されたＰＡＩを復号し

（２２０８）、復号結果をモデム制御手段１１２に送信する（２２０９）。

モデム制御手段１１２は、１又は複数のベースバンドモデム１０６から送信される１又は複数の端末１０３のＰＡＩを集約し（２２１０）、集約されたＰＡＩに基づいて各端末１０３にＲＲＵを割り当て（２２１１）、ＲＲＵの割り当て結果に応じたデータ通信を１又は複数のベースバンドモデム１０６に指示する（２２１２）。

そして、モデム制御手段１１２は、端末へのＲＲＵの割当結果、及び、端末毎に割り当てられたＲＲＵで用いられるＭＣＳ（Ｍｏｄｕｌａｔｉｏｎ ａｎｄ Ｃｏｄｉｎｇ Ｓｃｈｅｍｅ）を示すＲＲＵ割当情報（ＡＡＩ：Ａｎｔｅｎｎａ Ａｓｓｉｇｎ Ｉｎｆｏｒｍａｔｉｏｎ）を送信する（２２１３）。さらに、モデム制御手段１１２は、端末宛のデータ信号を送信したベースバンドモデム１０６とＲＲＵ１０８との位置関係に応じて、モデムーＲＲＵ間スイッチ１１３を制御するためのスイッチ制御情報を、モデムーＲＲＵ間スイッチ１１３へ送信する（２２１４）。

ベースバンドモデム１０６は、モデム制御手段１１２から送信された各端末宛のデータ２２１２及びＡＡＩ２２１３に基づいて、必要に応じて制御信号や参照信号を挿入することによってベースバンド信号を生成し（２２１５）、生成されたベースバンド信号をモデムーＲＲＵ間スイッチ１１３を経由して、各ＲＲＵ１０８へ送信する（２２１６、２２１７、２２１８）。

ＲＲＵ１０８は、生成されたベースバンド信号を無線周波数帯にアップコンバートし、アップコンバートされた信号を端末１０３宛にブロードキャストによって送信する（２２１９）。なお、ＲＲＵ１０８を選択するための電力測定用参照信号を、各端末宛のデータ及びＡＡＩと同時に送信してもよい。

端末１０３は、ブロードキャストされた信号を受信し、自端末宛の信号に含まれるデータを復号し（２２２０）、ＣＲＣチェック結果に応じてＡＣＫ又はＮＡＫの応答をベースバンドモデム１０６に送信する（２２２１）。

図２４は、第２の実施の形態の無線通信システムにおける上り通信時の各ノー

ドの動作を示すシーケンス図である。

ベースバンドモデム１０６は、ＲＲＵ１０８を経由して（２３０１）、モデム－ＲＲＵ間スイッチ１１３で経路を制御された上で（２３０２）、端末１０３が送信データ有無を問わず繰り返し送信する参照信号ＳＲＳ（Ｓｏｕｎｄｉｎｇ Ｒｅｆｅｒｅｎｃｅ Ｓｉｇｎａｌ）を受信し（２３０３）、受信した参照信号を電力測定用参照信号として使用し、ＲＲＵ１０８毎に端末１０３毎の長区間平均ＳＲＳ受信電力を測定する（２３０４）。受信電力の平均期間は、前述した下り通信時の動作（図２３）と同様に、フェージングによるドップラー周波数に基づいて定めるとよい。ベースバンドモデム１０６は、受信電力測定結果をモデム制御手段１１２に送信する（２３０５）。

モデム制御手段１１２は、端末１０３毎に、ＲＲＵ１０８間の受信電力測定結果を比較し、測定結果が高い順にＮ個のＲＲＵ１０８を選択する（２３０６）。選択されるＲＲＵ１０８の数Ｎは任意の負でない整数であり、下り通信時の動作（図４）と同様に定めるとよい。

モデム制御手段１１２は、ＲＲＵ１０８の選択が完了した後、端末毎ＲＲＵ毎の受信電力測定結果を用いて、選択されたＲＲＵ１０８毎又はその組合せによって確保できる通信品質（例えば、ＣＱ：Ｃｈａｎｎｅｌ Ｑｕａｌｉｔｙ）を推定する（２３０７）。モデム制御手段１１２は、推定された通信品質に基づいて、各端末１０３にＲＲＵ１０８を割り当てる（２３０８）。

そして、モデム制御手段１１２は、端末１０３毎に選択されたＲＲＵ１０８、及び、選択されたＲＲＵ１０８（又は、選択されたＲＲＵ１０８の組み合せ）によって得られる推定通信品質から求められるＭＣＳを含んだ情報（ＡＡＩ）を、ベースバンドモデム１０６に送信する（２３０９）。さらに、モデム制御手段１１２は、端末宛のデータ信号を送信したベースバンドモデム１０６とＲＲＵ１０８との位置関係に応じて、モデム－ＲＲＵ間スイッチ１１３を制御するためのスイッチ制御情報を、モデム－ＲＲＵ間スイッチ１１３へ送信する（２３１０）。

ベースバンドモデム１０６は、モデム制御手段１１２から受信したＡＡＩを下

り制御信号に含め、この下り制御信号を無線周波数帯にアップコンバートし、アップコンバートされた信号をアップコンバートされた下り制御信号を生成する（２３１１）。そして、生成された下り制御信号を端末１０３宛にブロードキャストによって送信する（２３１２）。

ベースバンドモデム１０６は、モデム制御手段１１２から受信したＡＡＩを、下り制御信号に載せて、モデム－ＲＲＵ間スイッチ１１３経由でＲＲＵ１０８に送信する（２３１３、２３１４）。

ＲＲＵ１０８は、受信した下り制御信号を無線周波数帯にアップコンバートし、アップコンバートされた信号を端末１０３宛にブロードキャストによって送信する（２３１５）。

端末１０３は、ブロードキャストされた信号を受信し、自端末宛の制御信号に含まれるＡＡＩを復号し、割り当てられたＲＲＵ１０８（アンテナ）の数及びＭＣＳに応じた上りデータ信号を生成し（２３１６）、生成された信号を、モデム－ＲＲＵ間スイッチ１１３を経由して、ベースバンドモデム１０６に送信する（２２１７、２３１８、２３１９）。なお、図２４のフロー上では別々のタイミングに送信しているＲＲＵ１０８を選択するための電力測定用参照信号２３０１を、ベースバンドモデム１０６宛のデータ２３１７と同時に送信してもよい。

ベースバンドモデム１０６は、受信した信号を復号し（２３２０）、ＣＲＣチェック結果に応じてＡＣＫ／ＮＡＫの応答を、モデム－ＲＲＵ間スイッチ１１３を経由して、端末１０３に送信する（２３２１、２３２３、２３２４）。また、ベースバンドモデム１０６は、受信に成功した（ＡＣＫを応答した）上りデータをモデム制御手段１１２に転送する（２３２２）。

図２５は、第２の実施の形態のベースバンドモデム１０６及びその周辺の構成を示すブロック図である。

第２の実施の形態では、前述した第１の実施の形態とは、ベースバンドモデム１０６とＲＲＵ１０８との間にモデム－ＲＲＵ間スイッチ１１３を設けた点と、ＲＲＵ１０８の下り送信側に電力推定参照信号挿入部２０８を追加した点が相違

する。

第２の実施の形態のベースバンドモデム１０６は、送信データバッファ２０１、ベースバンド信号生成部２０２、データ・制御信号分離２０３、ベースバンド信号解読部２０４及び長区間平均電力推定部２０５を備える。ベースバンドモデム１０６に備わる各構成は、前述した第１の実施の形態と同じである。

モデム－ＲＲＵ間スイッチ１１３は論理回路及び電気スイッチ（又は、光スイッチ）を備える。論理回路は、スイッチの入力ポートと出力ポートとの間の接続を切り替える。論理回路によって、スイッチのポート間の切り替え、分配、結合が容易に実現でき、スイッチの制御に柔軟性を持たせることができる。スイッチの接続の切り替えはモデム制御部１１２によって制御される。

第２の実施の形態のＲＲＵ１０８は、電力推定参照信号挿入部２０８、ＢＢ－ＲＦ変換部２０６及びアンテナ２０７を備える。ＢＢ－ＲＦ変換部２０６及びアンテナ２０７は、前述した第１の実施の形態と同じである。

電力推定参照信号挿入部２０８は論理回路及びメモリを備え、メモリは参照信号を格納する。電力推定参照信号挿入部２０８は、ベースバンドモデム１０６からモデム－ＲＲＵ間スイッチ１１３を経由して入力されるベースバンド信号に、メモリに格納されている参照信号パタンを重畳する。ＲＲＵ１０８が、参照信号を重畳するタイミングを知るために、ベースバンドモデム１０６が、参照信号を挿入するタイミングを通知するための制御情報（例えば、イネーブラ）をベースバンド信号に重畳するとよい。

なお、モデム－ＲＲＵ間スイッチ１１３は、上り信号と下り信号とで、個別に制御できるように、異なるスイッチによって構成されている。上り信号のスイッチは、長区間平均電力推定部２０５による電力測定の結果に基づいて、モデム制御部１１２によって決定されたスイッチ制御情報に従ってスイッチを切り換える。下り信号のスイッチは、端末がフィードバックしたＰＡＩに基づいて、モデム制御部１１２によって決定されたスイッチ制御情報に従ってスイッチを切り換える。

なお、前述した制御方法に限らず、上り信号のスイッチと下り信号のスイッチ

とを、同一のスイッチ制御情報に従って、同一に切り替えてもよい。この場合、モデム制御手段１１２は、長区間平均電力推定部２０５での電力測定の結果に基づくスイッチ制御情報と、端末がフィードバックしたＰＡＩに基づくスイッチ制御情報とのいずれか又は両方に従ってスイッチを切り替えるとよい。

第２の実施の形態のモデム制御部１１２の構成について、図１０を参照して説明する。

第２の実施の形態のモデム制御部１１２は、データバッファ３０１、下りＲＲＵマッピング部３０２、ＰＡＩバッファ３０３、スイッチ制御部３０４、上りＲＲＵマッピング部３０５、ＲＲＵ間電力比較部３０６、電力推定結果バッファ３０７及びネットワークインターフェース３０８を備える。

スイッチ制御部３０４は、下りＲＲＵマッピング部３０２から出力されるＤＬ＿ＡＡＩ及び上りＲＲＵマッピング部３０５から出力されるＵＬ＿ＡＡＩを受け、ベースバンドモデム－ＲＲＵ－端末間のルート情報を管理する。すなわち、スイッチ制御部３０４は、ＤＬ＿ＡＡＩ及びＵＬ＿ＡＡＩに従って、端末１０３の信号処理を担当するベースバンドモデム１０６とＲＲＵ１０８とが接続されるように、モデム－ＲＲＵ間スイッチ１１３を制御する。

なお、スイッチ制御部３０４以外の各構成は、前述した第１の実施の形態と同じである。

図２６は、第２の実施の形態のベースバンド信号生成部２０２の構成を示すブロック図である。

第２の実施の形態のベースバンド信号生成部２０２は、データフローコントローラ４０１、符号化・変調器４０２、レイヤマッピング部４０３、プレコーディング部４０４、ＳＣＭＡＰ４０５及びＩＦＦＴ部４０７を備える。

第２の実施の形態のベースバンド信号生成部２０２は、前述した第１の実施の形態のベースバンド信号生成部２０２（図２６）と異なり、ＲＲＵ個別参照信号部４０６とＩＦＦＴ４０７との配置が逆になっている。なお、ベースバンド信号生成部２０２に備わる各構成は、前述した第１の実施の形態のベースバンド信号

生成部２０２と同じである。

第２の実施の形態において、ＲＲＵ個別参照信号４０６は、時間領域において電力測定用ＲＲＵ個別参照信号を重畳する。このような第２の実施の形態のベースバンド信号生成部２０２の構成は、第１の実施の形態（図１）のように、ベースバンドモデム１０６とＲＲＵ１０８との間が直結される場合にも適用可能であるが、第２の実施の形態（図２２）のようにモデム－ＲＲＵ間スイッチ１１３を設ける場合は、ＲＲＵ個別参照信号４０６とＩＦＦＴ４０７との間にモデム－ＲＲＵ間スイッチ１１３が挿入される。

なお、図２６のＲＲＵ個別参照信号４０６は、図２５の電力推定参照信号挿入部２０８である。

また、プレコード部４０４以後の構成をＲＲＵ１０８側に搭載し、プレコード部４０４とＳＣＭＡＰ４０５との間にモデム－ＲＲＵ間スイッチ１１３を挿入してもよい。

図２７は、第２の実施の形態のモデム－ＲＲＵ間スイッチ１１３の構成を示すブロック図である。

第２の実施の形態のモデム－ＲＲＵ間スイッチ１１３は、スイッチコントローラ７０１、マスク部７０３及び加算器７０４を備え、論理回路によって構成される。モデム－ＲＲＵ間スイッチ１１３は、モデム制御手段１１２によって出力されるスイッチ制御情報に従って、スイッチコントローラ７０１が各データ線のＭＡＳＫ部７０３（入力ビット系列に対するＡＮＤマスク）への制御信号を全ビット０にするか全ビット１にするかを制御する。

図２７は下り通信側のスイッチを示しているが、上り通信側のスイッチは入力と出力の関係を入れ替えればよい。なお、スイッチ７０２を他の論理回路によって構成してもよい。

図２８から図３０は、第２の実施の形態のＲＲＵマッピング処理によるＲＲＵ割当結果を説明する図である。

図２８に示すように、ベースバンドモデム１０６に備わる１又は複数のＲＲＵ

入出力ポート毎にＲＲＵが接続されている場合、各ＲＲＵ１０８に割り当てられている端末の識別子を示す。端末は、図２８に示す状態でも通信は可能である。しかし、識別子が１及び３の端末は複数のモデムに跨って割り当てられている。この状態では、ベースバンド信号処理を複数のモデム間で連携させる必要があり、ベースバンド信号処理の複数のモデム間の連携は困難である。そこで、ベースバンドモデム１０６とＲＲＵ１０８との接続を変更して、各端末１０３のベースバンド信号処理が一つのベースバンドモデム１０６によって行われるようにする。

例えば、図２９に示すように、識別子が６と１５のＲＲＵを入れ替えるように制御する。同様に、識別子が８と９のＲＲＵ、識別子が１０と１６のＲＲＵ、識別子が１１と１２のＲＲＵを、各々、入れ替えるように制御する。その結果、図３０に示すように、各端末のベースバンド信号処理は一つのベースバンドモデムによって行われる。

このとき、識別子が１及び４のベースバンドモデム１０６には、複数の端末１０３が収容され、マルチユーザＭＩＭＯとなっている。このマルチユーザＭＩＭＯは、ＬＴＥでも行われる信号処理であり、確立された信号処理方法である。さらに、識別子が２のベースバンドモデム１０６には、どの端末も割り当てられていないので、識別子が２のモデム１０６は省略する（又は、停止する）ことができるモデムである。

以上説明したように、本発明の第２の実施の形態では、モデムーＲＲＵ間スイッチ１１３をシステムに備えることによって、１台の端末１０３との通信に使用されるベースバンドモデム１０６を１台に集約することができ、ベースバンドモデム１０６間で連携したベースバンド信号処理が不要となる。また、動作するベースバンドモデム１０６を集約することができるので、ベースバンドモデムを効率的に運用することができる。また、システムに実装すべきベースバンドモデムの数を減らすことができ、ベースバンドモデムによって消費される電力を低減することができる。

請求の範囲

請求項１

複数の基地局が各々複数のセルを構成し、１台の端末が前記複数の基地局と通信する無線通信システムであって、

前記各基地局は、１又は複数のアンテナを備え、

前記基地局は、少なくとも近傍の基地局間では重複しないアンテナ固有の第１の参照信号を送信し、

前記端末は、

前記第１の参照信号を受信して、前記アンテナ毎の前記第１の参照信号の受信電力を推定し、

前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、

前記アンテナの選択結果を前記基地局に送信し、

前記基地局は、

前記端末から送信された前記アンテナの選択結果を参照して、異なるセルに属する前記複数のアンテナを前記端末に割り当て、

前記アンテナの割当結果を前記端末に通知することを特徴とする無線通信システム。

請求項２

前記端末は、

前記第１の参照信号の長区間時間平均の受信電力に基づいて、前記アンテナ毎の受信電力を推定することによってフェージングの影響を排除し、

前記選択されたアンテナの数及び前記選択されたアンテナ固有の識別子を、前記アンテナの選択結果に含めて、前記基地局に送信することを特徴とする請求項１に記載の無線通信システム。

請求項３

前記端末は、さらに、前記選択されたアンテナによる通信の品質を示す情報を前記アンテナの選択結果に含めて、前記基地局に送信することを特徴とする請求項２に記載の無線通信システム。

請求項４

前記第１の参照信号には、前記端末が前記各アンテナから送信された参照信号を識別するために、少なくとも前記端末の近傍のアンテナの間で相互相関が低い系列が使用され、

前記第１の参照信号は、前記端末で長区間平均の受信電力を測定できるように、繰り返し送信されることを特徴とする請求項１に記載の無線通信システム。

請求項５

前記基地局は、割り当てたアンテナの数及び割り当てたアンテナ固有の識別子の少なくとも一つを、前記アンテナの割当結果に含めて、前記端末に通知することを特徴とする請求項１に記載の無線通信システム。

請求項６

前記基地局は、さらに、割り当てたアンテナによる通信の変調方式及び符号化方式の情報を前記アンテナの割当結果に含めて、前記端末に通知することを特徴とする請求項５に記載の無線通信システム。

請求項７

前記端末は、端末固有の第２の参照信号を送信し、

前記基地局は、

前記第２の参照信号を受信して、前記アンテナ毎に前記第２の参照信号の受信電力を推定し、

前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、

前記アンテナの選択結果を参照して、異なるセルに属する複数の前記アンテナを前記端末に割り当て、

前記アンテナの割当結果を前記端末に通知することを特徴とする請求項１に記載の無線通信システム。

請求項８

前記基地局は、複数のベースバンドモデムと、前記複数のベースバンドモデムを制御するモデム制御装置を備え、

前記ベースバンドモデムは、前記第２の参照信号を受信して、前記アンテナ毎に前記第１の参照信号の受信電力を測定し、

前記モデム制御装置は、

前記端末から送信された前記アンテナの選択結果、及び前記各ベースバンドモデムで測定された第２の参照信号の受信電力測定結果の、少なくとも一つを、前記複数のベースバンドモデムから取得し、

前記取得された情報に基づいて、異なるセルに属する前記複数のアンテナを前記端末に割り当て、

前記アンテナの割当結果を、前記ベースバンドモデムを経由して、前記端末に通知することを特徴とする請求項７に記載の無線通信システム。

請求項９

前記モデム制御手段は、

前記端末から送信された前記アンテナの選択結果、及び前記各ベースバンドモデムで測定された第２の参照信号の受信電力測定結果を、前記複数のベースバンドモデムから取得し、

前記取得されたアンテナの選択結果に基づいて、異なるセルに属する前記複数

のアンテナを、下り通信に使用するために、前記端末に割り当て、

前記収集された端末固有の参照信号の受信電力測定結果に基づいて、異なるセルに属する前記複数のアンテナを、上り通信に使用するために、前記端末に割り当て、

前記アンテナの割当結果を、前記ベースバンドモデムを経由して、前記端末に通知することを特徴とする請求項８に記載の無線通信システム。

請求項１０

前記複数のベースバンドモデムと前記複数のアンテナとの間に、前記複数のベースバンドモデムと前記複数のアンテナとの接続を切り替える切替装置を備え、

前記モデム制御装置は、前記アンテナの割当結果に基づいて、前記切替装置を制御することを特徴とする請求項８に記載の無線通信システム。

請求項１１

前記切替装置は、上り通信用のスイッチ及び下り通信用のスイッチを含み、

前記モデム制御手段は、上り通信用のスイッチと下り通信用のスイッチとを個別に制御することを特徴とする請求項１０に記載の無線通信システム。

請求項１２

前記端末に送信される信号に前記第１の参照信号を付加する参照信号付加装置を、前記複数のベースバンドモデムと前記複数のアンテナとの間に備え、

前記参照信号付加装置は、前記複数ベースバンドモデムの間で相互相関が低い系列によって前記参照信号を生成することを特徴とする請求項８に記載の無線通信システム。

請求項１３

前記端末は、

複数のアンテナから送信される第１の参照信号を受信し、前記受信した第１の参照信号の長区間時間平均の受信電力を推定する受信電力推定部と、

前記受信電力推定部によって推定された受信電力に基づいて、通信に適する複数の前記アンテナを選択するアンテナ選択部と、

前記アンテナ選択部による選択結果、及び前記アンテナで受信電力を測定するための端末固有の第２の参照信号を含む信号を生成するベースバンド信号生成部と、を備えることを特徴とする請求項１に記載の無線通信システム。

請求項１４

複数の基地局が各々複数のセルを構成し、１台の端末が前記複数の基地局と通信する無線通信システムにおいて、

前記各基地局は、１又は複数のアンテナを備え、

前記端末は、端末固有の第２の参照信号を送信し、

前記基地局は、

前記第２の参照信号を受信して、前記アンテナ毎に前記第２の参照信号の受信電力を推定し、

前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、

前記アンテナの選択結果を参照して、異なるセルに属する複数の前記アンテナを前記端末に割り当て、

前記アンテナの割当結果を前記端末に通知することを特徴とする無線通信システム。

請求項１５

前記基地局は、割り当てたアンテナの数及び割り当てたアンテナ固有の識別子の少なくとも一つを、前記アンテナの割当結果に含めて、前記端末に通知することを特徴とする請求項１４に記載の無線通信システム。

請求項１６

前記基地局は、さらに、割り当てたアンテナによる通信の変調方式及び符号化方式の情報を前記アンテナの割当結果に含めて、前記端末に通知することを特徴とする請求項１５に記載の無線通信システム。

請求項１７

複数の基地局が各々複数のセルを構成し、１台の端末が前記複数の基地局と通信する無線通信システムにおける通信制御方法であって、

前記各基地局は、１又は複数のアンテナを備え、

前記方法は、

前記基地局が、少なくとも近傍の基地局間では重複しないアンテナ固有の第１の参照信号を送信し、

前記端末が、前記第１の参照信号を受信して、前記アンテナ毎の前記第１の参照信号の受信電力を推定し、

前記端末が、前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、

前記端末が、前記アンテナの選択結果を前記基地局に送信し、

前記基地局が、前記端末から送信された前記アンテナの選択結果を参照して、異なるセルに属する複数の前記アンテナを前記端末に割り当て、

前記基地局が、前記アンテナの割当結果を前記端末に通知することを特徴とする通信制御方法。

請求項１８

前記端末が、端末固有の第２の参照信号を送信し、

前記基地局が、前記第２の参照信号を受信して、前記アンテナ毎に前記第２の参照信号の受信電力を推定し、

前記基地局が、前記受信電力の推定結果に基づいて、通信に適する複数の前記アンテナを選択し、

前記基地局が、前記アンテナの選択結果を参照して、異なるセルに属する複数の前記アンテナを前記端末に割り当て、

前記基地局が、前記アンテナの割当結果を前記端末に通知することを特徴とする請求項１７に記載の通信制御方法。

図1

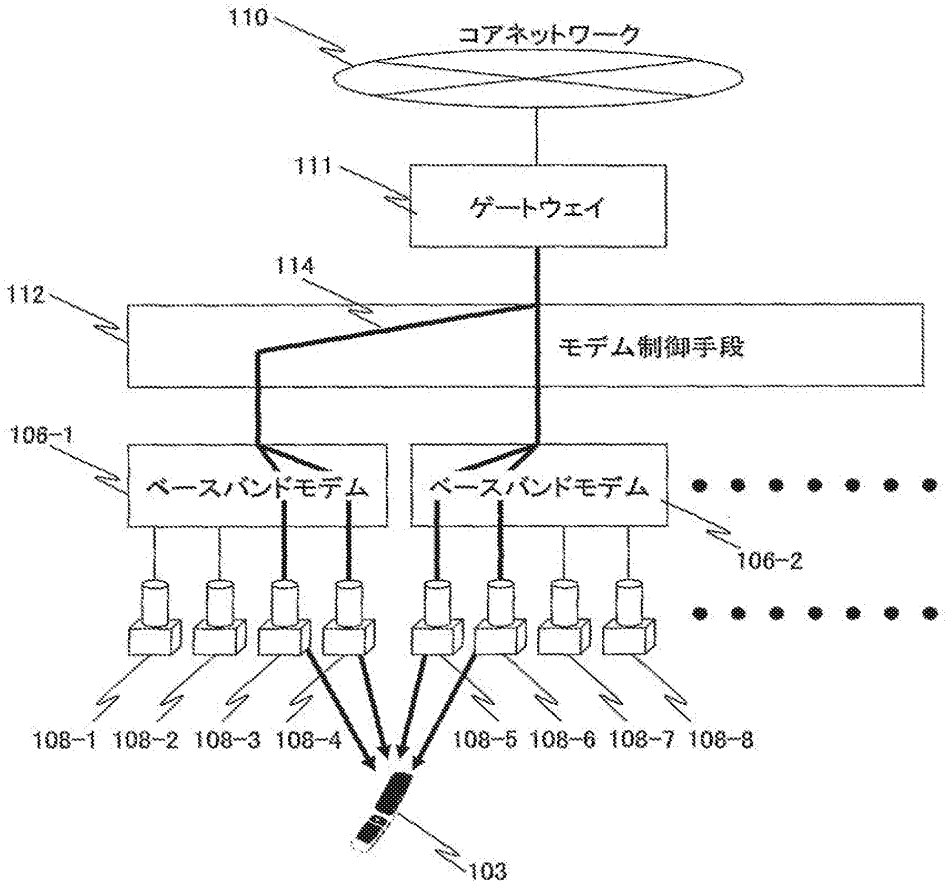

110
コアネットワーク
111
ゲートウェイ
114
112
モデム制御手段
106-1
ベースバンドモデム
ベースバンドモデム
106-2
108-1 108-2 108-3 108-4 108-5 108-6 108-7 108-8
103

図2

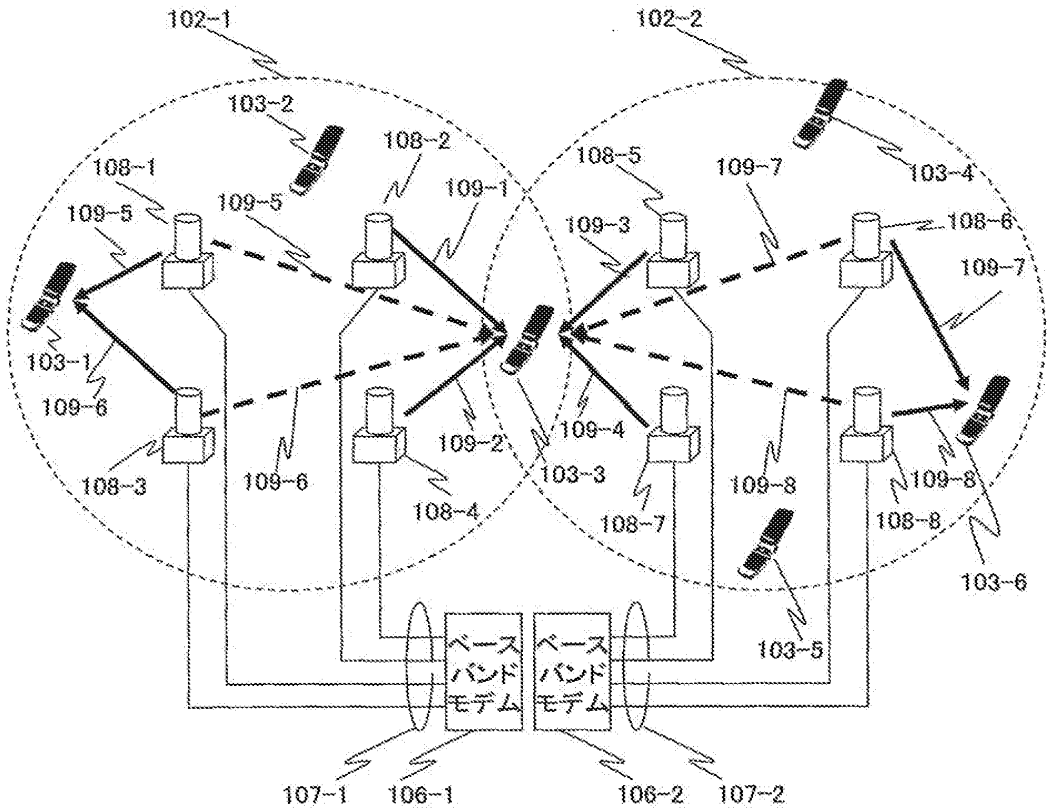

102-1
102-2
103-2
108-2
108-1
109-5
109-5
109-1
108-5
109-7
103-4
109-3
108-6
109-7
103-1
109-6
109-2
109-4
103-3
108-3
109-6
108-4
108-7
109-8
109-8
108-8
103-6
103-5
ベースバンドモデム
ベースバンドモデム
107-1
106-1
106-2
107-2

図3A

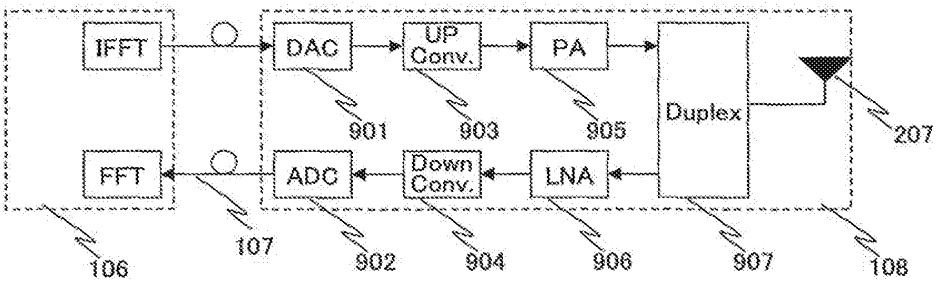

IFFT
DAC
UP Conv.
PA
Duplex
207
901
903
905
FFT
ADC
Down Conv.
LNA
106
107
902
904
906
907
108

図3B

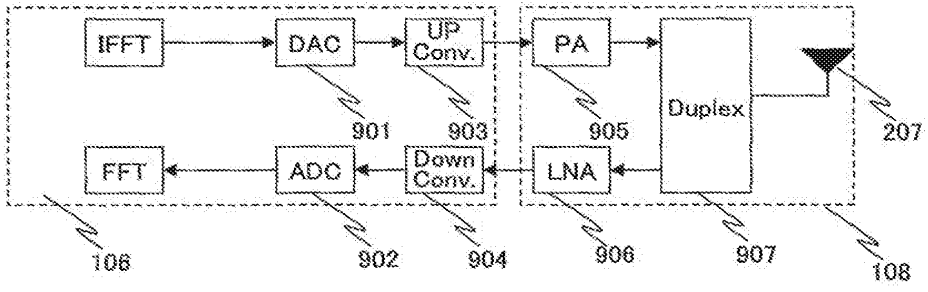

IFFT
DAC
UP Conv.
PA
Duplex
207
901
903
905
FFT
ADC
Down Conv.
LNA
106
902
904
906
907
108

図3C

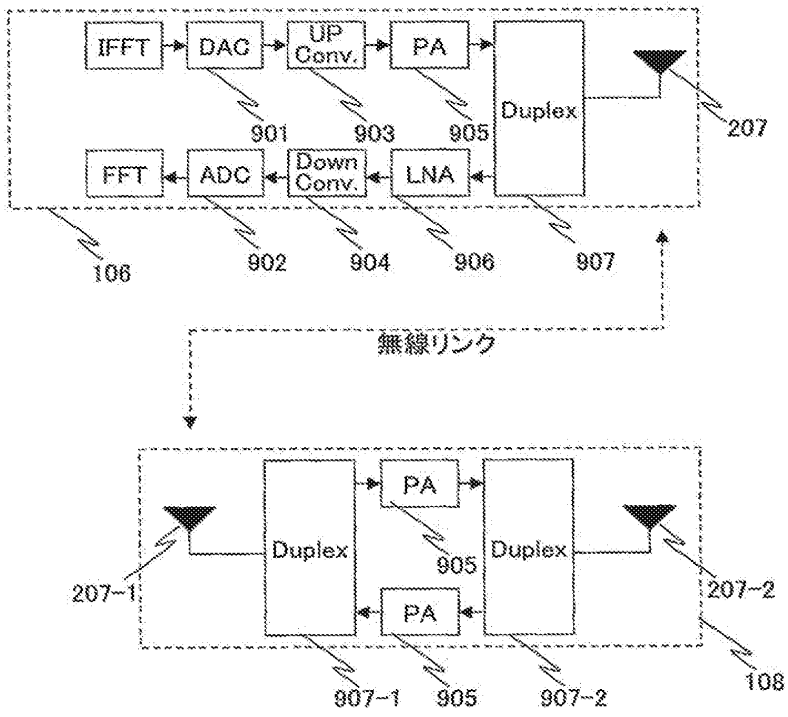

IFFT
DAC
UP Conv.
PA
Duplex
207
901
903
905
FFT
ADC
Down Conv.
LNA
106
902
904
906
907
無線リンク
PA
Duplex
Duplex
207-1
207-2
905
PA
907-1
905
907-2
108

図4

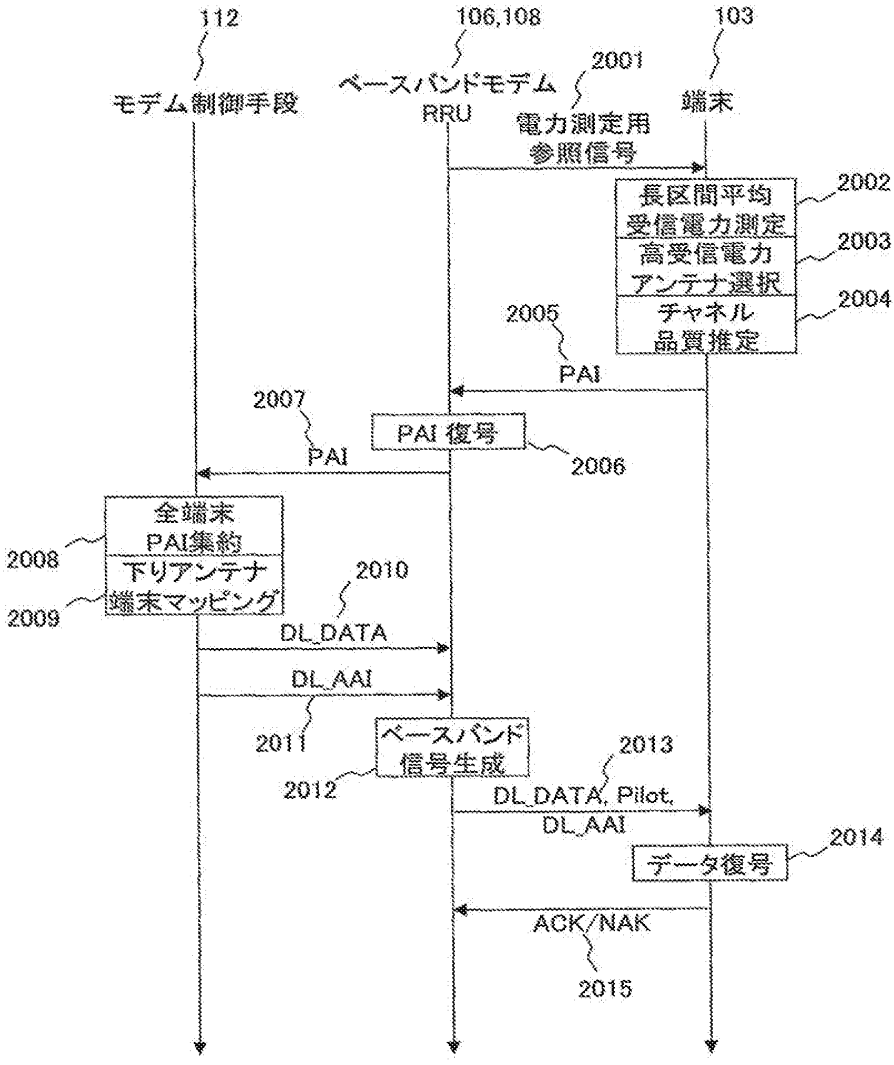

112
106,108
103
モデム制御手段
ベースバンドモデム
RRU
2001
電力測定用
参照信号
端末
長区間平均
受信電力測定
2002
高受信電力
アンテナ選択
2003
チャネル
品質推定
2004
2005
PAI
2007
PAI
PAI 復号
2006
全端末
PAI集約
2008
下りアンテナ
端末マッピング
2009
2010
DL_DATA
DL_AAI
2011
ベースバンド
信号生成
2012
2013
DL_DATA, Pilot,
DL_AAI
データ復号
2014
ACK/NAK
2015

図5

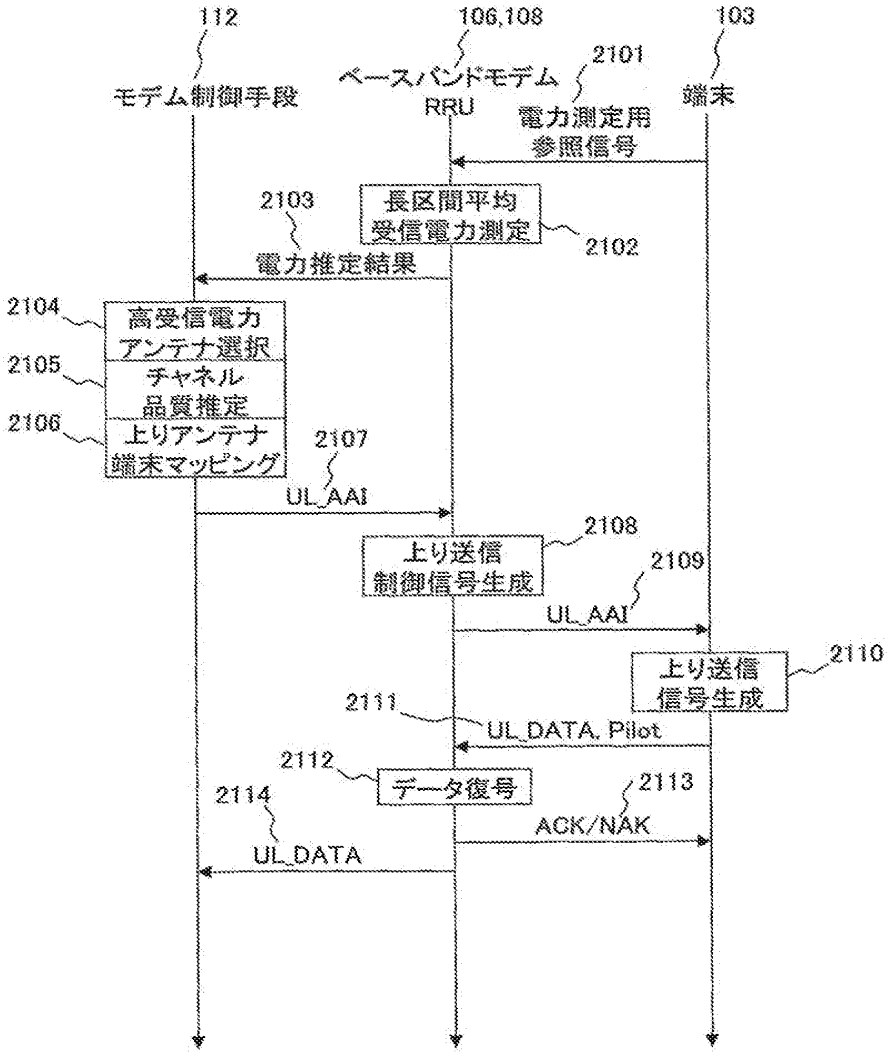

112
106,108
103
モデム制御手段
ベースバンドモデム
RRU
2101
電力測定用
参照信号
端末
2103
長区間平均
受信電力測定
2102
電力推定結果
2104
高受信電力
アンテナ選択
2105
チャネル
品質推定
2106
上りアンテナ
端末マッピング
2107
UL_AAI
2108
上り送信
制御信号生成
2109
UL_AAI
2110
上り送信
信号生成
2111
UL_DATA, Pilot
2112
データ復号
2113
ACK/NAK
2114
UL_DATA

図6

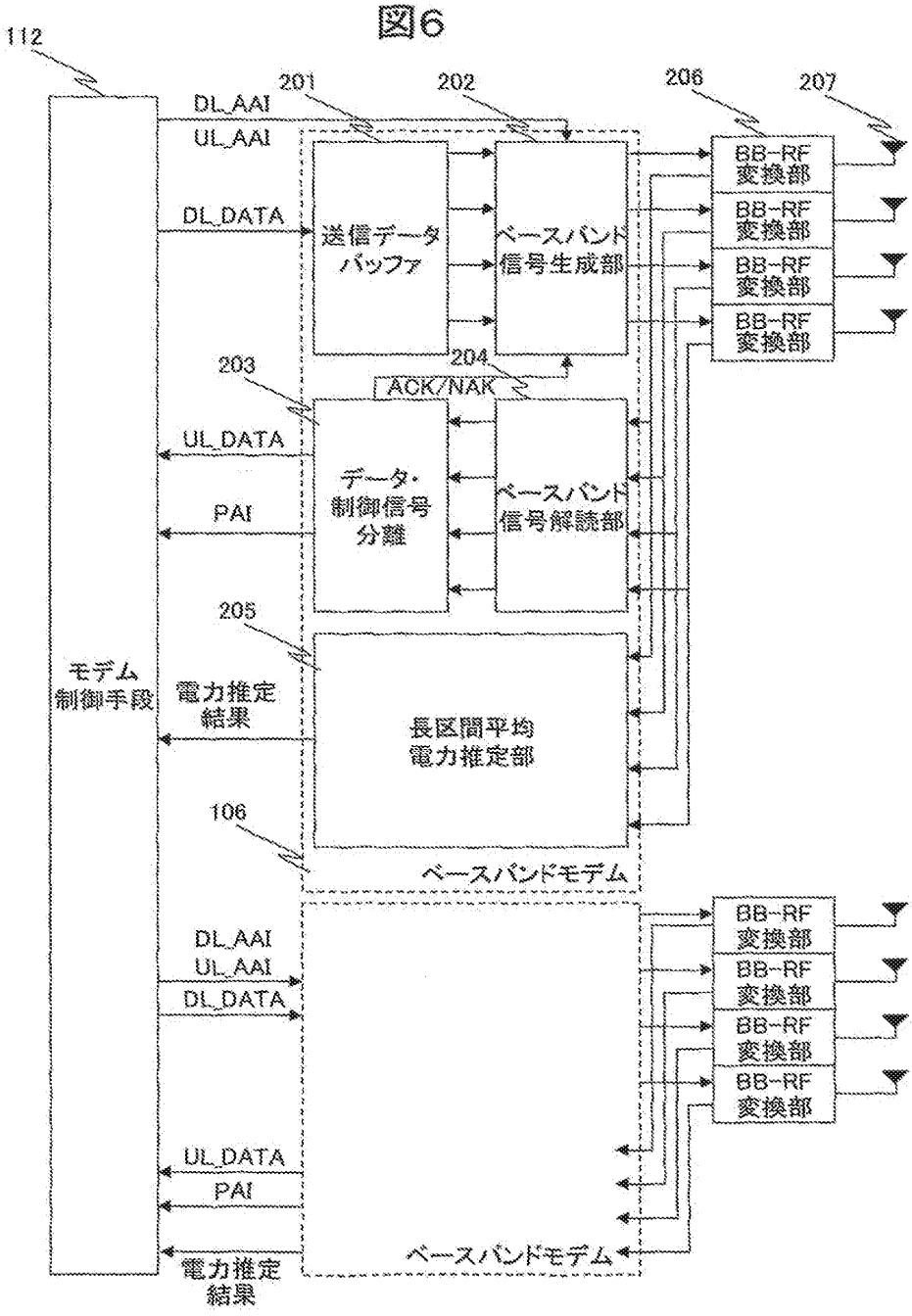

112
201
202
206
207
DL_AAI
UL_AAI
DL_DATA
送信データ
バッファ
ベースバンド
信号生成部
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
203
204
ACK/NAK
UL_DATA
PAI
データ・
制御信号
分離
ベースバンド
信号解読部
205
モデム
制御手段
電力推定
結果
長区間平均
電力推定部
106
ベースバンドモデム
DL_AAI
UL_AAI
DL_DATA
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
UL_DATA
PAI
電力推定
結果
ベースバンドモデム

図7

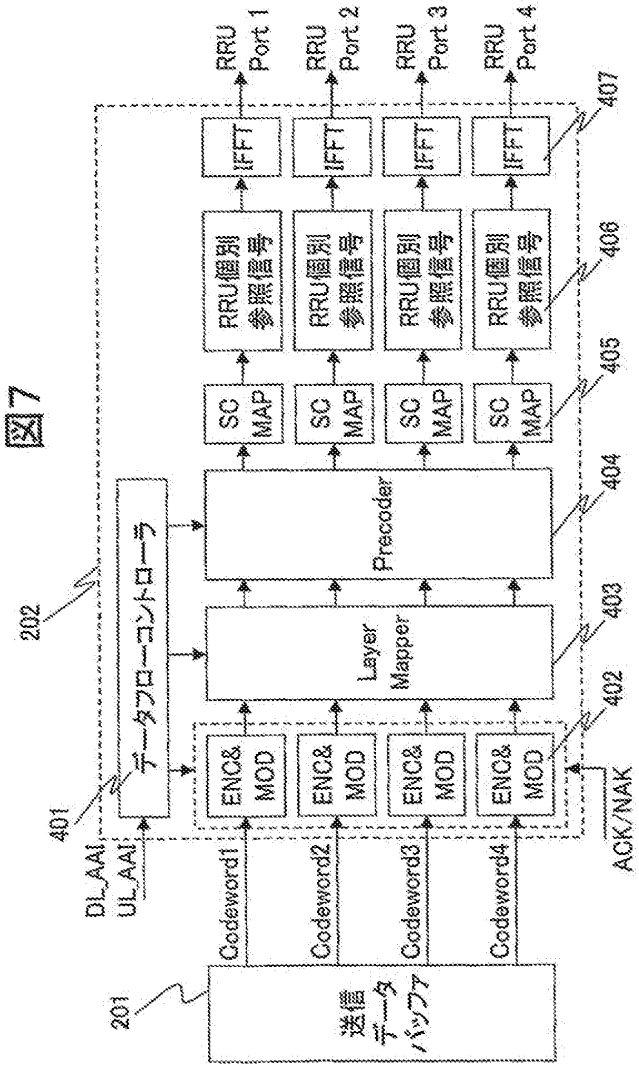

送信データバッファ
201
Codeword1
Codeword2
Codeword3
Codeword4
DL_AAI
UL_AAI
401
データフローコントローラ
202
ENC& MOD
Layer Mapper
403
Precoder
404
SC MAP
405
RRU個別参照信号
406
IFFT
407
RRU Port 1
RRU Port 2
RRU Port 3
RRU Port 4
ACK/NAK
402

図8

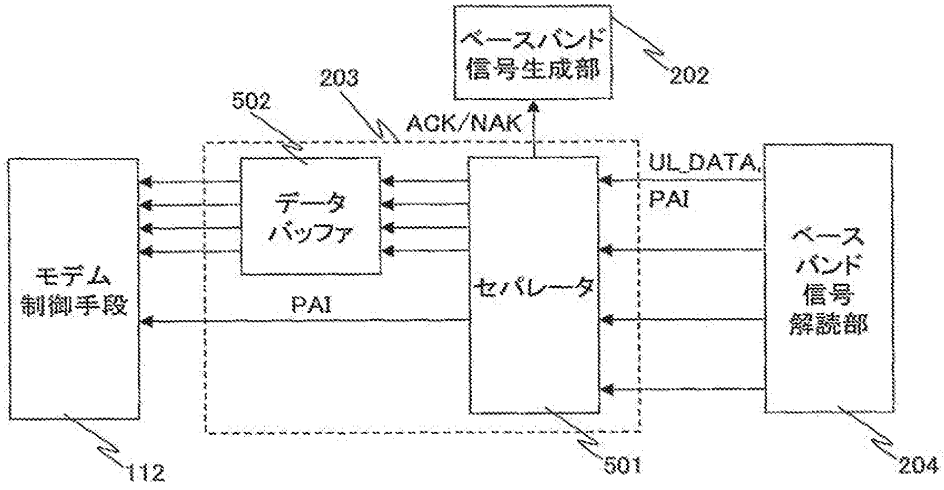

ベースバンド
信号生成部
202
203
502
ACK/NAK
UL_DATA,
PAI
データ
バッファ
モデム
制御手段
PAI
セパレータ
ベース
バンド
信号
解読部
112
501
204

図9

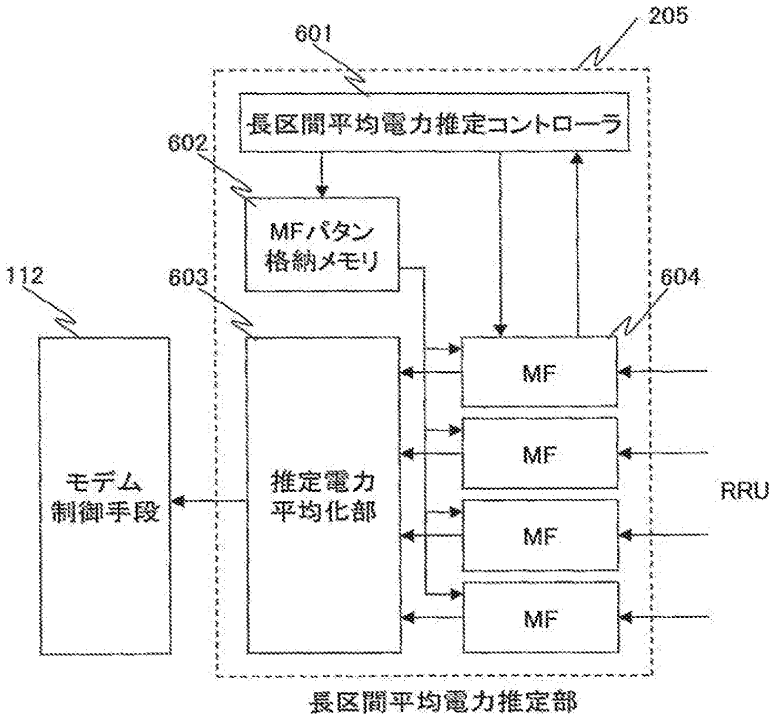

601
205
長区間平均電力推定コントローラ
602
MFパタン
格納メモリ
112
603
604
MF
MF
MF
MF
RRU
モデム
制御手段
推定電力
平均化部
長区間平均電力推定部

図10

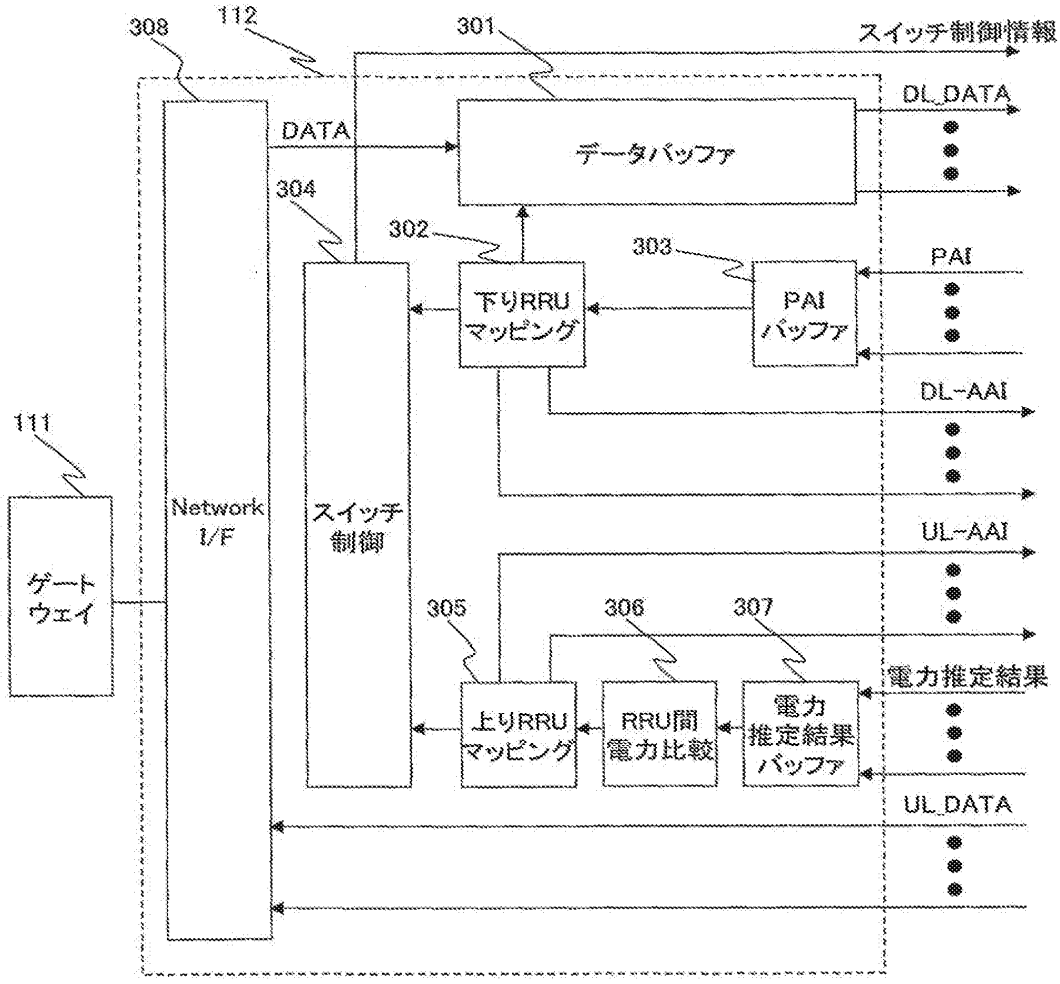

308
112
301
スイッチ制御情報
DL_DATA
DATA
データバッファ
304
302
303
PAI
下りRRU
マッピング
PAI
バッファ
DL-AAI
111
Network
I/F
スイッチ
制御
UL-AAI
ゲート
ウェイ
305
306
307
電力推定結果
上りRRU
マッピング
RRU間
電力比較
電力
推定結果
バッファ
UL_DATA

図11

1401 端末ID	1402 希望RRU数	1403 第1希望RRU-ID (MCS)	1404 第2希望RRU-ID (MCS)	1405 第3希望RRU-ID (MCS)	1406 第4希望RRU-ID (MCS)
1	4	4 (16)	8 (13)	12 (12)	16 (10)
2	4	1 (12)	2 (10)	3 (6)	4 (3)
3	3	6 (8)	8 (4)	10 (0)	————
4	2	13 (14)	14 (2)	————	————
5	1	4 (3)	————	————	————

図12

1501 モデムID	1502 RRUポート	1503 RRU-ID	1504 推定受信電力 端末ID1	1505 推定受信電力 端末ID2
1	0	1	20	1500
1	1	2	15	1200
1	2	3	10	1000
1	3	4	1000	800
2	0	5	6	2
2	1	6	4	4
2	2	7	3	3
2	3	8	950	2
3	0	9	1	10
3	1	10	1	15
3	2	11	2	12
3	3	12	850	18
4	0	13	15	8
4	1	14	20	4
4	2	15	25	2
4	3	16	700	1

図13

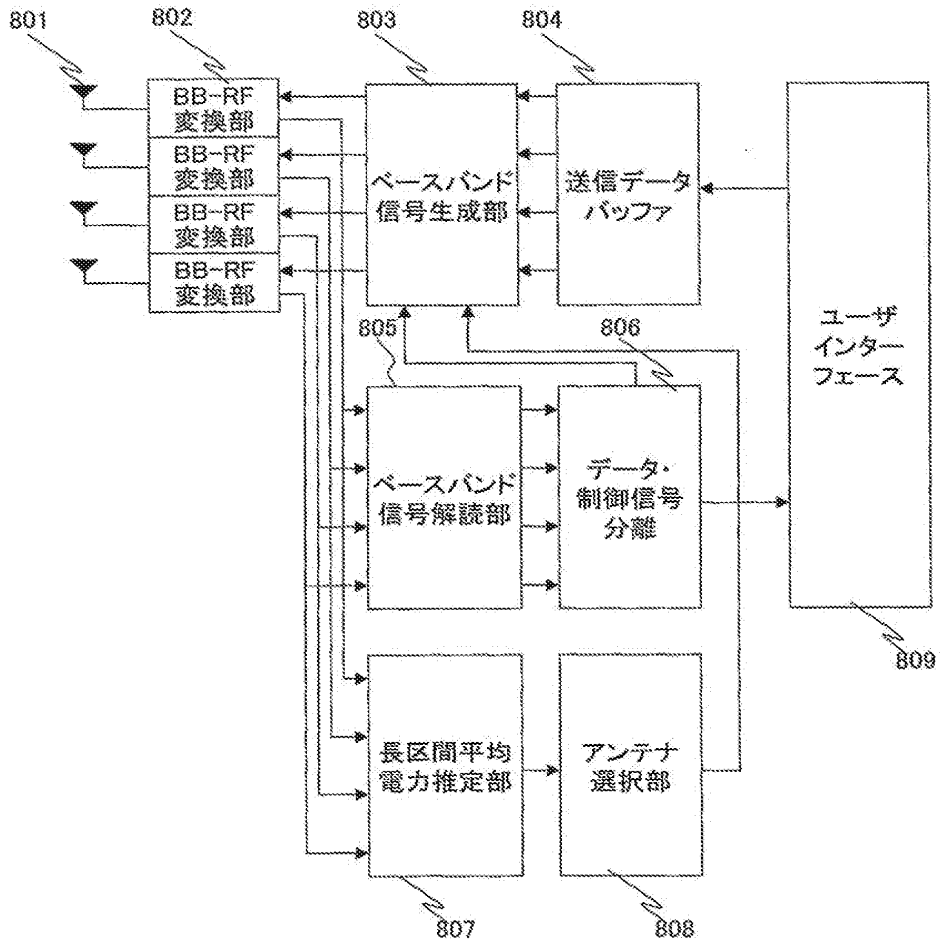

801
802
803
804
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
ベースバンド
信号生成部
送信データ
バッファ
ユーザ
インター
フェース
805
806
ベースバンド
信号解読部
データ・
制御信号
分離
809
長区間平均
電力推定部
アンテナ
選択部
807
808

図14A

項目	パラメータ	
端末識別子	1	2701
割り当てRRU数	3	2702
割り当てRRU-ID1	8	2703
割り当てRRU-ID2	12	
割り当てRRU-ID3	16	
MCS for RRU-ID1	8	2704
MCS for RRU-ID2	12	
MCS for RRU-ID3	16	

図14B

項目	パラメータ	
端末識別子	1	2711
割り当てRRU数	3	2712
MCS	11	2713

図15

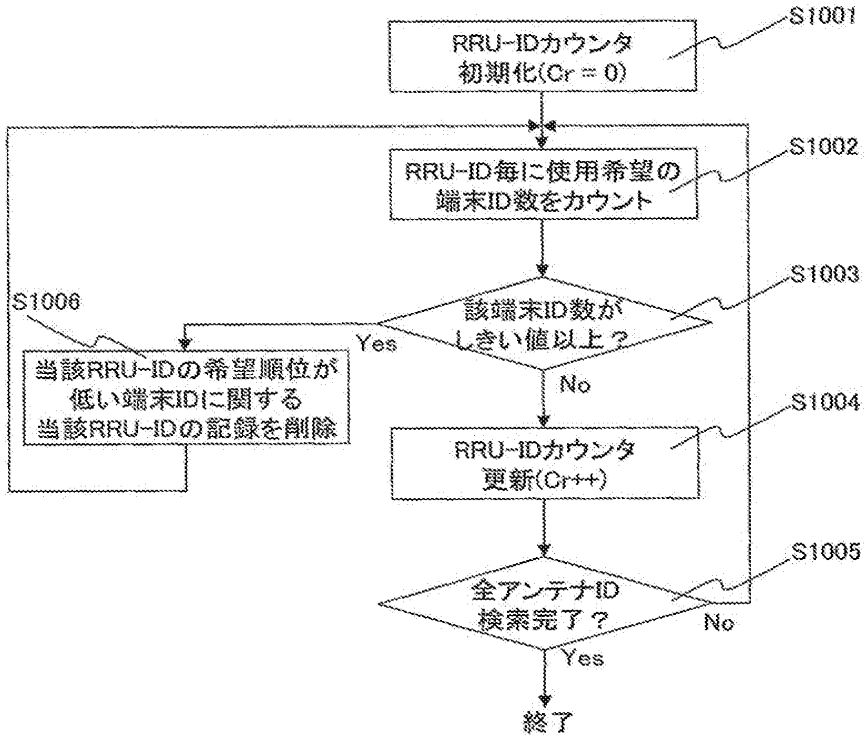

S1001
RRU-IDカウンタ
初期化(Cr = 0)
S1002
RRU-ID毎に使用希望の
端末ID数をカウント
S1003
該端末ID数が
しきい値以上？
Yes
No
S1006
当該RRU-IDの希望順位が
低い端末IDに関する
当該RRU-IDの記録を削除
S1004
RRU-IDカウンタ
更新(Cr++)
S1005
全アンテナID
検索完了？
No
Yes
終了

図16

1401 端末ID	1402 希望RRU数	1403 RRU-ID 第1希望	1404 RRU-ID 第2希望	1405 RRU-ID 第3希望	1406 RRU-ID 第4希望
1	4	4 (16)	8 (13)	12 (12)	16 (10)
2	~~4~~ ⇒3	1 (12)	2 (10)	3 (6)	~~4~~ ⇒削除
3	3	6 (8)	8 (4)	10 (0)	————
4	2	13 (14)	14 (2)	————	————
5	1	4 (3)	————	————	————

図17

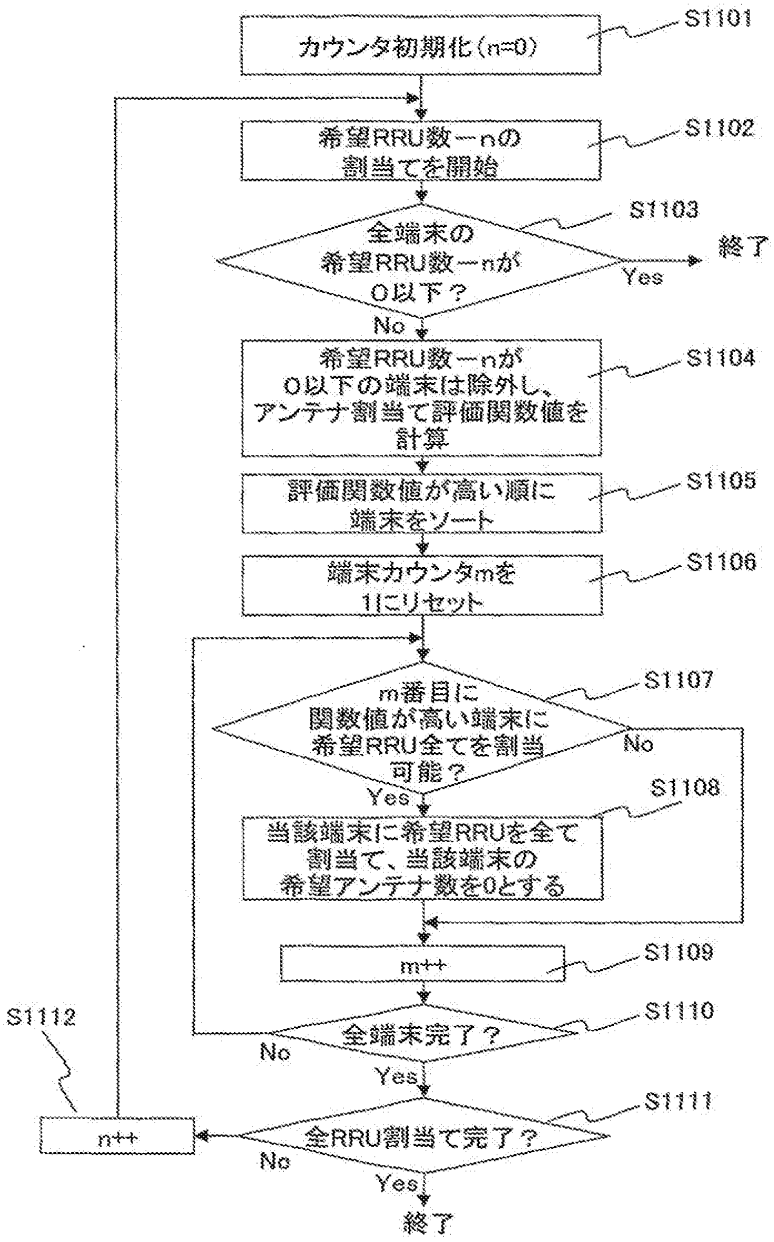

カウンタ初期化(n=0)
S1101
希望RRU数－nの
割当てを開始
S1102
全端末の
希望RRU数－nが
0以下？
S1103
Yes
終了
No
希望RRU数－nが
0以下の端末は除外し、
アンテナ割当て評価関数値を
計算
S1104
評価関数値が高い順に
端末をソート
S1105
端末カウンタmを
1にリセット
S1106
m番目に
関数値が高い端末に
希望RRU全てを割当
可能？
S1107
No
Yes
当該端末に希望RRUを全て
割当て、当該端末の
希望アンテナ数を0とする
S1108
m++
S1109
全端末完了？
S1110
No
Yes
S1112
n++
全RRU割当て完了？
S1111
No
Yes
終了

図18

1401 端末ID	1402 割当てRRU数	1403 割当て第1 RRU-ID	1404 割当て第2 RRU-ID	1405 割当て第3 RRU-ID	1406 割当て第4 RRU-ID
1	3	8	12	16	————
2	3	1	2	3	————
3	2	6	10	————	————
4	2	13	14	————	————
5	1	4	————	————	————

図19A

項目	パラメータ
端末番号	1
割当て希望RRU数	4
割当て希望RRU-ID1	4
割当て希望RRU-ID2	8
割当て希望RRU-ID3	12
割当て希望RRU-ID4	16

2801
2802
2803

図19B

項目	パラメータ
端末番号	1
割当て希望RRU数	4
CQI for RRU-ID1	16
CQI for RRU-ID2	14
CQI for RRU-ID3	10
CQI for RRU-ID4	7

2801
2802
2804

図19C

項目	パラメータ
端末番号	1
割当て希望RRU数	4
第1希望まで割当て時のCQI	16
第2希望まで割当て時のCQI	15
第3希望まで割当て時のCQI	13
第4希望まで割当て時のCQI	11

2801
2802
2805

図20A

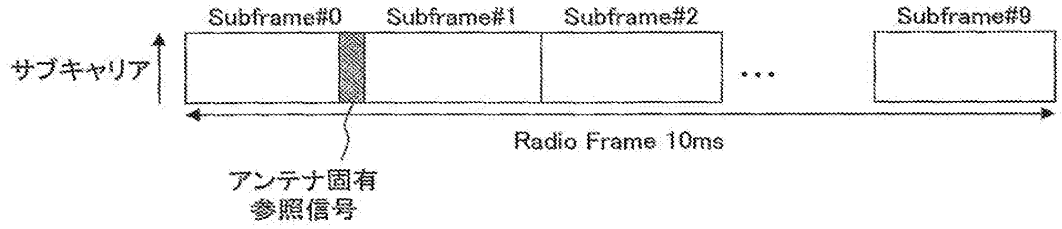


図20B

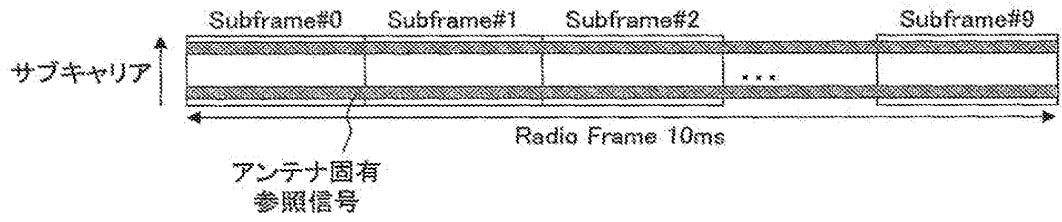


図20C

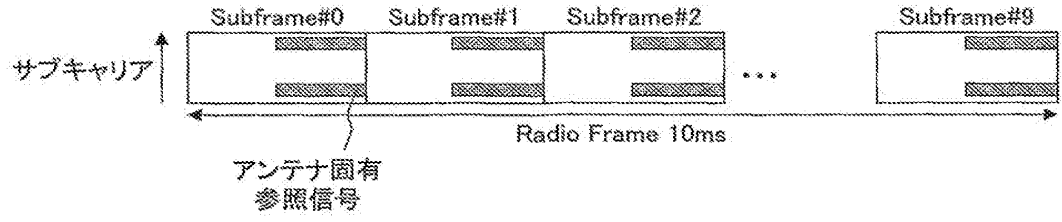


図21A

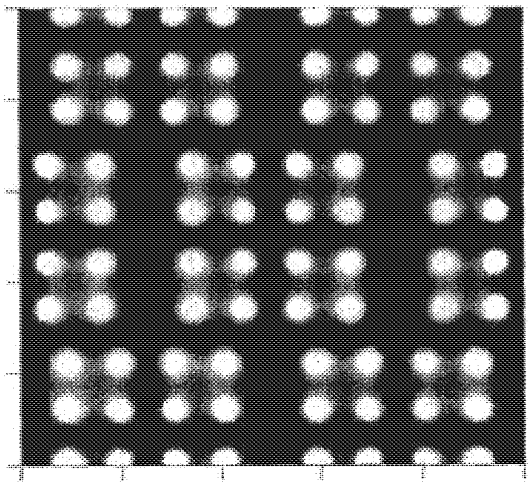


図21B

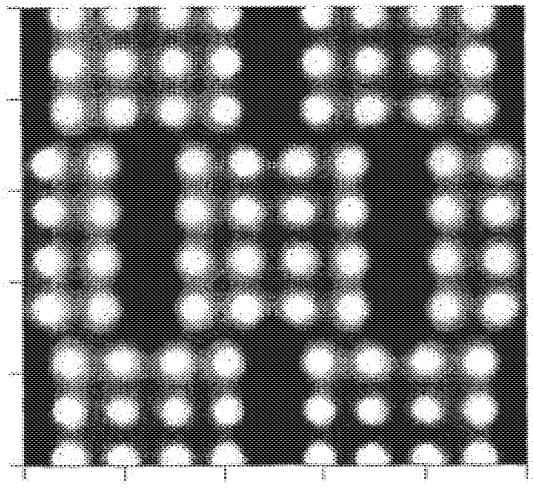


図22

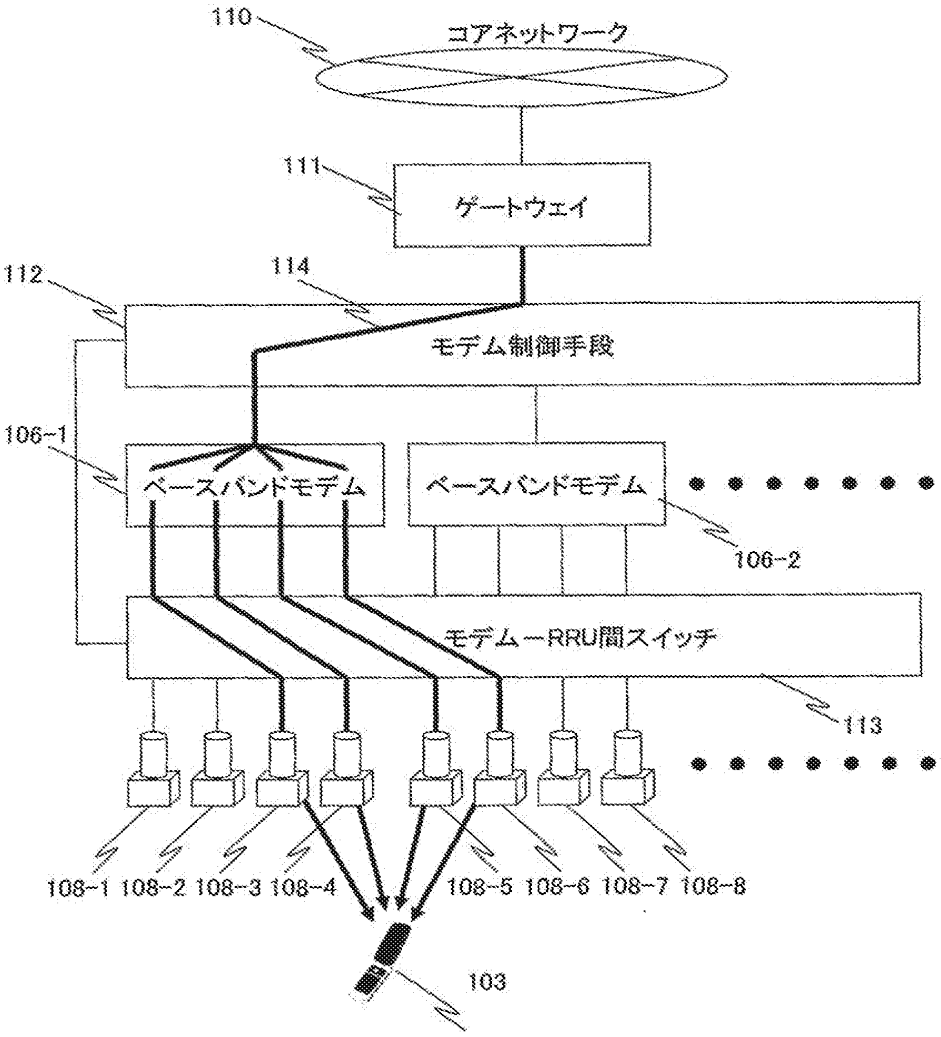

110
コアネットワーク
111
ゲートウェイ
112
114
モデム制御手段
106-1
ベースバンドモデム
ベースバンドモデム
106-2
モデムーRRU間スイッチ
113
108-1 108-2 108-3 108-4 108-5 108-6 108-7 108-8
103

図23

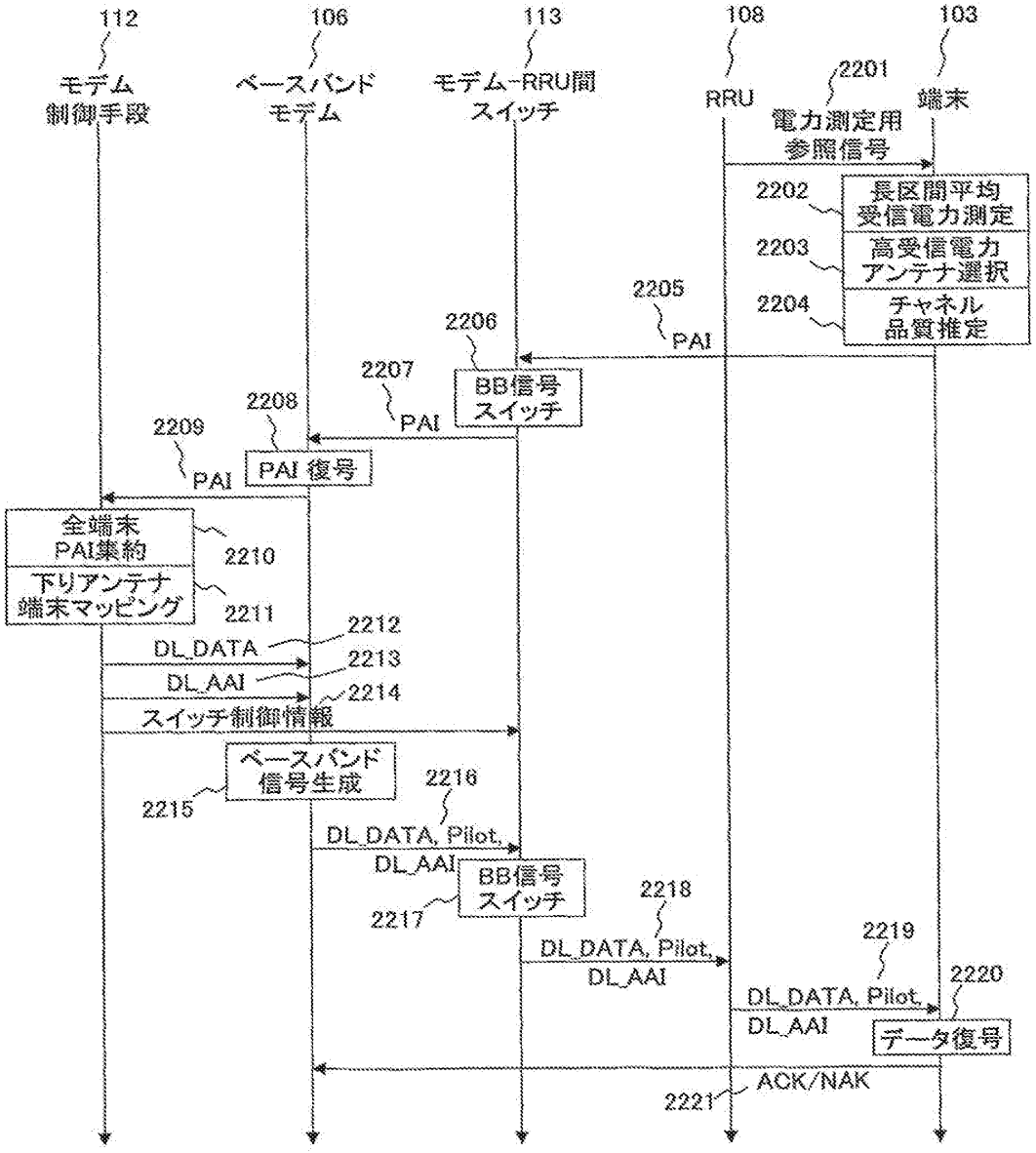

112
モデム
制御手段
106
ベースバンド
モデム
113
モデム-RRU間
スイッチ
108
RRU
103
端末
2201
電力測定用
参照信号
2202
長区間平均
受信電力測定
2203
高受信電力
アンテナ選択
2204
チャネル
品質推定
2205
PAI
2206
BB信号
スイッチ
2207
PAI
2208
PAI 復号
2209
PAI
全端末
PAI集約
2210
下りアンテナ
端末マッピング
2211
2212
DL_DATA
2213
DL_AAI
2214
スイッチ制御情報
ベースバンド
信号生成
2215
2216
DL_DATA, Pilot,
DL_AAI
BB信号
スイッチ
2217
2218
DL_DATA, Pilot,
DL_AAI
2219
2220
DL_DATA, Pilot,
DL_AAI
データ復号
ACK/NAK
2221

図24

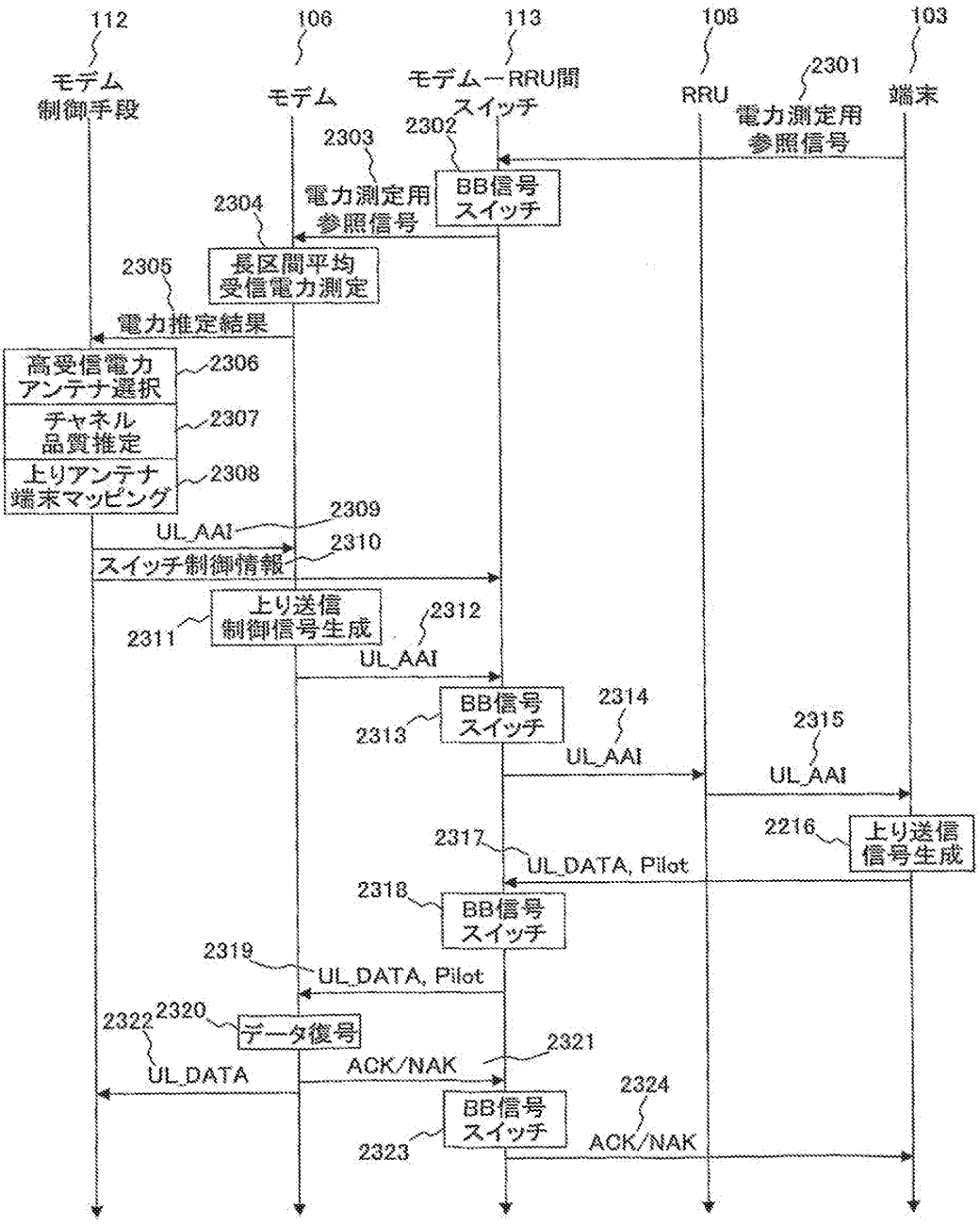

112
106
113
108
103
モデム制御手段
モデム
モデム－RRU間スイッチ
RRU
電力測定用参照信号
端末
2301
2302
2303
BB信号スイッチ
電力測定用参照信号
2304
長区間平均受信電力測定
2305
電力推定結果
高受信電力アンテナ選択
2306
チャネル品質推定
2307
上りアンテナ端末マッピング
2308
UL_AAI
2309
スイッチ制御情報
2310
上り送信制御信号生成
2311
2312
UL_AAI
BB信号スイッチ
2313
2314
UL_AAI
2315
UL_AAI
2216
上り送信信号生成
2317
UL_DATA, Pilot
2318
BB信号スイッチ
2319
UL_DATA, Pilot
2320
データ復号
2322
UL_DATA
ACK/NAK
2321
2324
BB信号スイッチ
2323
ACK/NAK

図25

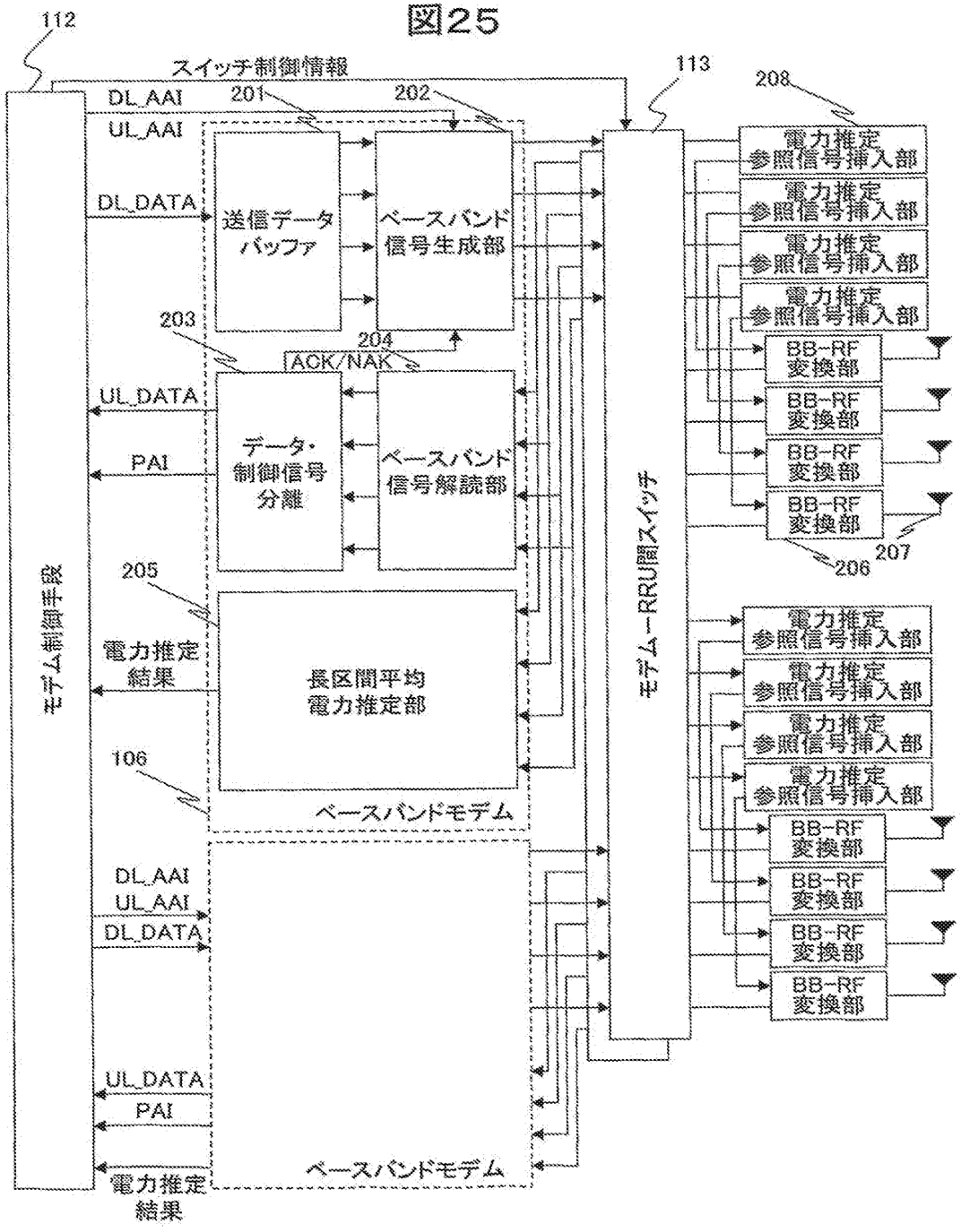

112
スイッチ制御情報
113
208
DL_AAI
201
202
UL_AAI
DL_DATA
送信データ
バッファ
ベースバンド
信号生成部
電力推定
参照信号挿入部
電力推定
参照信号挿入部
電力推定
参照信号挿入部
電力推定
参照信号挿入部
203
204
ACK/NAK
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
UL_DATA
PAI
データ・
制御信号
分離
ベースバンド
信号解読部
206
207
205
電力推定
結果
長区間平均
電力推定部
モデム制御手段
モデム-RRU間スイッチ
106
ベースバンドモデム
電力推定
参照信号挿入部
電力推定
参照信号挿入部
電力推定
参照信号挿入部
電力推定
参照信号挿入部
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
BB-RF
変換部
DL_AAI
UL_AAI
DL_DATA
UL_DATA
PAI
電力推定
結果
ベースバンドモデム

図26

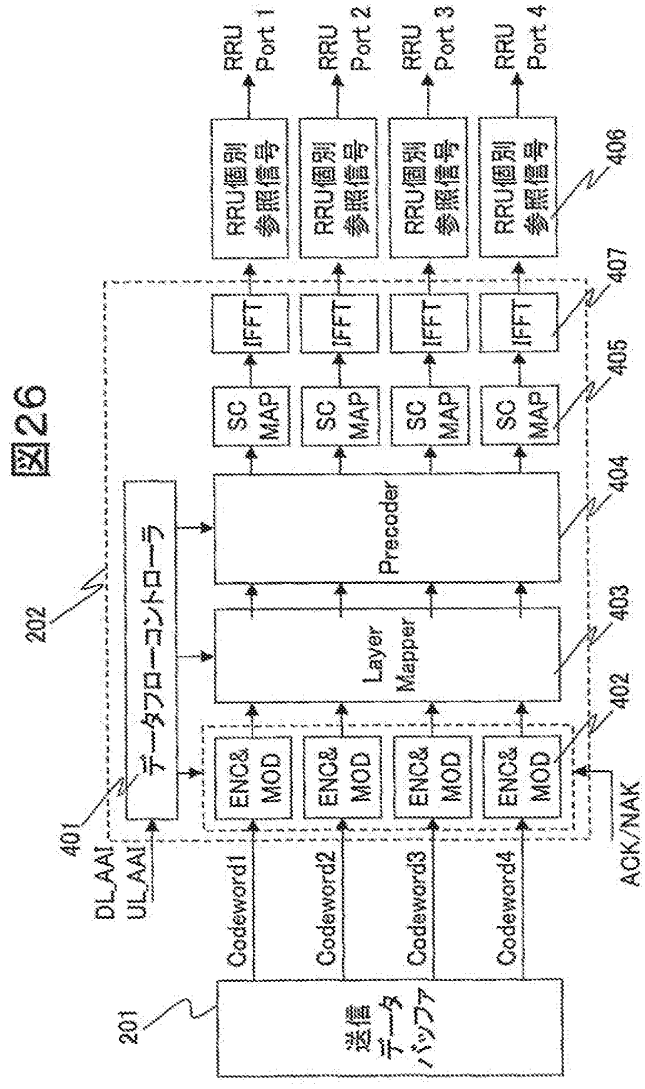

送信データバッファ
201
Codeword1
Codeword2
Codeword3
Codeword4
DL_AAI
UL_AAI
401
データフローコントローラ
202
ENC& MOD
Layer Mapper
403
Precoder
404
SC MAP
405
IFFT
407
RRU個別参照信号
406
RRU Port 1
RRU Port 2
RRU Port 3
RRU Port 4
ACK/NAK
402

図27

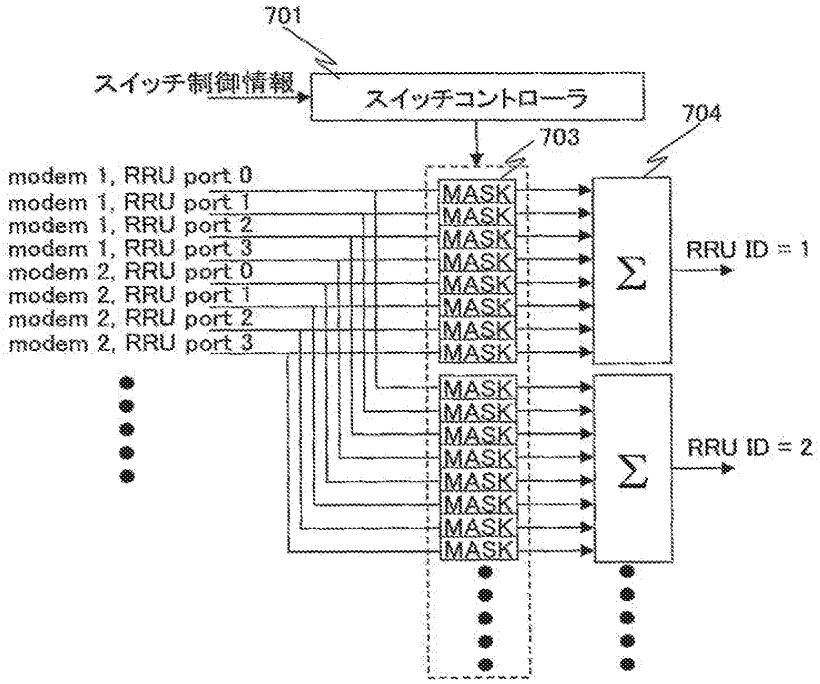
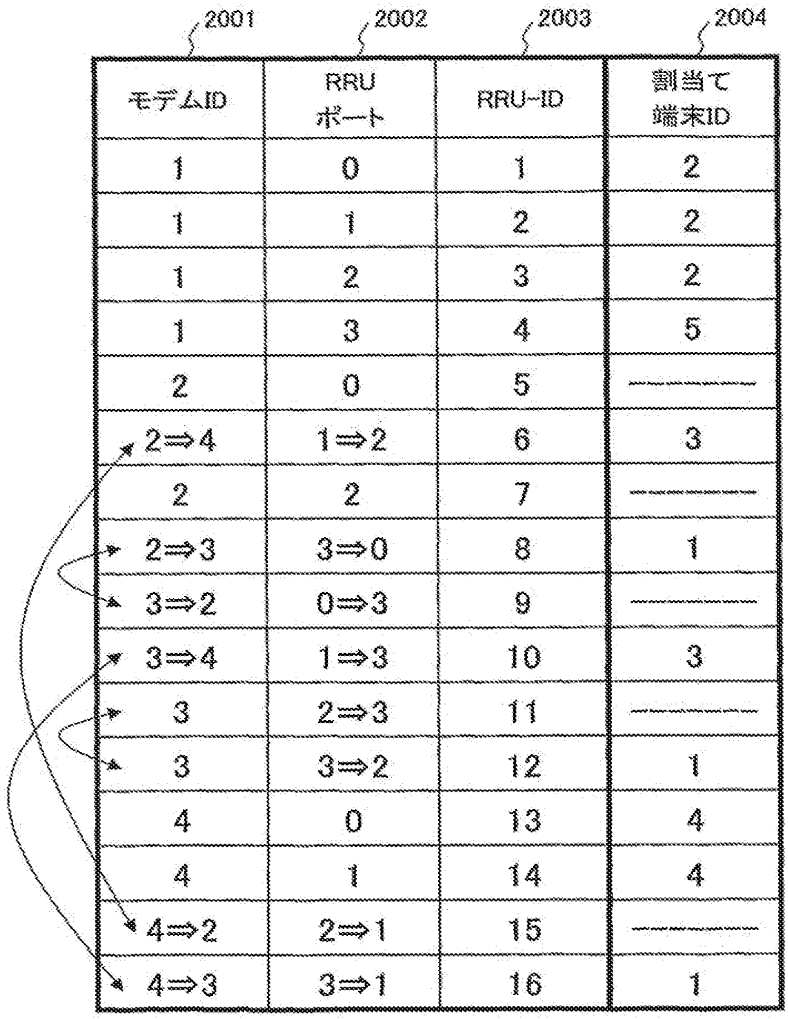

701
スイッチ制御情報
スイッチコントローラ
703
704
modem 1, RRU port 0
modem 1, RRU port 1
modem 1, RRU port 2
modem 1, RRU port 3
modem 2, RRU port 0
modem 2, RRU port 1
modem 2, RRU port 2
modem 2, RRU port 3
MASK
Σ
RRU ID = 1
RRU ID = 2

図28

2001 モデムID	2002 RRU ポート	2003 RRU-ID	2004 割当て 端末ID
1	0	1	2
1	1	2	2
1	2	3	2
1	3	4	5
2	0	5	――――
2	1	6	3
2	2	7	――――
2	3	8	1
3	0	9	――――
3	1	10	3
3	2	11	――――
3	3	12	1
4	0	13	4
4	1	14	4
4	2	15	――――
4	3	16	1

図29



2001 モデムID	2002 RRU ポート	2003 RRU-ID	2004 割当て 端末ID
1	0	1	2
1	1	2	2
1	2	3	2
1	3	4	5
2	0	5	————
2⇒4	1⇒2	6	3
2	2	7	————
2⇒3	3⇒0	8	1
3⇒2	0⇒3	9	————
3⇒4	1⇒3	10	3
3	2⇒3	11	————
3	3⇒2	12	1
4	0	13	4
4	1	14	4
4⇒2	2⇒1	15	————
4⇒3	3⇒1	16	1

図30

2001 モデムID	2002 RRU ポート	2003 RRU-ID	2004 割当て 端末ID
1	0	1	2
1	1	2	2
1	2	3	2
1	3	4	5
2	0	5	————
2	1	15	————
2	2	7	————
2	3	9	————
3	0	8	1
3	1	16	1
3	2	12	1
3	3	11	————
4	0	13	4
4	1	14	4
4	2	6	3
4	3	10	3

図31

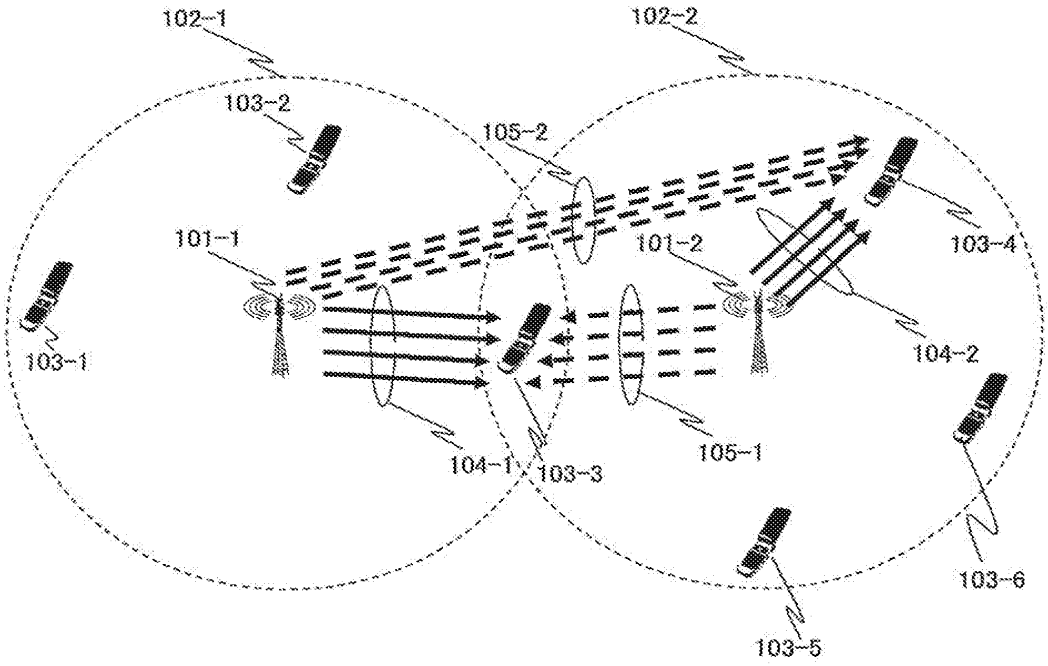
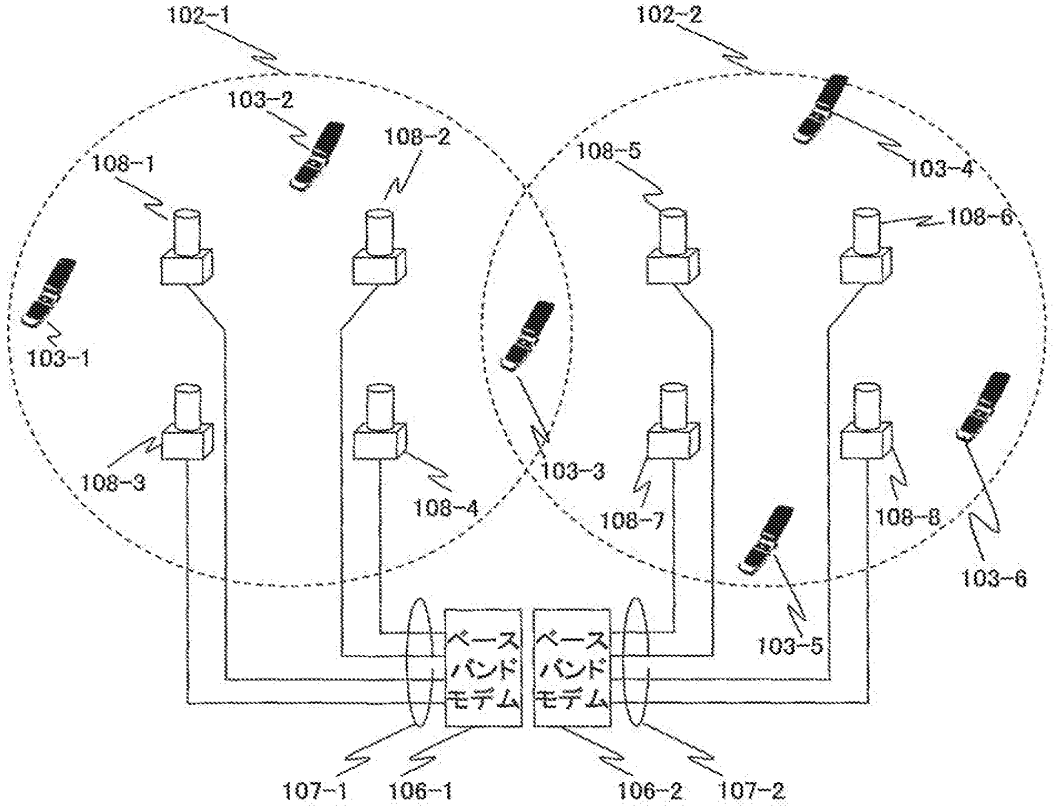

102-1
102-2
103-2
105-2
101-1
101-2
103-4
103-1
104-2
104-1
103-3
105-1
103-6
103-5

図32


102-1
102-2
103-2
108-2
108-1
108-5
103-4
108-6
103-1
103-3
108-3
108-4
108-7
108-8
103-6
103-5
ベースバンドモデム
ベースバンドモデム
107-1
106-1
106-2
107-2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/052008

A. CLASSIFICATION OF SUBJECT MATTER
H04W16/28(2009.01)i, *H04W88/02*(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B7/24-7/26, H04W4/00-99/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2004-519903 A (Koninklijke Philips Electronics N.V.), 02 July, 2004 (02.07.04), Abstract; Par. Nos. [0006] to [0042] & EP 1360851 A1 & US 2002/0119799 A1 & WO 2002/067603 A1 & CN 1457612 A & KR 2002-0091235 A	1-8,10-18 9
Y A	JP 2007-089113 A (NTT Docomo Inc.), 05 April, 2007 (05.04.07), Par. Nos. [0076] to [0088]; Fig. 28 & EP 1898542 A1 & WO 2006/134949 A1 & KR 2008-0030607 A	1-8,10-18 9

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 April, 2009 (20.04.09)	28 April, 2009 (28.04.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/052008

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2008/156065 A1 (NTT Docomo Inc.), 24 December, 2008 (24.12.08), Par. No. [0091] (Family: none)	5,6,15,16
Y A	JP 2004-040802 A (Samsung Electronics Co., Ltd.), 05 February, 2004 (05.02.04), Par. Nos. [0024] to [0043]; Figs. 1, 3 & US 2004/0004943 A1 & CN 1471331 A & KR 2004-0003262 A	8,10-12 9

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

国際調査報告	国際出願番号　PCT／JP2009／052008

A.　発明の属する分野の分類（国際特許分類（IPC））

Int.Cl.　H04W16/28(2009.01)i, H04W88/02(2009.01)i

B.　調査を行った分野

調査を行った最小限資料（国際特許分類（IPC））

Int.Cl.　H04B7/24-7/26, H04M3/00-99/00

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	1922－1996年
日本国公開実用新案公報	1971－2009年
日本国実用新案登録公報	1996－2009年
日本国登録実用新案公報	1994－2009年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

C.　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
Y A	JP 2004-519903 A（コーニンクレッカ　フィリップス　エレクトロニクス　エヌ　ヴィ）2004.07.02, 要約、【0006】－【0042】 & EP　1360851 A1 & US　2002/0119799 A1 & WO　2002/067603 A1 & CN　1457612 A & KR　2002-0091235 A	1-8, 10-18 9
Y A	JP 2007-089113 A（株式会社エヌ・ティ・ティ・ドコモ）2007.04.05, 【0076】－【0088】及び図28 & EP　1898542 A1 & WO　2006/134949 A1 & KR　2008-0030607 A	1-8, 10-18 9

☑　C欄の続きにも文献が列挙されている。　　☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「A」特に関連のある文献ではなく、一般的技術水準を示すもの
「E」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「L」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「O」口頭による開示、使用、展示等に言及する文献
「P」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「T」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「X」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Y」特に関連のある文献であって、当該文献と他の1以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「&」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
20．04．2009	28．04．2009

国際調査機関の名称及びあて先	特許庁審査官（権限のある職員）	5J	3782
日本国特許庁（ISA／JP） 郵便番号100－8915 東京都千代田区霞が関三丁目4番3号	石原　由晴		
	電話番号　03－3581－1101　内線　3534		

様式PCT／ISA／210（第2ページ）（2007年4月）

T-Mobile Ex. 1037

Ｃ（続き）．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
Ｙ	ＷＯ 2008/156065 Ａ１（株式会社エヌ・ティ・ティ・ドコモ）2008.12.24, 【００９１】 （ファミリーなし）	5, 6, 15, 16
Ｙ	ＪＰ 2004-040802 Ａ（三星電子株式会社）2004.02.05,　【００２４】	8, 10-12
Ａ	－【００４３】，図１及び図３ ＆ ＵＳ　2004/0004943 Ａ１　＆　ＣＮ　1471331 Ａ　＆　ＫＲ　2004-0003262 Ａ	9

Electronic Acknowledgement Receipt	
EFS ID:	27578836
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull/Brian Kanter
Filer Authorized By:	Kelvin B. Catmull
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	21-NOV-2016
Filing Date:	29-JUL-2016
Time Stamp:	18:26:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		102440US_IDS.pdf	173989 2cf100749636fbcb5dd02b5856cf342fb91f869b	yes	8

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	8	
Warnings:					
Information:					
2	Foreign Reference	JP2008506322A_41pages.pdf	1895234 cfd6f1aaefaf3f69326738dfb04b7cb4a38fa591	no	41
Warnings:					
Information:					
3	Foreign Reference	WO2010087031A1redux.pdf	11129591 9df018d2e5355f8eed31cee80d54a06009deadf9	no	85
Warnings:					
Information:					
		Total Files Size (in bytes):	13198814		

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.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on Novemiber 21, 2016.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Not Yet Assigned
Application No.: 15/223,819	Technology Center/Art Unit: 2414
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

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

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided.

In accordance with the Waiver of the Copy Requirements in 37 CFR §1.98 for Cited Pending U.S. Patent Applications, 1287 O.G. 163 (October 19, 2004), a copy of the cited, unpublished US Patent Application is available in the IFW and, therefore, not provided.

In accordance with 37 CFR §1.98(d), copies of the references can be found in 14/800,515 filed July 15, 2015, 14/260,145 filed April 23, 2014 and 13/211,247 filed August 16, 2011.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

This IDS is being filed before the mailing date of the first Office Action on the merits.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

/Kelvin B. Catmull/

Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

PUBLICATION NOTICE



Title:DISTRIBUTED ANTENNA SYSTEM

Publication No.US-2017-0055198-A1
Publication Date:02/23/2017

NOTICE OF PUBLICATION OF APPLICATION

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

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

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

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

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

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

PTO/AIA/80 (07-12)
Approved for use through 11/30/2014. 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 revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

■ Practitioners associated with Customer Number: 20350

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	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 assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

■ The address associated with Customer Number: 20350

OR

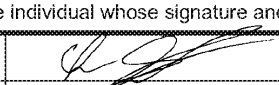
☐	Firm or Individual Name		
	Address		
	City	State	Zip
	Country		
	Telephone	Email	

Assignee Name and Address: Dali Wireless, Inc.
535 Middlefield Road
Menlo Park, California 94025

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be Filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, 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

Signature		Date	Jan. 12, 2017
Name	Christopher Schenck	Telephone	408.481.9400 ext. 1110
Title	Director of Legal		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Privacy Act Statement

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

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

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

Document Description: Application Data Sheet to update/correct info
Doc Code: ADS.CORR

CORRECTED ADS FORM

Application Number	15223819
Title of Invention	DISTRIBUTED ANTENNA SYSTEM

Inventor Information

****If no data is shown, no data has been corrected****

	Data of Record	Updated Data
Order Number		
Name		
Residence Information		
Residency		
City		
State		
Country of Residence		
Mailing Address of Inventor		
Address 1		
Address 2		
City,State/Province, Postal Code		
Country		

Corrected ADS 1.0

Document Description: Application Data Sheet to update/correct info
Doc Code: ADS.CORR

Application Information

	Data of Record	Updated Data
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	
Attorney Docket Number	091172-1017552-102440US	
Entity Type	Small	

Domestic Benefit/National Stage Information

****If no data is shown, no data has been corrected****

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121,365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S. C. 119(e) or 120, and 37 CFR 1.78(a).

		Data of Record	Updated Data
	Prior Application Status		
	Application Number		
	Continuity Type		
	Prior Application Number		
	Filing Date (YYYY-MM-DD)		
	Patent Number		
	Issue Date (YYYY-MM-DD)		

Foreign Priority Information

Corrected ADS 1.0

Document Description: Application Data Sheet to update/correct info
Doc Code: ADS.CORR

****If no data is shown, no data has been corrected****

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

		Data of Record	Updated Data
	Application Number		
	Country		
	Filing Date		
	Access Code		

Applicant Information

****If no data is shown, no data has been corrected****
Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

	Data of Record	Updated Data
Applicant Type	ASG	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is		
Name of the Deceased or Legally Incapacitated Inventor		
Applicant is an Organization	Yes	
Name		
Organization Name	~~Dali Systems Co. Ltd.~~	Dali Wireless, Inc.
Address 1		535 Middlefield Road
Address 2		

Corrected ADS 1.0

City,State/Province,Postal Code	~~George Town KY1-1104~~	Menlo Park CA 94025
Country	~~KY~~	US
Phone Number		
Fax Number		
Email Address		

Assignee Information including Non-Applicant Assignee Information

****If no data is shown, no data has been corrected****
Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office

	Data of Record	Updated Data
Order		
Applicant is an Organization		
Name		
Organization Name		
Mailing Address		
Address 1		
Address 2		
City,State/Province,Postal Code		
Country		
Phone Number		
Fax Number		
Email Address		

Corrected ADS 1.0

Signature

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b).

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

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

Signature	/Craig C. Largent/	Registration Number	56400
First Name	Craig C.	Last Name	Largent

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
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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.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Dali Wireless, Inc.

Application No./Patent No.: 15/223,819 Filed/Issue Date: July 29, 2016

Titled: DISTRIBUTED ANTENNA SYSTEM

Dali Wireless, Inc., a corporation

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

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

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

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

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

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

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

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

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

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

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

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

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

   1. From: Shawn Patrick Stapleton, Paul Lemson, Bin Lin To: Dali Systems Co. Ltd.

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

      Reel 027052, Frame 0064, or for which a copy thereof is attached.

   2. From: Albert S. Lee To: Dali Systems Co. Ltd.

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

      Reel 036229, Frame 0936, or for which a copy thereof is attached.

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

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

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

STATEMENT UNDER 37 CFR 3.73(c)

3. From: Dali Systems Co. Ltd. To: Dali Wireless, Inc.

The document was recorded in the United States Patent and Trademark Office at
Reel 039645, Frame 0347, or for which a copy thereof is attached.

4. From: _____ To: _____

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

5. From: _____ To: _____

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

6. From: _____ To: _____

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

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

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

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

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

/Craig C. Largent/	2017-03-23
Signature	Date
Craig C. Largent	56400
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

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

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

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

Electronic Acknowledgement Receipt	
EFS ID:	28724566
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Craig Cody Largent/Brian Kanter
Filer Authorized By:	Craig Cody Largent
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	23-MAR-2017
Filing Date:	29-JUL-2016
Time Stamp:	19:48:39
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	POA_Dali_Wireless_Inc.pdf	93212 7726f5d2640ee20048fd02a56980cfcfabc33872	no	2

Warnings:

Information:					
2	Application Data Sheet	ADS_102440US.pdf	65331 6f752821c45ceae99494c061e5a3fba5831605c4	no	5
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3	Assignee showing of ownership per 37 CFR 3.73	373c_102440US.pdf	121044 331a311fea1096774aa0f4f337e82bb42e779730	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	279587		

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 NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

POA ACCEPTANCE LETTER

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

OC000000090262584

Date Mailed: 03/30/2017

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/23/2017.

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**.

/sleutchit/

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/223,819	07/29/2016	2475	800	091172-1017552-102440US	20	3

CONFIRMATION NO. 3273

CORRECTED FILING RECEIPT

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

OC000000090262823

Date Mailed: 03/30/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Shawn Patrick Stapleton, Burnaby, CANADA;
Paul Lemson, Woodinvile, WA;
Bin Lin, Burnaby, CANADA;
Albert S. Lee, San Mateo, CA;

Applicant(s)

Dali Wireless, Inc., Melo Park, CA;

Power of Attorney: The patent practitioners associated with Customer Number 20350

Domestic Priority data as claimed by applicant

This application is a CON of 14/800,515 07/15/2015 PAT 9419837
which is a CON of 14/260,145 04/23/2014 PAT 9137078
which is a CON of 13/211,247 08/16/2011 PAT 8737300
which claims benefit of 61/439,940 02/07/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 08/11/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/223,819**

Projected Publication Date: Not Applicable

Non-Publication Request: No

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

DISTRIBUTED ANTENNA SYSTEM

Preliminary Class

370

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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

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

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

NOT GRANTED

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

SelectUSA

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

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Document Description: Application Data Sheet to update/correct info
Doc Code: ADS.CORR

CORRECTED ADS FORM

Application Number	15223819
Title of Invention	DISTRIBUTED ANTENNA SYSTEM

Inventor Information

****If no data is shown, no data has been corrected****

	Data of Record	Updated Data
Order Number		
Name		
Residence Information		
Residency		
City		
State		
Country of Residence		
Mailing Address of Inventor		
Address 1		
Address 2		
City,State/Province, Postal Code		
Country		

Corrected ADS 1.0

Document Description: Application Data Sheet to update/correct info
Doc Code: ADS.CORR

Application Information

	Data of Record	Updated Data
Title of Invention	DISTRIBUTED ANTENNA SYSTEM	
Attorney Docket Number	091172-1017552-102440US	
Entity Type	Small	

Domestic Benefit/National Stage Information

****If no data is shown, no data has been corrected****

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121,365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S. C. 119(e) or 120, and 37 CFR 1.78(a).

		Data of Record	Updated Data
	Prior Application Status		
	Application Number		
	Continuity Type		
	Prior Application Number		
	Filing Date (YYYY-MM-DD)		
	Patent Number		
	Issue Date (YYYY-MM-DD)		

Foreign Priority Information

Corrected ADS 1.0

Document Description: Application Data Sheet to update/correct info
Doc Code: ADS.CORR

****If no data is shown, no data has been corrected****

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

		Data of Record	Updated Data
	Application Number		
	Country		
	Filing Date		
	Access Code		

Applicant Information

****If no data is shown, no data has been corrected****
Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

	Data of Record	Updated Data
Applicant Type	ASG	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is		
Name of the Deceased or Legally Incapacitated Inventor		
Applicant is an Organization	Yes	
Name		
Organization Name	Dali Wireless, Inc.	
Address 1		
Address 2		

Corrected ADS 1.0

City,State/Province,Postal Code	~~Melo Park CA 94025~~	Menlo Park CA 94025
Country	US	
Phone Number		
Fax Number		
Email Address		

Assignee Information including Non-Applicant Assignee Information

****If no data is shown, no data has been corrected****
Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office

	Data of Record	Updated Data
Order		
Applicant is an Organization		
Name		
Organization Name		
Mailing Address		
Address 1		
Address 2		
City,State/Province,Postal Code		
Country		
Phone Number		
Fax Number		
Email Address		

Corrected ADS 1.0

Signature

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b).

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

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

Signature	/Craig C. Largent/	Registration Number	56400
First Name	Craig C.	Last Name	Largent

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on April 6, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No. 091172-1017552-102440US
Client Ref. No. DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Shawn Patrick Stapleton et al.
Application No.: 15/223,819
Filed: July 29, 2016
For: DISTRIBUTED ANTENNA SYSTEM

Confirmation No.: 3273
Examiner: Wei Zhao
Technology Center/Art Unit: 2475

REQUEST FOR CORRECTED FILING RECEIPT

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

Commissioner:

Attached is a marked-up copy of the official Filing Receipt received from the Patent and Trademark Office in connection with the above-noted application for which Applicant requests correction.

There is an error in spelling of the name of the city of applicant. The city name should be corrected as follows:

Applicant(s) Dali Wireless, Inc., ~~Melo Park~~ Menlo Park, CA;

A Corrected Application Data Sheet is submitted with this request.

Applicants respectfully request issuance of a correct Filing Receipt.

Respectfully submitted,

/Craig C. Largent/
Craig C. Largent
Registration No. 56,400

KILPATRICK TOWNSEND & STOCKTON LLP
Tel: 650-326-2400

Attachment

Marked-Up Filing Receipt

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/223,819	07/29/2016	2475	800	091172-1017552-102440US	20	3

CONFIRMATION NO. 3273

CORRECTED FILING RECEIPT

20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

OC000000090262623

Date Mailed: 03/30/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Shawn Patrick Stapleton, Burnaby, CANADA;
Paul Lemson, Woodinvile, WA;
Bin Lin, Burnaby, CANADA;
Albert S. Lee, San Mateo, CA;

Applicant(s)

Dali Wireless, Inc., ~~Melo Park~~ Menlo Park, CA;

Power of Attorney: The patent practitioners associated with Customer Number 20350

Domestic Priority data as claimed by applicant

This application is a CON of 14/800,515 07/15/2015 PAT 9419837
which is a CON of 14/260,145 04/23/2014 PAT 9137078
which is a CON of 13/211,247 08/16/2011 PAT 8737300
which claims benefit of 61/439,940 02/07/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 08/11/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/223,819**

Projected Publication Date: Not Applicable

Non-Publication Request: No

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

DISTRIBUTED ANTENNA SYSTEM

Preliminary Class

370

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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

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

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

NOT GRANTED

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

SelectUSA

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

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Electronic Acknowledgement Receipt	
EFS ID:	28854834
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	
Customer Number:	20350
Filer:	Craig Cody Largent/Brian Kanter
Filer Authorized By:	Craig Cody Largent
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	06-APR-2017
Filing Date:	29-JUL-2016
Time Stamp:	15:47:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet to update/ correct info	CorrectedADS.pdf	64855 44718c9168e79c449a70bd240995945d3e1f7499	no	5

Warnings:

Information:					
2	Request for Corrected Filing Receipt	CFR_MUFR.pdf	1610176 a2dacb49600ac3c23cadd1126fe5eded7bb46335	no	5
Warnings:					
Information:					
			Total Files Size (in bytes):	1675031	

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/223,819	07/29/2016	2475	800	091172-1017552-102440US	20	3

CONFIRMATION NO. 3273

CORRECTED FILING RECEIPT

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Inventor(s)

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Applicant(s)

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Power of Attorney: The patent practitioners associated with Customer Number 20350

Domestic Priority data as claimed by applicant

This application is a CON of 14/800,515 07/15/2015 PAT 9419837
which is a CON of 14/260,145 04/23/2014 PAT 9137078
which is a CON of 13/211,247 08/16/2011 PAT 8737300
which claims benefit of 61/439,940 02/07/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/223,819**

Projected Publication Date: Not Applicable

Non-Publication Request: No

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

DISTRIBUTED ANTENNA SYSTEM

Preliminary Class

370

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2475
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-4,775,795		07-05-1998	Page	
	2.	US-4,999,831		03-12-1991	Grace	
	3.	US-5,457,557	A	10-10-1995	Zarem et al.	
	4.	US-5,579,341	A	11-26-1996	Smith et al.	
	5.	US-5,619,202	A	04-08-1997	Wilson et al.	
	6.	US-5,621,730	A	04-15-1997	Kelley	
	7.	US-5,627,879	A	05-06-1997	Russell et al.	
	8.	US-5,644,622	A	07-01-1997	Russell et al.	
	9.	US-5,748,683	A	05-05-1998	Smith et al.	
	10.	US-5,818,883	A	10-06-1998	Smith et al.	
	11.	US-5,852,651	A	12-22-1998	Fischer et al.	
	12.	US-6,005,506	A	12-21-1999	Bazarjani et al.	
	13.	US-6,005,884	A	12-21-1999	Cook et al.	
	14.	US-6,014,366	A	01-11-2000	Ichiyoshi	
	15.	US-6,112,086	A	08-29-2000	Wala	
	16.	US-6,253,094	B1	06-26-2001	Schmutz	
	17.	US-6,356,369	B1	03-12-2002	Farhan et al.	
	18.	US-6,373,611	B1	01-16-2002	Farhan et al.	
	19.	US-6,594,496	B2	07-15-2003	Schwartz	
	20.	US-6,697,603	B1	02-24-2004	Lovinggood et al.	
	21.	US-6,704,545	B1	03-09-2004	Wala	
	22.	US-6,785,558	B1	08-31-2004	Stratford et al.	
	23.	US-6,826,164	B2	11-30-2004	Mani et al.	
	24.	US-6,831,901	B2	12-14-2004	Millar	
	25.	US-6,836,660	B1	12-28-2004	Wala	
	26.	US-7,257,328	B2	08-14-2007	Levinson et al.	
	27.	US-7,286,507	B1	10-23-2007	Oh et al.	
	28.	US-7,610,460	B2	10-27-2009	Wala	
	29.	US-7,787,854	B2	08-31-2010	Conyers et al.	
	30.	US-8,010,116	B2	08-30-2011	Scheinert	
	31.	US-8,346,091	B2	01-01-2013	Kummetz et al.	
	32.	US-8,446,530	B2	05-21-2013	Bellers	
	33.	US-8,737,454	B2	05-27-2014	Wala et al.	
	34.	US-8,958,789	B2	02-17-2015	Bauman et al.	
	35.	US-9,531,473	B2	12-27-2016	Lemson et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	36.	US-2005/0157675	A1	07-21-2005	Feder et al.	
	37.	US-2008/0119198	A1	05-22-2008	Hettstedt et al.	
	38.	US-2010/0128676	A1	05-27-2010	Wu et al.	
	39.	US-2006/0094470	A1	05-04-2006	Wake et al.	

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	First Named Inventor	Shawn Patrick Stapleton
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	Examiner Name	Wei Zhao
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	40.	US-2009/0180426	A1	07-16-2009	Sabat et al.	
	41.	US-2010/0296816	A1	11-25-2010	Larsen	
	42.	US-2009/0238566	A1	09-24-2009	Boldi et al.	
	43.	US-2003/0143947	A1	07-31-2003	Lyu	
	44.	US-2009/0170543	A1	07-02-2009	Mostafa et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	45.	0368673	EP	A1	05-16-1990	British Telecommunications		
	46.	01/56197	WO	A2	08-02-2001	Scientific-Atlanta, Inc.		
	47.	98/24256	WO	A2	06-04-1998	Ericsson Inc.		
	48.	0642243	EP	A1	03-08-1995	Roke Manor Research Limited		
	49.	2002-158615	JP	A	05-31-2002	Nat Inst Land & Infrastru ture		
	50.	2008-135955	JP	A	06-12-2008	Toshiba Corp		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	51.	BICSI, "Network Design Basics for Cabling Professionals", 2002, 393 pages, McGraw-Hill, New York, NY, USA.	
	52.	"Common Public Radio Interface (CPRI) Specification V1.4", dated 2006-03-31, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 64 pages.	
	53.	"Common Public Radio Interface (CPRI) Specification V2.1", dated 2006-03-31, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 76 pages.	
	54.	"Common Public Radio Interface (CPRI) Specification V3.0", dated 2006-10-20, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 89 pages.	
	55.	"Common Public Radio Interface (CPRI) Specification V4.0", dated 2008-06-30, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 96 pages.	

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	56.	"Common Public Radio Interface (CPRI) Specification V4.1", dated 2009-02-18, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 109 pages.	
	57.	GRUNDMANN et al., "An empriacal comparison of a distrubuted antenna microcell system versus a single antennal microcell system for indooor spread spectrum communications at 1.8 GHz", ICUPC Conference, 1993, 5 pages.	
	58.	ZHAOHUI et al., " A rake type receiver structure for CDMA mobile communication systems using antenna arrays", IEEE, 1996, pages 528-530.	
	59.	"Mastering The Mix In Signal Processing", Mixed-Signal Design Seminar, 1991, Analog Devices, Inc., 3 pages.	
	60.	GRACE, Martin K., "Synchronous quantized subcarrier multiplexing for transport of video, voice, and data", IEEE Journal on Selected Areas in Communications, September 1990, Vol. 8, No. 7., pp. 1351-1358.	
	61.	Wala, Philip M., "A new microcell architecture using digital optical transport", 1993, IEEE, pp 585-588.	
	62.	CROFUT, Walter, "Remote monitoring of wirelss base stations June 1, 1998"; http://urgentcomm.com/print/mag/remote-monitoring-wireless-base-stations, downloded on March 13, 2017, 4 pages.	
	63.	CYR et al., "The digital age is here, Digital radio frequency transport enhances cellular network performance", July 4, 1993, Telephony, pp 20-24.	
	64.	CityCell 824, "Remote Site Manual, How to use it, Preliminary Version"; February 1, 1993, 237 pages.	
	65.	CHEUN, Kyungwhoon, "Performance of direct-sequence spread-spectrum rake receives with randon spreading sequences", IEEE Transactions On Communication, September 9, 1997, Vol. 45, No. 9, pp. 1130-1143.	
	66.	BRUNNER et al., "On space-time rake receiver structure for WCDMA", 1999, IEEE, pp 1546-1551.	
	67.	GRAF, Rudolf F., "Modern Dictionary of Electronics, 7th Ed.", 1999, Newnes publishing, 9 pages.	
	68.	Office Action for Japanese Patent Application No. 2016-139702, mailed April 20, 2017, 7 pages.	

EXAMINER SIGNATURE

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	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

Examiner Signature		Date Considered	

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☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2017-05-12
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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(19) Europäisches Patentamt
European Patent Office
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(11) Publication number: **0 368 673 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **89311656.6**

(22) Date of filing: **10.11.89**

(51) Int. Cl.5: **H04Q 7/04, H04B 7/26, H04M 1/72**

(30) Priority: **11.11.88 GB 8826476**

(43) Date of publication of application: **16.05.90 Bulletin 90/20**

(84) Designated Contracting States: **ES GR**

(71) Applicant: **BRITISH TELECOMMUNICATIONS public limited company**
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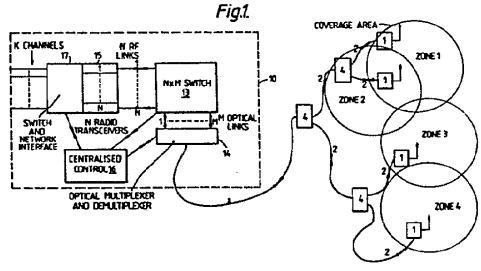
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(54) Communicationssystem.

(57) A communications system has a base centre with radio transceivers 15 for providing a number of radio frequency (RF) communications links and a plurality of fixed radio ports 1 through which RF signals can be transmitted and received over the air. A fibre optic network (2, 4) interconnects the RF transceivers 15 and the fixed radio ports 1, and carrys the RF signals by means of optical signals. There are plurality of radio/optical interfaces by which RF signals can be modulated onto and demodulated from one or more optical signals, between the RF transceivers and the fibre optic network, and between the fibre optic network and the fixed radio ports. A matrix switch 13 selectively interconnects the transceivers and the radio ports through the fibre optic network.

Fig.1.



EP 0 368 673 A1

T-Mobile Ex. 1037

COMMUNICATIONS SYSTEM

The present invention relates to a communications system, and in particular to a system for interconnecting mobile radio (RF) units to a fixed network or system e.g. PSN, ISDN, LAN or PBX.

At present, for example, in a cellular radio system mobile radio (RF) units communicate with fixed base stations which have radio transceivers that are connected to a switching control centre which is in turn coupled to the PSTN. In the proposed Telepoint system, cordless telephones (CTs) will be able to access the PSTN via radio communication with fixed base stations equiped with radio transceivers which are directly connected to the PSTN. In both these examples radio transceivers and base stations proliferate in the connection between the mobile user and the PSTN, or other network. These systems are therefore complicated and expensive. Future systems will want to provide improved coverage including the provision of many small radio "cells", and hence many base stations and radio transceivers will be required.

Difficulties in finding appropriate base station sites and the costs of equipping them may make such conventional developments impracticable; certainly they reduce the commercial attractiveness of such projects. The present invention seeks to provide a communication system of simplified structure and improved performance.

According to a first aspect the invention provides a communications system comprising: a base centre having one or more radio transceivers for providing a number of radio frequency (RF) communications links; a plurality of fixed radio ports through which RF signals can be transmitted and received over the air; a fibre optic network for interconnecting the RF transceivers and the fixed radio ports, and for carrying the RF signals by means of optical signals; a plurality of radio/optical interfaces by which RF signals can be modulated onto and demodulated from one or more optical signals, which interfaces are between the RF transceivers and the fibre optic network, and between the fibre optic network and the fixed radio ports.

The present invention also provides a communications system comprising: a base centre having one or more radio transceivers for providing a number of radio frequency (RF) communications links; a plurality of fixed radio ports through which RF signals can be transmitted andreceived over the air; a fibre optic network for interconnecting the RF transceivers and the fixed radio ports, and for carrying the RF signals by means of optical signals; a plurality of radio/optical interfaces by which RF signals can be modulated onto and demodulated from one or more optical signals, which interfaces are between the RF transceivers and the fibre optic network, and between the fibre optic network and the fixed radio ports; and a matrix switch for selectively interconnecting the transceivers and the radio ports through the fibre optic network.

The present invention allows for centralisation of transceivers into base centres, and the consequent advantages in terms of technical and commercial gain, by having the transceivers selectively connectable through the fibre optic network to the RF ports.

The RF Communication linking may for example, be time division multiplexed (TDM) or frequency division multiplexed (FDM).

A preferred embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, wherein:

- Figure 1 is a schematic block diagram of a communications system according to a preferred embodiment of the invention;
- Figure 2a is a schematic block diagram of an optical matrix switch which can form part of the preferred embodiment;
- Figure 2b is a schematic block diagram of an RF matrix switch which can form part of the preferred embodiment; and
- Figure 3 is a schematic view of another embodiment of the invention.

The preferred embodiment illustrated in Figure 1 is a multi-user, area coverage radio distribution system using an optical network 2,4 to link the fixed radio distribution ports 1 to a centralised radio and other signal processing base centre 10. An important feature of the system is the use of an optical carrier modulated, e.g. amplitude modulated, with a radio frequency (RF) signal.

In both the base centre 10 and RF ports 1 there are, arranged in different ways, radio/optical interfaces which can place an RF signal onto an optical carrier or conversely recover an RF signal from an optical carrier. The modulation of the optical carrier may be achieved by driving a suitable laser device with the input RF signal so that output of the laser is effectively intensity or amplitude modulated by the RF signal. With this method, a suitable optical detector receiving the amplitude modulated optical signal can produce a direct RF output. In the present specification, the term radio/optical interface is used in this context.

The radio ports 1 each have a radio/optical interface which receives and transmits radio carriers from and to roaming radio equipment. The radio carriers to be sent/received from the centralised location are placed onto/taken off an optical carrier, e.g. as described above. The optical net-

work 2,4 linking the radio ports 1 to the base centre 10 is generally conventional, having optical links carrying RF carrier/carriers on optical carrier/carriers. Each optical link is shown as bidirectional. However, separate links could be provided for each direction. Within the optical system are optical multiplexers/demultiplexers (M + D) 4. Each multiplexer concentrates a number of optical carriers, say X, onto a fewer number of optical links than X. The demultiplexersplits a number of optical carriers onto individual optical links.

At the base centre 10 the optical system 2,4 is connected to an optical multiplexer and demultiplexer (M + D) 14. The M + D 14 is connected (illustratively) by M optical lines to an NxM matrix switch 13, which will be described below in more detail. The NxM matrix switch 13 has N RF links to a number (N) radio transceivers 15. The radio transceivers 15 are connected through a switch 17 to a number (K) channels of another network which may be ISDN, cellular, LAN, PBX etc. K may be greater than or equal to N. Also in the base centre 10, a central unit 16 is connected to the switch 17, NxM matrix switch, and M + D 14 to control optical, RF, and baseband routing and switching, and coordinate the allocation of RF carriers and channels in conjunction with mobile equipment.

A central part of the base centre 10 is the NxM matrix switch 13. This multiplexes many of the N radio carriers onto any of the M optical transmission lines, i.e. none, one or more of the radio carriers may be on any one of the optical carriers at any one time. The NxM matrix switch 13 may be configured in one of two ways, as shown in Figures 2a and 2b. In each case, the radio/optical interface places the RF carriers to be transmitted from the central transceivers onto the optical carrier(s) and takes off, from the optical carrier(s), the RF carriers to be received by the central transceivers. The switching may be optical (Figure 2a), in which case the radio/optical interface is on the radio "side" of the switch, or the switch may be a radio (RF) matrix switch (Figure 2b), in which case the radio optical interface is on the optical system "side" of the switch. In either case, the overall result is that the N radio lines can be multiplexed onto the M optical lines.

The advantages of the system of the preferred embodiment are profound. A user can access the external network through any of the radio ports 1 with a suitable RF transceiver, e.g. a cordless telephone (CT), and be connected to a free one of the N transceivers 15. Provided the RF capacity was available, all N transceivers could be employed in calls to/from a particular one of the radio ports 1, or as would be more likely, the usage of the transceivers would be distributed among the radio ports of the system. Here lies a key advantage of the system: the centralisation of the radio transceivers. In the present system the radio transceivers are centralised, allowing more economic use and facilitating maintenance etc. Other significant advantages include the possibility of handover between ports covering different zones or areas, by simply switching between optical carriers, i.e. by switching within the NxM matrix switch 13. Also the use of diversity can easily be achieved centrally through switching or combining links to 2 or more ports, to improve performance of mobiles covered by those ports. Further, advantageous use of the RF system can be achieved because any of the carriers allocated to the service, rather than a given subset, can be dynamically assigned by the centralised base, to a given zone or cell. Thus an RF carrier may be allocated to both zone 1 and zone 4, but to different users. At another time, RF carrier may be assigned to just zone 3. The total number of users may remain more or less constant for the whole system, but user density within the system may vary. For example, all the users may shift from zone 1 down to zone 4, with all the central transceivers continually active. If transceivers were placed remotely in each of the zones, the same number of transceivers as that at a centrallocation would be required in each of the zones to meet the peak traffic demand during the day, even though they could remain idle for much of the time. Four times the number of transceivers of the centraiised configuration would then be required for the system of Figure 1, hence the improved trunking performance of the centralised scheme, minimising the cost of providing transceivers, the quantity of equipment in the field and affording a potential reduction in maintenance and installation costs.

Handover requires a change of base transceiver as a mobile transits zones. This need no longer be necessary as the switch, block 3, simply switches the active transceiver for a given mobile from one zone to another as the mobile makes the transition. Thus handover break is reduced to a potentially very short optical or RF switch time compared to the much longer period required to switch between transceivers.

The spectrum efficiency of many radio distribution systems are increased if the RF transmissions within the system are synchronised. This is difficult if transceivers are spread over several locations, but more straightforward when they are centralised.

An alternative embodiment of the invention is shown in Figure 3 and is very similar to that of Figure 1, except that the optical system does not incorporate multiplexing/demultiplexing. Thus there are no M + Ds 4 and the M outputs of NxM switch 13 are connected directly to the radio ports 1. There is therefore a permanent 1 to 1 correspondence between the optical lines in the NxM switch

13 and the radio ports 1.

The embodiment of the invention described is based on the use of frequency division multiple access, where each communications link is on a separate radio frequency. As an alternative, time division multiple access could beused, where each communication link exists on separate time slots on a single radio channel. In this case there may still be multiple transceivers in the base centre 10 to cope with the traffic demand and hence provide frequency/timeslot reuse at the radio distribution ports 1. The connection from the transceivers 15 to the matrix switch 13 will then be by N radio links with P timeslots each, making NxP links in total to the matrix switch 13 from the transceivers 15. An extension of this approach is the possibility of a hybrid time and frequency division access system, with multiple radio carriers and several timeslots on each.

An example of a form of an RF switch is shown in Figure 4. The figure shows the RF matrix switch in a three distribution point system demonstrator. The RF matrix switch interconnects the four radio transceivers 51 (with their associated isolator circuits 52) to the three circuits each of which feeds a distribution point via a pair of fibres. Bi-directional RF connections for all the combinations of base unit and D.P. are made via switches that allow either through connection or isolation of the connection path. These switches are under computer control.

The signals from/to the radio transceiver 51 are split/combined in four 3 way combiners 53 (these are actually 4 way combiners with the spare output feeding to the scanning receiver 52) with each output/input passing through a switch that can isolate that output/input. From the switches the signals go to the inputs of one of the three 4 way combiners 55 and hence to/from the D.P.s via one of the three RF/optical interfaces 56.

These switches are under microprocessor control and allow the RF matrix to switch any transceiver to any combination of the distribution points and conversely a distribution point to any combination of the transceivers. Thus a base unit can feed all the distribution points simultaneously then by changing the switches feed only one distribution point.

Two examples of the elements for optical switch and shown in Figure 5. There are two basic technologies; (i) Bulk Optic Devices and (ii) Guided Wave Devices.

A bulk optic switch element, shown in Figure 5-(a), uses mechanical or physical reorientation of the optical path to achieve the switching of the incoming optical signals between output ports. An example of this type of switch is presented below for a single input switchable between two outputs. Other switch configurations using this as a basic building block facilitate 2x2 and 2x4 switches.

A guided wave device switch element, shown in Figure 5(b), uses the electro-optic effect to change the optical propagation characteristics of switch waveguides through the application of electric fields. An example of this device type is the Mach Zender Inteferometer (MZI) shown in Figure 5(b). This type of switch can be extended from a simple 2x2 to a non-blocking 8x8 switch matrix.

Claims

1. A communications system comprising: a base centre having one or more radio transceivers for providing a number of radio frequency (RF) communications links; a plurality of fixed radio ports through which RF signals can be transmitted and received over the air; a fibre optic network for interconnecting the RF transceivers and the fixed radio ports, and for carrying the RF signals by means of optical signals; a plurality of radio/optical interfaces by which RF signals can be modulated onto and demodulated from one or more optical signals, which interfaces are between the RF transceivers and the fibre optic network, and between the fibre optic network and the fixed radio ports.

2. A communications system comprising: a base centre having one or more radio transceivers for providing a number of radio frequency (RF) communications links; a plurality of fixed radio ports through which RF signals can be transmitted and received over the air; a fibre optic network for interconnecting the RF transceivers and the fixed radio ports, and for carrying the RF signals by means of optical signals; a plurality of radio/optical interfaces by which RF signals can be modulated onto and demodulated from one or more optical signals, which interfaces are between the RF transceivers and the fibre optic network, and between the fibre optic network and the fixed radio ports; and a matrix switch for selectively interconnecting the transceivers and the radio ports through the fibre optic network.

3. A communications system as claimed in claim 2 wherein the RF links are frequency division multiplexed.

4. A communications system as claimed in claim 2 wherein the RF links are time division multiplexed.

5. A communications system as claimed in claim 2, 3 or 4, wherein there is means for combining RF signals to or from one or more of the RF ports.

6. A communications system as claimed in any one of claims 2 to 5 wherein the matrix switch is for switching optical signals and between the op-

tical matrix switch and the one or more RF transceivers there are one or more RF/optical interfaces.

7. A communications system as claimed in any of claims 2 to 5 wherein the matrix switch is for switching RF signals, and between the RF matrix switch and the fibre optic network there are one or more RF/optical interfaces.

8. A communications system as claimed in any preceding claim wherein there is multiplexing/demultiplexing of the optical signals in the fibre optic network.

9. A communications system as claimed in any preceding claim wherein the fibre optic network incorporates wavelength routing of optical signals.

10. A communication system as described in any preceding claim which call handover is between radio ports is controlled in the base centre through switching the radio transceiver from one radio port to another radio port by the matrix switch.

11. A communication system as claimed in any preceding claim which diversity operation is provided by combining or switching between two or more radio points in the matrix switching.

12. A communication system as claimed in any preceding claim which dynamic channel allocation is controlled in the base centre.

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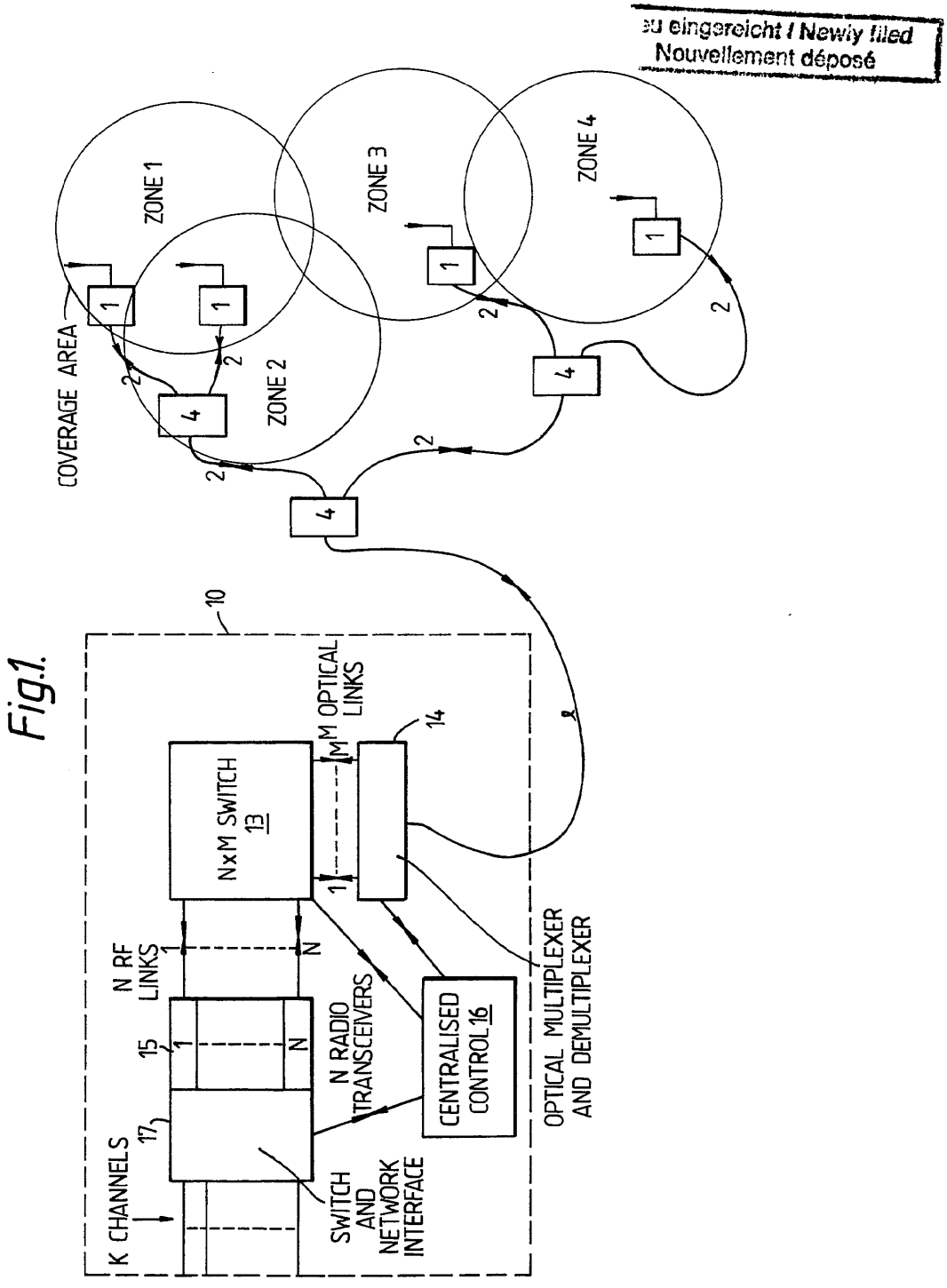
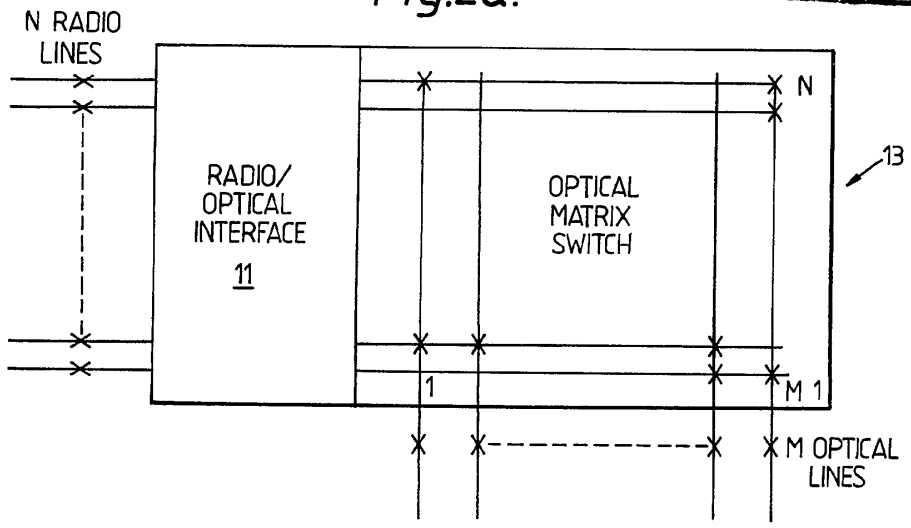


Fig.1.

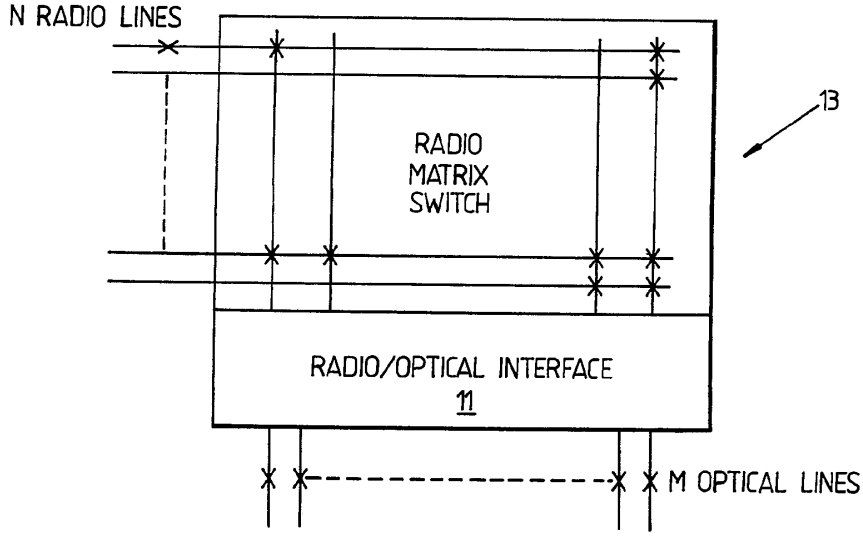
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Fig.2a.



* DENOTES CONNECTION OF A COLUMN TO A ROW THUS COLUMN M IS SHOWN CONNECTED TO ROWS 1, N-1 AND N

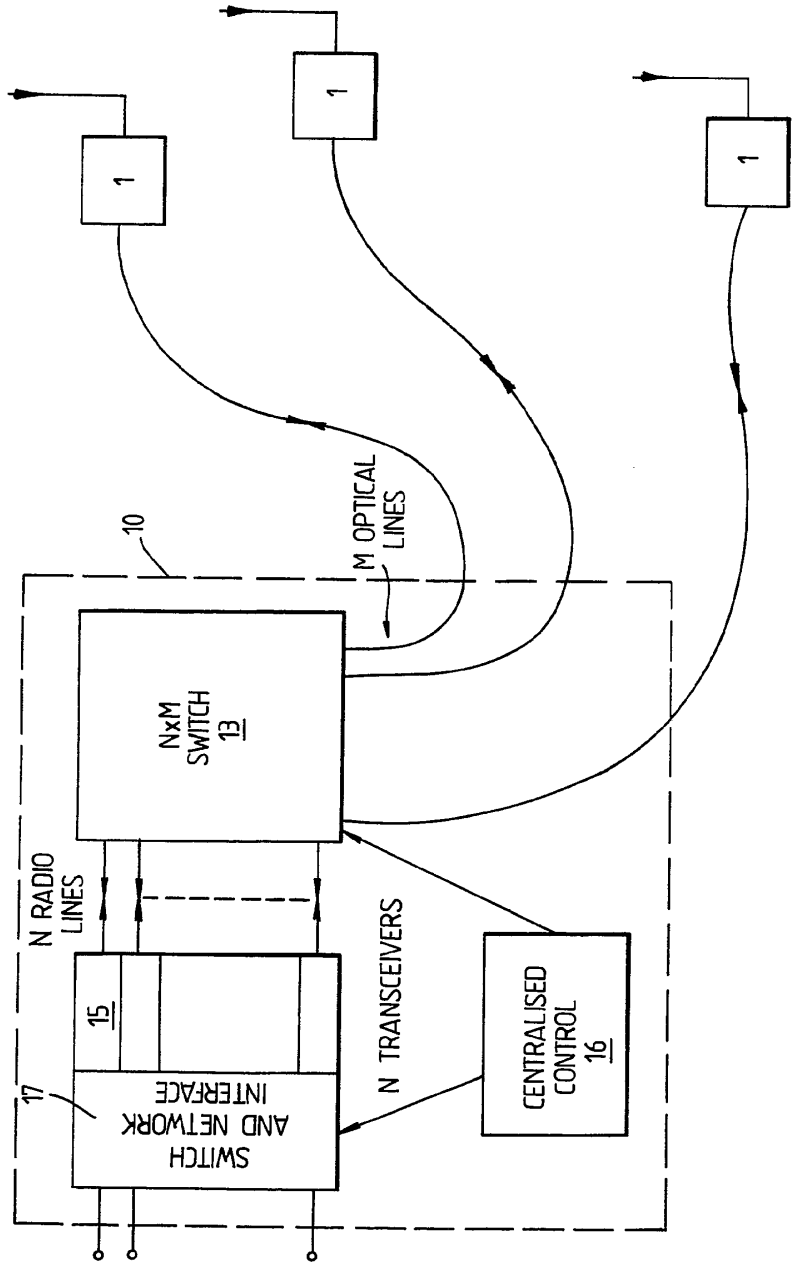
Fig.2b.



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Fig.3.



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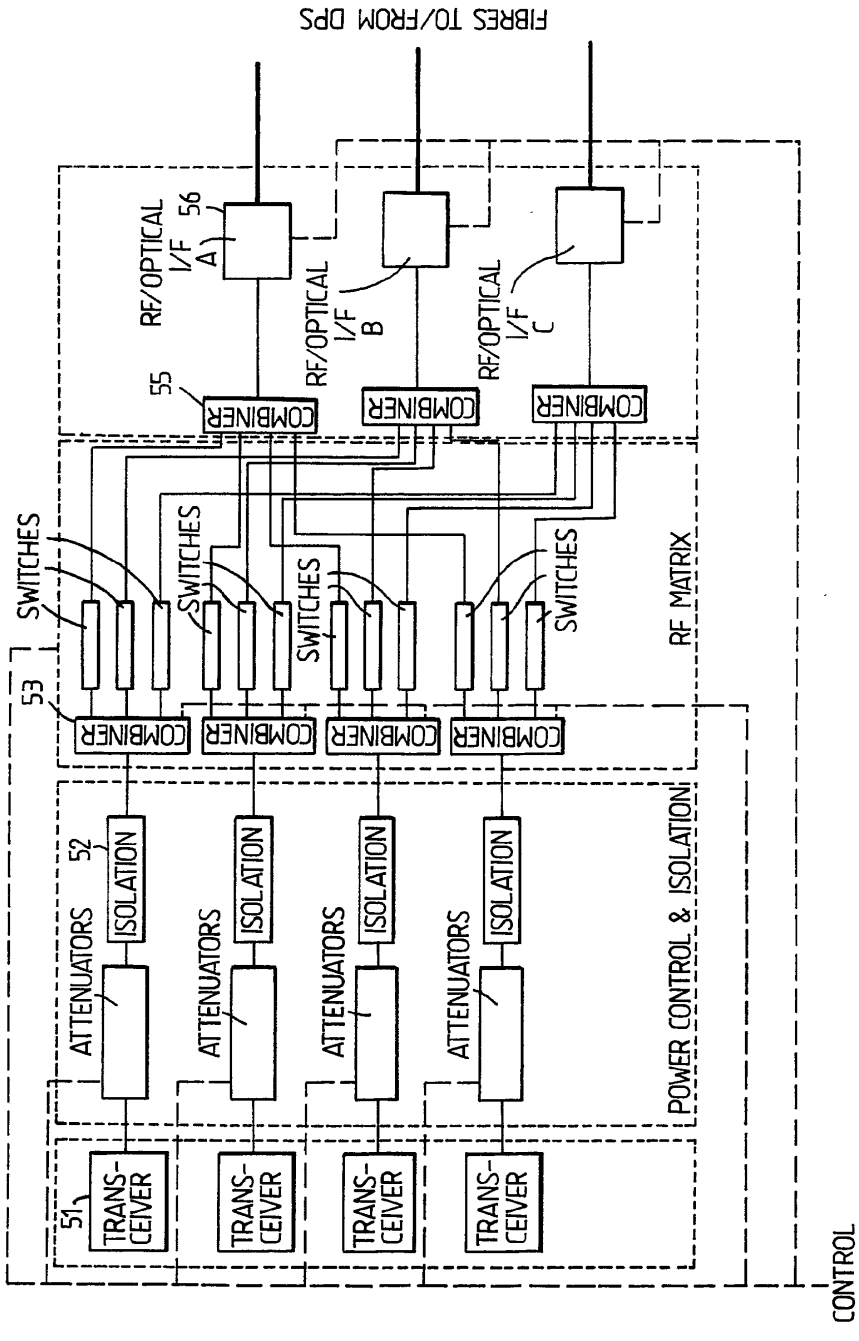


Fig.4.

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Fig.5a.

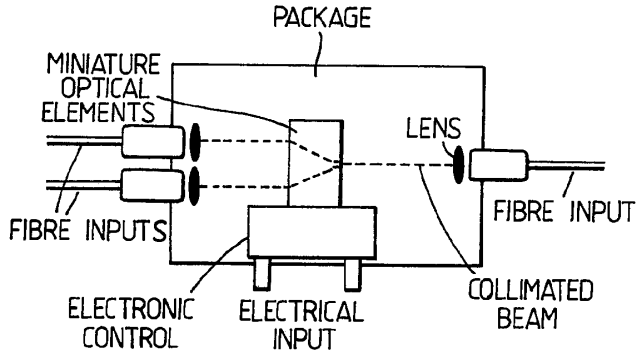
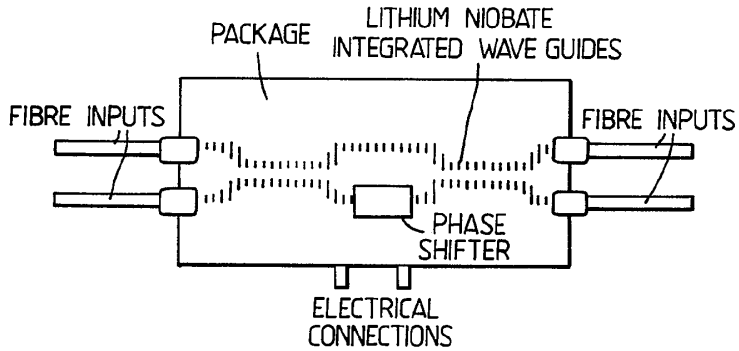


Fig.5b.



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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 31 1656

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PROCEEDINGS OF THE IEEE, vol. 75, no. 4, April 1987, pages 436-477, IEEE, New York, US; D.C. COX: "Universal digital portable radio communications" * Page 441, right-hand column, paragraph IV; page 452, right-hand column, paragraph e, lines 1-15; page 456, right-hand column, lines 19-25; page 457, right-hand column, paragraph 3 - page 459, right-hand column, paragraph c; page 465, left-hand column, paragraph c - right-hand column, paragraph 7 * ---	1-5,11-12	H 04 Q 7/04 H 04 B 7/26 H 04 M 1/72
A	GB-A-2 138 652 (STD. TELEPHONES AND CABLES) * Page 1, lines 1-54; page 1, line 76 - page 2, line 10; page 2, lines 28-62; page 2, line 98 - page 3, line 35 * ---	1,2,4	
A	EP-A-0 233 963 (ANT) * Page 6, lines 13-31; page 6, line 49 - page 7, line 5; page 7, line 42 - page 12, line 11 * ---	2-4,7,10,12	TECHNICAL FIELDS SEARCHED (Int. Cl.5) H 04 B H 04 M H 04 Q
A	DE-A-3 135 231 (S.E.L.) * Page 5, line 18 - page 6, line 15; page 7, lines 1-13; page 8, line 1 - page 9, line 20 * ---	1,2,5,8	
A	EP-A-0 156 336 (S.E.L.) * Page 2, line 12 - page 4, line 27 * ---	1,2,4,10	
A	PATENT ABSTRACTS OF JAPAN, vol. 5, no. 15 (E-43)[687], 29th January 1981, page 87 E 43; & JP-A-55 143 854 (NIPPON DENSHIN DENWA KOSHA) 10-11-1980 -----	1,2,5,11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08-02-1990	GERLING J.C.J.

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P0401)

T-Mobile Ex. 1037

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 August 2001 (02.08.2001)

PCT

(10) International Publication Number
WO 01/56197 A2

(51) International Patent Classification[7]: H04B 10/155, H04N 7/173, 7/22

(21) International Application Number: PCT/US01/02503

(22) International Filing Date: 25 January 2001 (25.01.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/494,097 28 January 2000 (28.01.2000) US

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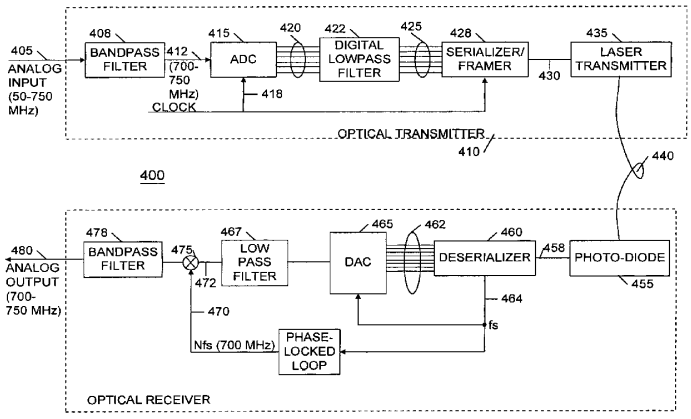
(81) Designated State *(national)*: BR.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DIGITAL FORWARD COMMUNICATION SYSTEM



(57) Abstract: A broadband communication system includes an optical transmitter (410) for receiving an analog electrical signal and transmitting a digital optical signal. The transmitter (410) includes an analog filter (415) having a bandwidth for filtering the analog electrical signal to generate a bandwidth-limited analog signal having a lower frequency and an upper frequency. The bandwidth-limited analog signal is sampled by an analog-to-digital converter (415) at a sampling frequency that equals or exceeds the bandwidth of the analog filter (408), thereby generating a digital electrical signal that is shifted in frequency from the analog electrical signal. The lower frequency of the bandwidth-limited analog signal is greater than the sampling frequency used by the converter (415). A digital filter (422) then processes the output of the analog-to-digital converter (415) to pass the digital electrical signal that is frequency-shifted, and a laser transmitter (435) that transmits the digital electrical signal.

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DIGITAL FORWARD COMMUNICATION SYSTEM

Field of the Invention

This invention relates generally to broadband communications systems, and more specifically to systems for the distribution of video, digital, and other information signals from a transmitting station to number of receiving stations via optical fibers.

Background of the Invention

Cable television (CATV) systems typically include a headend section for receiving high frequency signals and demodulating them to baseband. In modern systems, signal sources may include satellites for digital and analog television programming, public telephony networks for voice telephony, and digital networks, such as the Internet, for the transfer of computer generated data. Regardless of origin, the headend transforms these signals to a composite broadband frequency division multiplexed analog signal that is transmitted via fiber optic cable to nodal stations, i.e., nodes, in the cable distribution plant. At the nodes, the optical signal is received and converted to a radio frequency (RF) electrical signal that is carried to individual subscribers by a "tree" network of coaxial conductors and amplifiers.

In the fiber optic portion of a typical prior art cable television transmission system, information is transported by amplitude modulation of a lightwave carrier in an analog fashion. Various factors influence the ability to accurately transmit and receive these signals. For example, optical nonlinearities degrade the signal-to-noise ratio of the signal as it travels through a fiber optic cable. Furthermore, analog modulation schemes are highly sensitive to variations in the input signal level and the electro-optical properties of the transmitting laser. As a result, nonlinearities in the optical signal may be caused or worsened by temperature fluctuations and/or changes of the electrical characteristics of the laser diode junction with environment and time.

In the reverse path of a cable television system, these problems may be addressed by using an on/off keyed, digital reverse system, such as that described in U.S. patent application serial no. 09/102,344 to Farhan et al., entitled "Digital Optical Transmitter" (*"Farhan"*) the teachings of which are hereby incorporated by reference. However, difference in bandwidth requirements (i.e., 750 MHz forward vs. 50 MHz reverse) can render the direct use of the *Farhan* invention impractical for transmission in the forward direction. Thus, what is needed is an improved technique capable of providing accurate and reliable transmission of optical signals within a cable television system.

Brief Description of the Drawings

FIG. 1 is a block diagram of a bidirectional hybrid fiber/coax broadband distribution system in accordance with the present invention.

FIG. 2 is a block diagram showing the input and output ports of an analog-to-digital converter in accordance with the present invention.

FIG. 3 is a graph showing the input and output spectra of an undersampled analog to digital conversion process in accordance with the present invention.

FIG. 4 is a block diagram of an optical transmission system in accordance with the present invention.

FIG. 5 is a block diagram of an alternative optical transmitter employed in a broadband communication system in accordance with the present invention.

Detailed Description of a Preferred Embodiment

Optical communications systems with their inherently high information carrying capacity are commonly utilized for the transport of video and other information signals from a transmitting station to one or more receivers. Two-way communication may also be accomplished by choosing separate transmission wavelengths for the oppositely directed signals.

FIG. 1 shows the optical portion of a hybrid fiber/coax (HFC) broadband distribution system, such as a cable television system, that is bidirectional and in which the majority of the available bandwidth is devoted to the distribution of analog and television signals from a headend station 110 to individual subscribers 155. Forward, or downstream, distribution occurs in the frequency range of about 50 MHz to 750 MHz or higher. A smaller band of frequencies, typically stretching from about 5 to 50 MHz, is reserved for the communication in the reverse, or upstream, direction.

In FIG. 1, satellite transmissions of analog and digital television signals are received by the headend station 110 and converted to an intermediate radio frequency by one or more receivers 112. Optionally, a digital transceiver 114 and/or telephony transceiver 116 may provide bidirectional links between the headend station 110 and external systems that are usually land-based. The digital transceiver 114 can be connected to the Internet, and the telephony unit 116 communicates with a public telephone network. In each case, these units 114, 116 transform electronic signals at an intermediate frequency, or other acceptable format, to modulator/demodulator 120 via RF cables 118. The modulator/demodulator 120 processes and combines the forward-travelling RF signals in a manner suitable for transmission by the laser transmitter included within the transceiver 126.

Optical information signals are carried from the headend 110 by optical fibers 130 to one or more fiber optic nodes 142 that convert the optical signals to RF electronic signals. These RF signals are distributed to subscriber equipment 155 by RF branches that may include one or more coaxial transmission lines 144, distribution amplifiers 146, line extenders 148, taps 150, and coaxial service lines 152 that connect the individual subscribers 155 to the system.

In the reverse direction, subscriber generated information that may include special programming requests, Internet communications, and voice telephony are transmitted in the reverse or upstream direction through the coaxial portion of the HFC plant to the fiber optic node 142 via a separate frequency than that of the forward band. At the node 142, this information is converted to a form suitable for optical transmission and sent, via laser transmitter, to the optical transceiver 126 at the headend station 110. The optical receiver 126 within the headend 110 converts the received upstream optical signal to an electronic

form that can be processed by the modulator/demodulator 120. This unit 120 identifies, splits, and reformats appropriate portions of the return signal in a manner that is compatible with cable program selectors, the Internet, and the public telephone network, as necessary.

Conventionally, optical transceivers that are located throughout the optical portion of an HFC plant transmit information using an analog modulation format, such as intensity or amplitude modulation. While capable of transmitting high-bandwidth information signals, this modulation technique has a number of drawbacks. Specifically, nonlinearities in the fiber optic cable produce a degradation in the signal quality with distance. Furthermore, analog modulation schemes are highly sensitive to variations in the input signal level and the electro-optical properties of the transmitting laser. For example, nonlinearities in the optical signal may be caused or worsened by temperature fluctuations and/or changes of the electrical characteristics of the laser diode junction with environment and time.

Accordingly, the reverse path of the optical plant of the present invention transmits signals in an on/off keyed digital format to avoid problems presented by return path analog transmissions. More specifically, the reverse-directed RF signals received by the nodes 142 are digitized using conventional analog-to-digital converters and transmitted as a serial bit stream to the headend station 110. Because the optical information signal consists of a series of 1's and 0's, reductions in the signal-to-noise ratio due to nonlinearities in the fiber and laser transmitter are minimized.

The comparatively narrow bandwidth and low frequency of the return band (5 MHz - 40 MHz according to most standards) permit on/off keying to be realized in a straightforward and economical fashion. Key to this ease of deployment is the availability of component-level analog-to-digital converters with sampling rates exceeding 80 MHz. Operated at their maximum clock speed, these components can digitize any return signal without violating the Nyquist criterion. This well-known principle states that significant distortion will be present in the digitized signal in cases where the highest frequency in the input spectrum exceeds the sampling rate of the analog-to-digital converter (ADC).

According to currently-accepted standards, the forward-directed information is generally transmitted at RF frequencies between 50 MHZ and 750 MHz. Since ADCs operate at clock speeds of about 100 MHz, digitization of the forward-directed RF signal violates the Nyquist criterion. Therefore, direct application of the *Farhan* reverse digital invention to the forward direction would be likely to lead to an decrease in the signal-to-noise ratio far in excess of any improvement afforded by on/off keyed transmission, at least in cases in which conventional ADCs are used.

Selected bands, however, of the forward RF spectrum may be digitized using conventional, component-level ADCs and subsequently transmitted by on/off keying without experiencing this problem. To better understand the system proposed in accordance with the present invention, consider conversion of an analog RF signal to a series of digital output words by an ADC, as illustrated in FIG. 2.

The ADC 200 includes an RF signal input 210 and a clock input 213. In operation, the RF input signal is sampled at a rate determined by the clock. For example, an ADC 200 with a sampling rate of 100 MHz would determine the amplitude of the RF input signal at 10 nsec intervals. These amplitudes are expressed as binary numbers that are output on the parallel bus 218 at the sampling rate.

FIG. 3 shows graphs of the spectra of an idealized input signal 310 and the ADC output 315 under conditions where the sampling frequency 320 exceeds the bandwidth 325 of the input signal but is significantly smaller than the lowest input frequency 330. In the figure, f_l represents the value of the minimum input frequency 330 and f_h represents the value of the maximum input frequency 335. Thus, the bandwidth 325 of the analog input signal is $\Delta=(f_h-f_l)$. If this signal is digitized at a sampling rate, f_s, satisfying the conditions that $2\Delta \leq f_s \leq f_l$, the spectrum of the output signal will be distorted as shown in the bottom graph that corresponds to the ADC output 315.

More specifically, several lower frequency images 340 of the input signal 310 are generated. These images have the same spectral content as the input signal 310, but are displaced from it by integral multiples of the sampling rate. When $f_l = (N * f_s)$, the lowest frequency image 345 is a baseband representation of the input signal 310 starting at 0 MHz.

According to the system of the present invention, the properties of this distortion may be advantageously used to establish one or more forward-directed, on/off keyed channels in the optical portion of the broadband distribution system of FIG. 1. If a frequency band in the input spectrum with a width Δ that is less than half the ADC sampling frequency is selected using a conventional bandpass filter, the distorted output of the ADC will contain a baseband image of the input signal. This image may be isolated using a digital low pass filter and subsequently transmitted using known technology. Bandpass filters having different center frequencies may be used to establish additional channels up to the limiting case in which the entire desired input spectrum is covered.

FIG. 4 is a block diagram of an optical communications system 400 that utilizes the method described with reference to FIG. 3 to digitize RF analog signals for subsequent transmission in the frequency band between about 700 MHz and 750 MHz. According to a preferred embodiment of the present invention, an analog input signal with a frequency spectrum covering the band from 50 MHz to 750 MHz is applied to the input 405 of the optical transmitter 410, which can, for example, be located in a headend section of a broadband communication system. An analog bandpass filter 408 selects the desired frequency band to be transmitted via on/off keying. In this example, the desired band is 50 MHz wide, with a minimum frequency, f_l, equal to 700 MHz and a maximum frequency, f_h, of 750 MHz. An RF transmission line 412 carries signals lying within the selected frequency band to the input of the ADC 415.

The sampling frequency of the ADC 415 is fixed by the clock input 418 at 100 MHz, a value equal to or greater than twice the bandwidth of the analog input signal. The ADC 415 undersamples the input, thereby generating a distorted series of digital output values on the parallel output bus 420. As shown in FIG. 3, the frequency spectrum of the ADC output contains images of the input spectrum that are shifted to lower values by integral multiples of the sampling frequency. In the example system of FIG. 4, the fourteenth image has a minimum frequency of zero and and maximum frequency of 50 MHz. This can be verified by subtracting fourteen times the sampling frequency (50 MHz) from the minimum frequency of the analog input (700 MHz). In the case where $f_l - Nf_s > 0$, say when $f_l - Nf_s = d$, where $f_s/2 > d > 0$, a digital spectral shifting may be required in order to shift d closer to zero. This process may the channel bandwidth transport capacity.

Unwanted frequencies are removed from the ADC output by the digital low-pass filter 422, and the resulting 0-50 MHz image of the original signal is output on the parallel bus 425. Data on this bus is serialized and framed in a conventional manner by the serializer 428 and, optionally, combined with other digital information that may be used to generate a clock signal at the receiver. The serial output 430 of the serializer 428 is connected to the input of the laser transmitter 435, which generates an on/off keyed optical signal for downstream distribution within the broadband communication system over an optical communication channel 440.

At the receiver 450, which may, for instance, be a node or hub, a photodiode detector 455 converts the optical signal to a serial electronic bitstream 458. A deserializer 460 converts the photodiode output to a parallel format that is sent to a digital-to-analog converter (DAC) 465 on the parallel bus 462. The deserializer 460 extracts transmitted clock frequency information to generate a local clock signal 464 for the digital to analog conversion process. The analog signal generated by the DAC 465 is filtered by a low pass filter 467 to remove components lying outside the 0 - 50 MHz band.

The local clock signal 464 is also used to synchronize a phase-locked loop 469 that generates a frequency equal to the shift between the transmitter input spectrum and that spectrum actually transmitted. In this example, the frequency shift is equal to 700 MHz. The output 470 of the phase-locked loop 469 is mixed with the filtered DAC output 472 using a conventional RF mixer 475. The output of the mixer 475 includes an image of the baseband analog signal that is shifted by 700 MHz. Frequency components lying outside the 700 MHz - 750 MHz band are removed from the mixer output by a conventional analog bandpass filter 478. The receiver output 480 will be an image of bandpass-filter-selected transmitter input signal.

While a 100 MHz clock rate has been used for this example, it should be noted that the teachings herein can be applied to any ADC process in which the input data is undersampled and the bandwidth of the input signal is less than the sampling rate. Thus, the development of ADC components with faster sampling rates may, at some point, make it desirable to use the teachings herein to transmit the entire 700 MHz-wide forward broadband signal, or larger sub-bands thereof, using on/off keyed digital modulation. Assuming, for example, that ADCs were available with sampling rates of greater than

200 MHz, such as 300 MHz, the forward broadband signal spectrum could be divided into five segments for transmission along a single fiber using wavelength or time division multiplexing.

Until ADCs having much greater sampling rates are available, the entire spectrum from 50 MHz to 750 MHz can be transmitted as shown in FIG. 5. As shown in FIG. 5, parallel processing branches within an optical transmitter 500 can be employed to divide the incoming analog signal spectrum into equal 50 MHz sub-bands. This can be done, for example, by providing the analog input 505 to multiple bandpass filters 510, each of which pass a separate 50 MHz segment of the signal. When bandpass filters 510 are used to pass 50 MHz segments and the incoming signal has a frequency range of 50 MHz to 750 MHz, fourteen bandpass filters would receive the analog signal. The first would pass signals at 50-100 MHz, the second would pass 100-150 MHz, the third would pass 150-200 MHz, and so on. It will be appreciated that this parallel processing scheme can be used to pass an analog signal having a frequency spectrum that is different from, greater, or smaller than that set forth in this example.

The outputs of each bandpass filter 510 are then provided to an ADC 515, which digitizes the signal as explained with reference to FIGs. 3 and 4. The resulting digital signals are filtered by digital lowpass filters 520 and passed to an interleaver 525, which uses time division multiplexing to generate interleaved outputs. Next, the interleaved outputs are serialized and framed by device 530, subsequent to which the resulting serial bit stream is transmitted as a digital optical signal by the laser transmitter 535. In this manner, the entire forward band, or larger parts thereof, can be digitally transmitted throughout the broadband communication system.

In summary, the digital transmission system described above provides for the optical transmission of one or more bands of a broadband analog signal via optical fiber while preventing many of the problems inherent in prior art analog systems. As a result, information can be sent from the headend station to the subscriber in a more reliable and less expensive manner.

What is claimed is:

CLAIMS

1. An optical transmitter for receiving an analog electrical signal and transmitting a digital optical signal, the optical transmitter comprising:

an analog filter having a bandwidth for filtering the analog electrical signal to generate a bandwidth-limited analog signal having a lower frequency and an upper frequency;

an analog-to-digital converter (ADC) for sampling the bandwidth-limited analog signal at a sampling frequency that equals or exceeds the bandwidth of the analog filter, thereby generating a digital electrical signal that is shifted in frequency from the analog electrical signal, wherein the lower frequency is greater than the sampling frequency;

a digital filter for processing the output of the ADC to pass the digital electrical signal that is frequency-shifted; and

a laser transmitter for transmitting the digital electrical signal.

2. The optical transmitter of claim 1, wherein the optical transmitter is included in a headend station of a broadband communication system.

3. The optical transmitter of claim 1, further comprising:

a serializer coupled between the digital filter and the laser transmitter for serializing and framing the digital electrical signal for transmission.

4. The optical transmitter of claim 1, wherein the analog filter is a bandpass filter.

5. The optical transmitter of claim 1, wherein the digital filter is a lowpass filter.

6. A broadband communication system, comprising:

an optical receiver for receiving a digital optical signal transmitted within the broadband communication system; and

an optical transmitter for receiving an analog electrical signal and transmitting the digital optical signal for reception by the optical receiver, the optical transmitter comprising:

an analog filter having a bandwidth for filtering the analog electrical signal to generate a bandwidth-limited analog signal having a lower frequency and an upper frequency;

an analog-to-digital converter (ADC) for sampling the bandwidth-limited analog signal at a sampling frequency that equals or exceeds the bandwidth of the analog filter, thereby generating a digital electrical signal that is shifted in frequency from the analog electrical signal, wherein the lower frequency is greater than the sampling frequency;

a digital filter for processing the output of the ADC to pass the digital electrical signal that is frequency-shifted; and

a laser transmitter for transmitting the digital electrical signal as the digital optical signal.

7. The broadband communication system of claim 6, further comprising:

an optical communication channel coupling the optical transmitter to the optical receiver.

8. The broadband communication system of claim 6, wherein the optical transmitter is included in a headend station.

9. The broadband communication system of claim 6, wherein the optical receiver is included in one of a node and a hub.

10. The broadband communication system of claim 6, wherein the optical transmitter further comprises:

a serializer coupled between the digital filter and the laser transmitter for serializing and framing the digital electrical signal for transmission.

11. The broadband communication system of claim 6, wherein the analog filter included in the optical transceiver comprises a bandpass filter.

12. The broadband communication system of claim 6, wherein the digital filter comprises a lowpass filter.

13. The broadband communication system of claim 6, wherein the optical receiver comprises:

a detector for receiving the digital optical signal and converting it to a digital electrical signal;

a digital-to-analog converter (DAC) for converting the digital electrical signal to an analog electrical signal;

an analog filter for filtering the analog electrical signal to generate a filtered signal;

a mixer for mixing the filtered signal to shift it in frequency by an amount equal to the lower frequency of the bandwidth-limited analog signal processed by the optical transmitter; and

a bandpass filter for filtering the output of the mixer to generate a signal representative of the analog electrical signal provided to the optical transmitter.

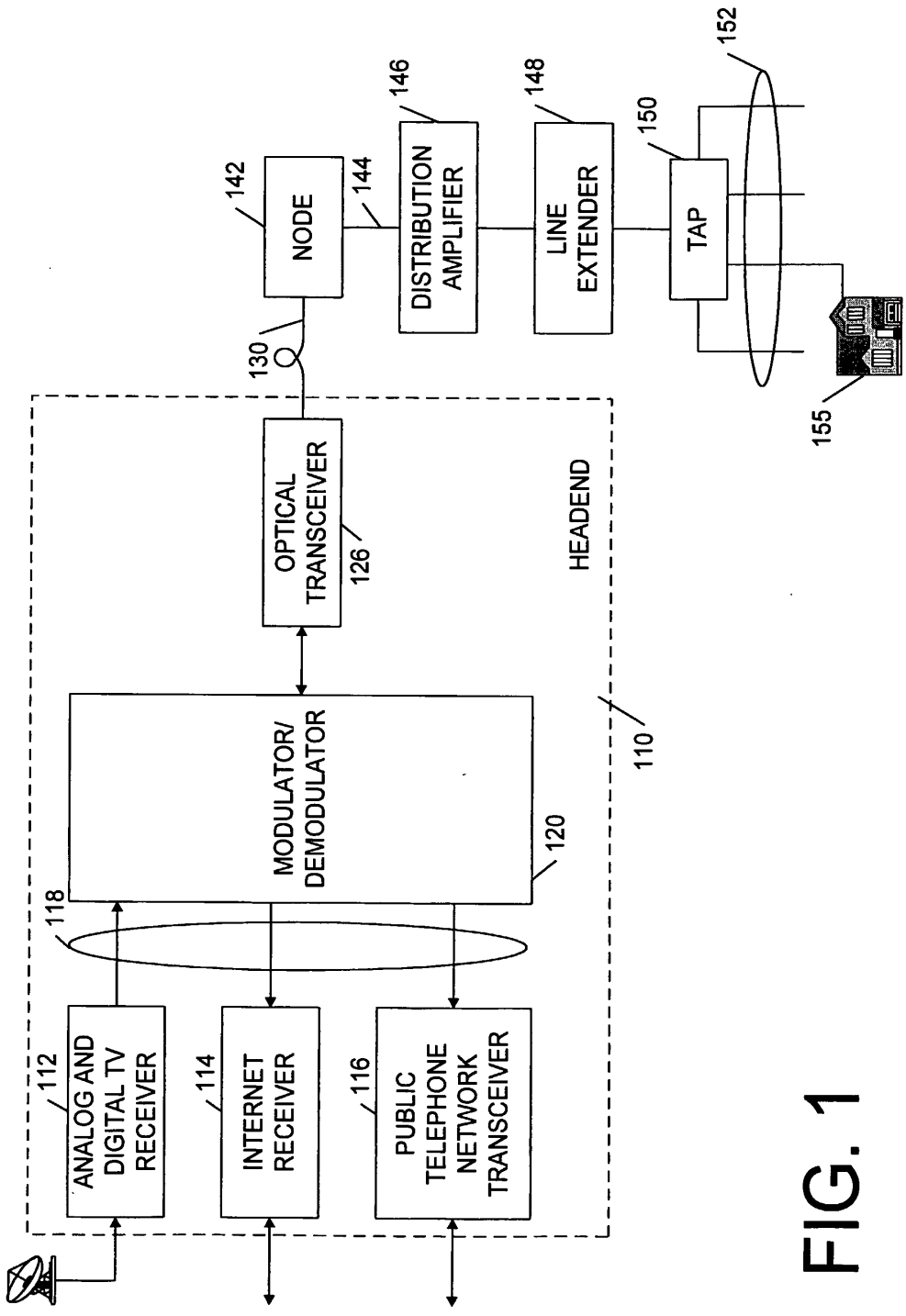

HEADEND
110
ANALOG AND DIGITAL TV RECEIVER
112
INTERNET RECEIVER
114
PUBLIC TELEPHONE NETWORK TRANSCEIVER
116
118
MODULATOR/ DEMODULATOR
120
OPTICAL TRANSCEIVER
126
130
NODE
142
144
DISTRIBUTION AMPLIFIER
146
LINE EXTENDER
148
TAP
150
152
155

FIG. 1

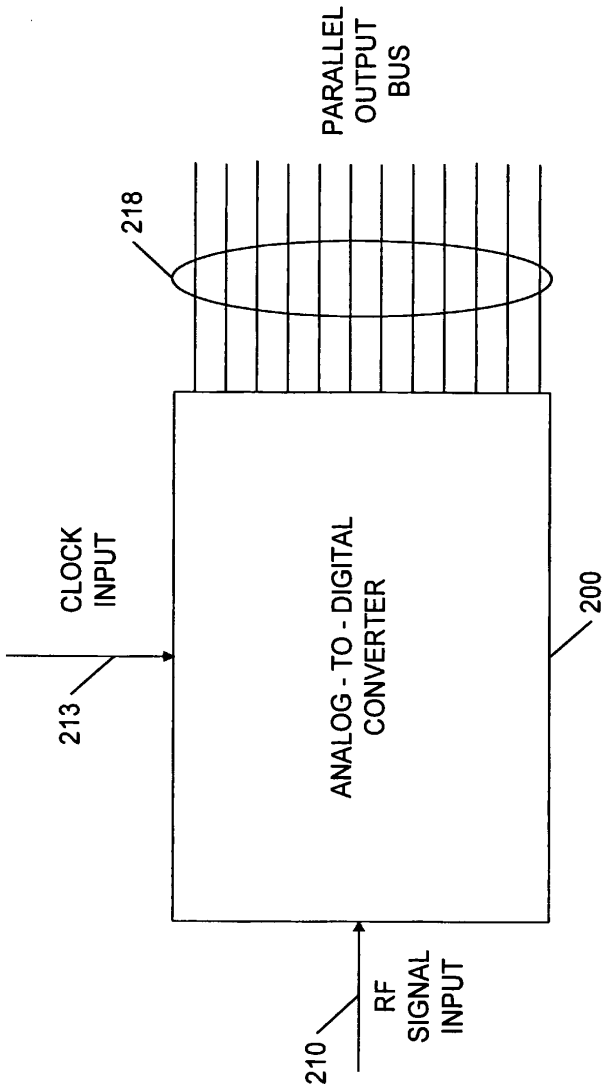

PARALLEL OUTPUT BUS
218
CLOCK INPUT
213
ANALOG - TO - DIGITAL CONVERTER
200
RF SIGNAL INPUT
210

FIG. 2

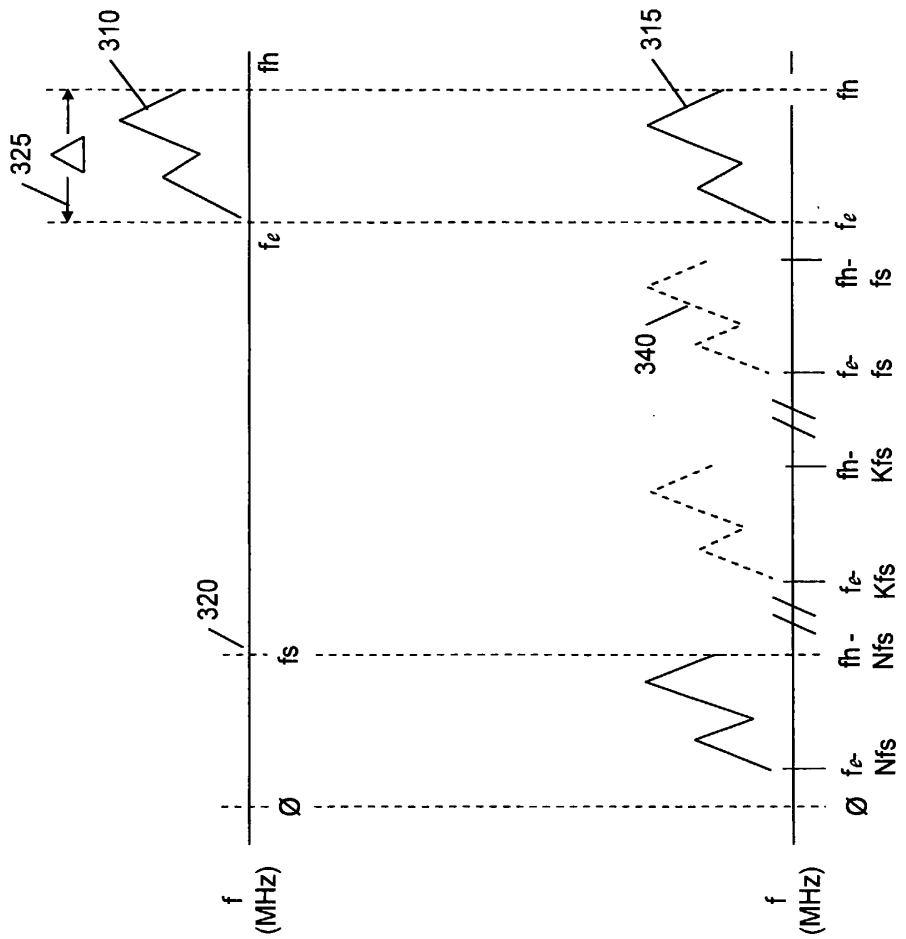

310
325
315
fh
fe
fs
Ø
320
340
f
(MHz)
fh-
fs
fe-
fs
fh-
Kfs
fe-
Kfs
fh-
Nfs
fe-
Nfs

FIG. 3

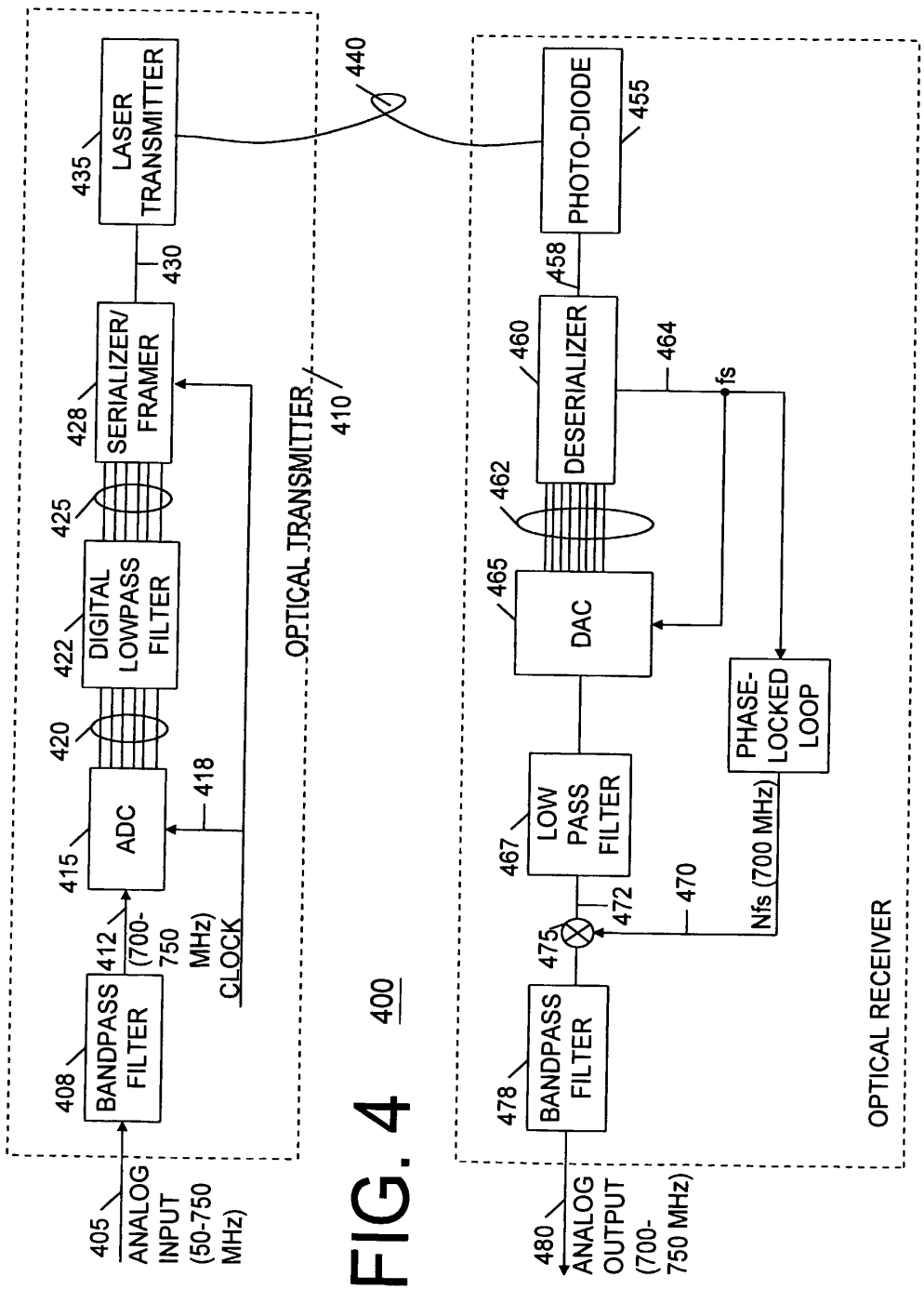

405
ANALOG INPUT (50-750 MHz)
408
BANDPASS FILTER
412
(700-750 MHz) CLOCK
415
ADC
418
420
422
DIGITAL LOWPASS FILTER
425
428
SERIALIZER/ FRAMER
430
435
LASER TRANSMITTER
OPTICAL TRANSMITTER
410
440
455
PHOTO-DIODE
458
460
DESERIALIZER
462
464
fs
465
DAC
467
LOW PASS FILTER
470
472
475
478
BANDPASS FILTER
480
ANALOG OUTPUT (700-750 MHz)
Nfs (700 MHz)
PHASE-LOCKED LOOP
OPTICAL RECEIVER

FIG. 4 400

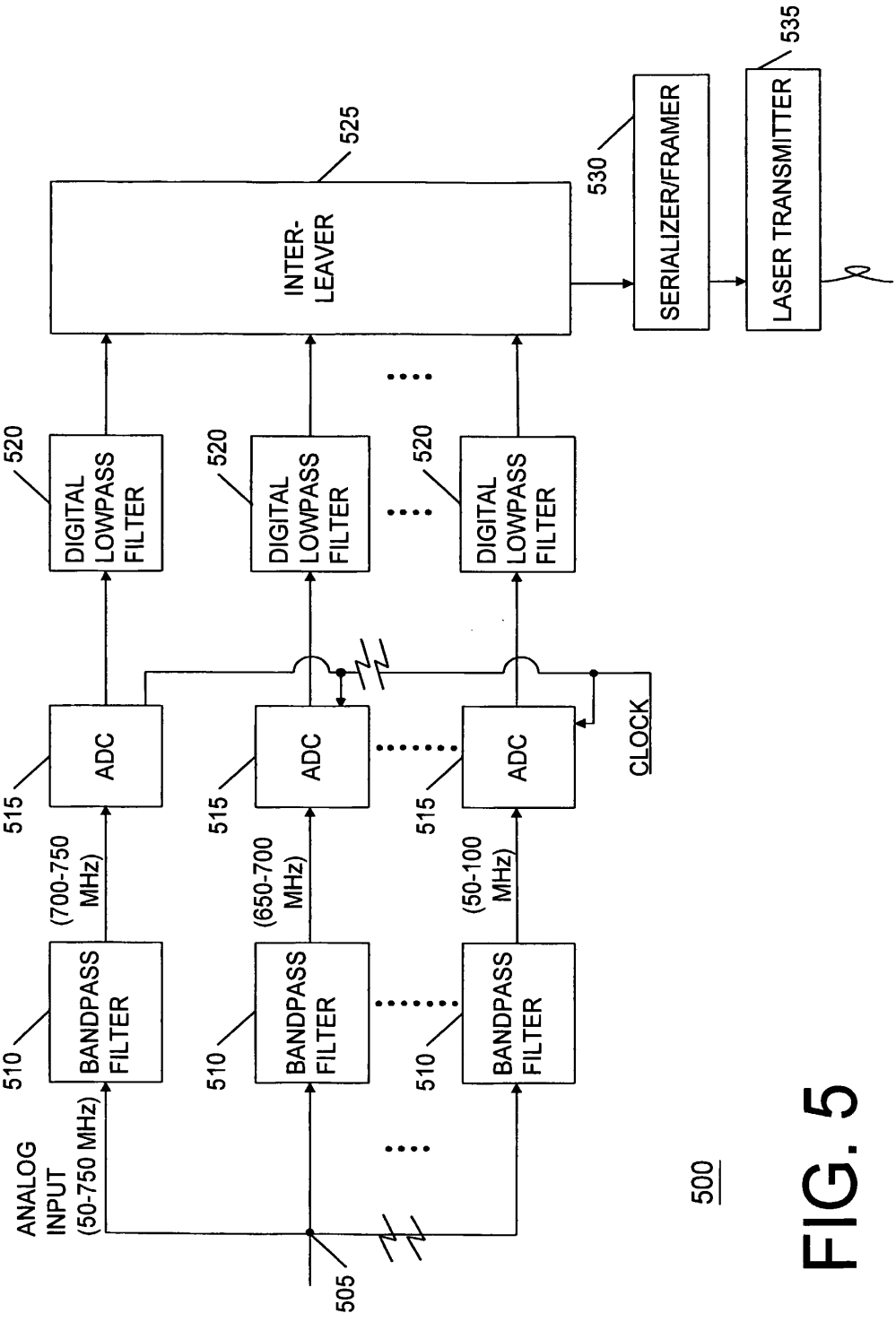

ANALOG INPUT (50-750 MHz)
505
BANDPASS FILTER
510
(700-750 MHz)
(650-700 MHz)
(50-100 MHz)
ADC
515
CLOCK
DIGITAL LOWPASS FILTER
520
INTER-LEAVER
525
SERIALIZER/FRAMER
530
LASER TRANSMITTER
535
500

FIG. 5

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H04Q 7/30, 7/22

A2

(11) International Publication Number: **WO 98/24256**

(43) International Publication Date: 4 June 1998 (04.06.98)

(21) International Application Number: PCT/US97/18987

(22) International Filing Date: 28 October 1997 (28.10.97)

(30) Priority Data:
08/753,437 25 November 1996 (25.11.96) US

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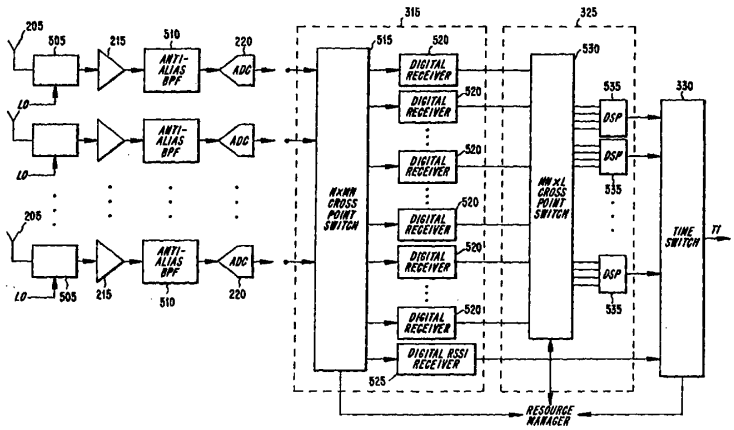
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(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: A FLEXIBLE WIDEBAND ARCHITECTURE FOR USE IN RADIO COMMUNICATIONS SYSTEMS



(57) Abstract

A wideband digital architecture for use in radio communications systems. In an exemplary embodiment, a central hub station is coupled by high speed digital data transports to multiple distributed radio transceivers. The radio transceivers are designed to perform relatively little signal processing, while the central hub is designed to perform computationally intensive signal processing tasks. By exchanging wideband data between the radio transceivers and the hub, by centralizing key system resources at the hub, and by adaptively allocating the system resources in accordance with actual system usage, the radio architecture of the present invention maximizes overall system capacity, flexibility, and resource usage efficiency while minimizing overall system cost.

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T-Mobile Ex. 1037

A FLEXIBLE WIDEBAND ARCHITECTURE FOR USE IN RADIO COMMUNICATIONS SYSTEMS

BACKGROUND

The present invention relates to radio communications and, more particularly, to a distributed wideband architecture for use in radio communications systems.

Today, indoor cellular systems, as well as many small-cell, or pico-cell, outdoor systems, use relatively unintelligent, centralized base stations in conjunction with distributed analog transceivers to transmit and receive communication signals to and from local mobile users operating within the systems. Communication signals are allocated to, and modulated on, frequency division multiplexed (FDM) carriers, or channels, within an overall frequency bandwidth designated for use by the systems. Channel selection and allocation is typically performed using relatively costly, narrowband analog filters located within the analog transceivers or within the base station. The analog filters are tuned to a pre-selected and fixed frequency bandwidth and are capable of supporting only a single air-interface standard. Thus, current systems are inflexible in terms of protocol and, for a given number of transceivers, are limited with respect to the overall number of users which can be simultaneously accommodated in an overall geographic coverage area.

The inflexible nature of current system design also yields fixed user capacity within each single-transceiver coverage area and makes extremely inefficient use of transceiver hardware. As a result, available FDM channels may lie dormant even as potential users are denied access to the system. Empirical data suggest that usage efficiency in these systems is typically less than 30%. Such inefficiency often requires that a large number of analog transceivers be used to obtain only modest system capacity and sometimes leads to overly complex and overly costly base station design. Also, due to the fixed-protocol nature of current systems, system designers must practice careful pre-installation frequency planning and coordination with respect to existing, comparatively powerful, outdoor systems. This can result in high installation and operations costs and may further limit the capacity of the

installed system. Thus, there is a real need for an improved radio system architecture.

SUMMARY

The present invention fulfills the above-described and other needs by providing an improved wideband digital architecture which significantly increases overall hardware usage efficiency as compared to conventional systems. The present invention centralizes, shares, and re-uses key system resources, incorporates programmable frequency bandwidths, and adaptively supports a variety of air-interface standards in order to maximize system capacity and flexibility and to minimize the need for careful frequency planning and coordination with respect to existing systems. For example, by monitoring call traffic conditions at multiple distributed radio transceivers, a radio system constructed in accordance with the teachings of the present invention can adaptively allocate what would otherwise be idle system resources to heavy traffic areas on an as needed basis. Additionally, by measuring prevailing signal strengths on available frequency channels, such a radio system can automatically develop a frequency allocation plan which does not conflict with surrounding systems.

In brief, the present invention teaches a digital radio system architecture based on an intelligent wideband radio base station, or hub, controlling streamlined, distributed radio transceivers, or radio heads. The scaled-down radio heads are linked to the central hub station through high speed digital data transports and are designed to perform relatively little signal processing (e.g., multi-carrier RF power amplification, frequency upconversion and downconversion, wideband low-noise amplification, digital-to-analog and analog-to-digital conversion, etc.). The central hub, on the other hand, is designed to perform more computationally intensive signal processing tasks (e.g., signal modulation and demodulation, channel selection and allocation, channel coding and decoding, air-frame synchronization, etc.). By centralizing and adaptively allocating system resources in accordance with actual system usage, the present invention teaches an extremely flexible architecture which combines high system capacity with low overall system cost.

The radio heads are designed to be very small, unobtrusive units which are readily installed, for example, in the ceilings and corners of office buildings, manufacturing facilities, shopping malls, sports arenas, etc. Because the radio heads need perform only minimal signal processing tasks, their cost and overall power consumption is significantly lower as compared to the analog radio transceivers of conventional systems. Additionally, the hub station of the present invention cost effectively consolidates, or pools, many of the required signal processing resources at a single central location. As described below, a resource manager within the hub station can be programmed to dynamically allocate system resources among the radio heads, as necessary, based on changing call traffic conditions. Thus, system usage efficiency is dramatically improved, and tremendous savings in terms of system cost, size, and complexity are possible. These and other features and advantages of the present invention are explained hereinafter with reference to the illustrative examples shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of an exemplary radio communications system constructed in accordance with the teachings of the present invention.

Figure 2 is a block diagram of an exemplary radio transceiver, or radio head, which may be used, for example, in implementing the system of Figure 1.

Figure 3 is a block diagram of an exemplary central hub station which may be used in conjunction with the radio transceiver of Figure 2 to implement the radio communications system of Figure 1.

Figure 4 is a conceptualization of a translation, between frequency division multiplexed (FDM) information signals and corresponding time division multiplexed (TDM) signals, which may be performed, for example, using components located within the embodiments of Figures 1-3.

Figure 5 depicts a first exemplary embodiment of an adaptive signal channelizer which may be used, for example, in the hub station of Figure 3.

Figure 6 is a block diagram of a digital receiver which may be used, for example, in constructing the exemplary channelizer of Figure 5.

Figure 7 depicts a second exemplary embodiment of an adaptive signal channelizer which may be used, for example, in the hub station of Figure 3.

Figure 8 is a block diagram of an exemplary discrete Fourier transform (DFT) circuit used, for example, in constructing the exemplary channelizer of Figure 7.

DETAILED DESCRIPTION

Figure 1 depicts a radio system architecture constructed in accordance with the teachings of the present invention. As shown, a central hub station 120 is coupled, through multiple high speed data transports 130, to a number of distributed radio head transceivers 110. The hub station 120 is also coupled, through an industry standard T1 TDM channel, to a mobile switching center (MSC) 100. The MSC is used to connect the local radio system comprising the hub 120 and the radio heads 110 to other communication networks (e.g., the public switched telephone network). Thus, mobile users within the coverage area of the radio heads 110 can communicate with other local users in the same coverage area or with remote users in other networks. The hub station 120 and the radio heads 110 might be used, for example, to provide mobile telephone and pager service within an office building or manufacturing plant.

The radio heads 110 transmit and receive information signals to and from local user mobile stations on multiple FDM carriers lying within a specified frequency band. For example, the U.S. industry standard IS-136 (AMPS/D-AMPS) cellular frequency plan includes 416 30kHz FDM channels spanning a 12.5MHz FDM band. Therefore, calls to and from local users are allocated, during system operation, to specific FDM channels. Also, because the MSC communication link typically utilizes a TDM scheme, information signals are translated back and forth between the FDM and TDM formats.

As described above, analogous conventional systems utilize inflexible, analog-type radio transceivers tuned to specific FDM channels. Each such analog transceiver can accommodate only a fixed number of users on a fixed number of FDM channels. Therefore, as system usage fluctuates over time, local users near one transceiver may be denied system access even as available FDM channels,

dedicated for use by other transceivers, lie dormant. A common example of usage fluctuation occurs when workers in an office building gather in one confined area, such as a cafeteria or auditorium. In a conventional system, a transceiver located in the common gathering place may be completely idle most of the time, but may not be able to accommodate the periodic spikes in user demand. By way of contrast, the present invention teaches a system which utilizes modern digital technology to adaptively allocate frequency channels across the multiple radio heads 110 of Figure 1. By pooling critical resources at the hub station 120 of Figure 1, the system of the present invention is not only highly flexible, but also extremely efficient, and therefore, cost effective.

Figure 2 depicts an exemplary radio head 110 which can be used to implement the system of Figure 1. As shown, an RF antenna 205 is connected to a duplexer 230 which is in turn connected to a receive, or uplink, signal processing path and a transmit, or downlink, signal processing path. In the uplink signal processing path, the duplexer 230 is coupled to a low-noise amplifier (LNA) 225 which is in turn coupled to an uplink heterodyne mixer 210. The uplink mixer 210 is connected to an amplifier 215 which is in turn connected to an analog-to-digital converter (ADC) 220. The ADC 220 feeds a parallel-to-serial data converter 250 which in turn feeds an input of a high speed data transport 130 connected to the hub station (not shown). In the downlink signal processing path, an output of the high speed data transport 130 is coupled to a serial-to-parallel data converter 255 which is in turn coupled to a digital-to-analog converter (DAC) 245. The DAC 245 feeds a downlink heterodyne mixer 240 which feeds a multi-carrier power amplifier (MCPA) 235. An output of the MCPA 235 is connected to an input of the duplexer 230.

During uplink operation, a wideband signal (i.e., a signal including all FDM channels within the overall reserved frequency band) is received at the radio head antenna 205 and amplified at the LNA 225 and the amplifier 215 to a signal level which is appropriate for input to the ADC 220. The uplink mixer 210 is used to downconvert the wideband signal to an intermediate frequency (IF) level. The ADC 220 digitizes the wideband signal and provides the resulting digital samples, through the parallel-to-serial converter 250, to the high speed data transport 130 for transfer

to the hub station. During downlink operation, the radio head 110 receives wideband digital carrier samples from the hub station via the high speed data transport 130. The wideband samples are fed through the serial-to-parallel converter 255 and converted to a wideband analog signal at the DAC 245. The wideband, multi-carrier signal is upconverted to an RF frequency level at the downlink mixer 240, amplified at the MCPA 235, and ultimately broadcast at the radio head antenna 205. Note that the duplexer 230 isolates the uplink signal processing path from the antenna 205 during downlink operations and vice versa.

Figure 3 depicts an exemplary hub station 120 which may be used, for example, in conjunction with radio heads constructed in accordance with Figure 2 to implement the radio system of Figure 1. As shown, a series of high speed data transports 130, each connected to a radio head (not shown), are coupled through a connecting block 310 to an uplink channel selector 315 and a downlink channel selector 320. The uplink channel selector 315 is connected to a multi-channel demodulator 325 which is in turn connected to an uplink time switch 330. The uplink time switch 330 is connected to an MSC (not shown). A downlink time switch 345, also connected to the MSC, is coupled to a multi-channel modulator 340 which is in turn coupled to the downlink channel selector 320. A resource manager 335 is connected to the uplink and downlink channel selectors 315, 320, as well as the multi-channel demodulator 325, the multi-channel modulator 340, and the uplink and downlink time switches 330, 345.

During uplink operation, digital wideband FDM signals are received at the hub 120 from the radio heads 110 via the high speed data transports 130, and information signals (e.g., voice signals) are delivered from the hub 120 to the MSC via a standard T1 TDM communication channel. Individual carriers within the wideband signals received from the radio heads 110 are adaptively selected, demodulated, and arranged in TDM format within an uplink channelizer 350 which includes the uplink channel selector 315, the multi-channel demodulator 325, and the uplink time switch 330. As is described in more detail below, precisely which hardware components within the uplink channelizer 350 operate on precisely which individual carriers from precisely which radio heads at any given time is controlled by the resource manager 335.

Conversely, during downlink operation, information signals are received at the hub 120 from the MSC via a standard T1 TDM channel, and digital wideband FDM signals are delivered from the hub 120 to the radio heads 110 via the high speed data transports 130. The information signals received at the hub 120 from the MSC are modulated on digital FDM carriers and selectively delivered to the radio heads 110 by a downlink channelizer 355 made up of the downlink channel selector 320, the multi-channel modulator 340, and the downlink time switch 345. Again, precisely which hardware components within the downlink channelizer 355 operate on precisely which radio head carriers at any given time is controlled by the resource manager 335.

Because the resource manager 335 can monitor system activity and then adaptively and selectively route information signals to and from any and all of the wideband radio heads 110 as appropriate, the radio system of Figure 3 can easily handle the above described problems associated with continually changing call traffic conditions. Additionally, because the channel allocation, modulation, demodulation, and format conversion functions are collected at the central hub station 120, maximum resource utilization and efficiency can be achieved.

It is important to note here that the components of Figure 3 are conceptual in nature and are intended primarily to aid understanding of the teachings of the present invention. Practical implementation of the various aspects of Figure 3 may be accomplished using hardware components that may not correspond one-to-one with the broad functional blocks of Figure 3. For example, the connecting block 310 situated between the data transports 130 and the uplink and downlink channel selectors 315, 320 is included in Figure 3 merely to indicate that any information signal received from, or directed to, the MSC can be directed to, or received from, any one of the radio heads 110. As is made clear below, the precise type of connection between the data transports 130 and the uplink and downlink channel selectors 315, 320 will depend upon which of several possible uplink and downlink channelizer embodiments is being implemented. Additionally, though the uplink channelizer 350 of Figure 3 is shown to include three distinct functional blocks, namely the uplink channel selector 315, the multi-channel demodulator 325, and the uplink time switch 330, actual implementation of the uplink channelizer 350 may

result in a blending of functionality across discrete hardware components. The same may be said of the downlink channelizer 355 which is shown in Figure 3 to include the downlink time switch 345, the multi-channel modulator 340, and the downlink channel selector 320.

The resource manager 335 may be implemented as a stand-alone component, using for example a designated programmable micro-controller, or it may instead be implemented in software running on a processor which is used to otherwise control hub station functionality. Many standard processors available today are well suited for carrying out the tasks associated with the resource manager 335. As is described in more detail below, the resource manager 335 monitors signal levels and interference measurements received from receive signal strength indicators (RSSIs) within the uplink channelizer 350, as well as call traffic messages received from the MSC 100, to assign calls to appropriate channels (i.e., frequency carriers and time slots) within the system and to control non-blocking switches within the uplink and downlink channelizers 350,355 to dynamically allocate signal processing resources as capacity requirements evolve.

Implementation of the high speed data transports 130 of Figure 3 will depend upon, among other things, the physical separation between the radio heads 110 and the hub station 120. Because wideband digital signals are transferred, data rates in the uplink direction may be as high as 550 mega-bits per second (Mbps), while downlink data rates may be as high as 640Mbps for current cellular bandwidths. However, several media exist today which can accommodate such high speed data transfer rates. For example, Fiber Channel and Fiber Distributed Data Interface (FDDI) protocols are available at these rates, as are Asynchronous Transfer Mode (ATM) and Synchronous Optical Network / Synchronous Data Hierarchy (SONET/SDH) protocols. While fiber should most likely be used for distances greater than 100 meters, Gigabit Ethernet is often suitable for shorter distances.

As described below, both the uplink channelizer 350 and the downlink channelizer 355 can be implemented effectively in several different ways. No matter the exact implementation, however, the high-level functionality of the channelizers is as shown in Figure 4. With respect to the uplink channelizer 350, Figure 4 indicates that, among multiple wideband FDM signals arriving at the hub

station from multiple radio heads, individual information signals are selected, demodulated, and ultimately delivered to an MSC in time-domain format. Conversely, with respect to the downlink channelizer 355, Figure 4 indicates that individual information signals, arriving at the hub station from an MSC in time-domain format, are modulated and selectively dispersed to the multiple radio heads in wideband FDM format. Those skilled in the art will appreciate that individual FDM carriers within the system may contain a single information signal (e.g., in an AMPS mode) or multiple information signals assigned to interleaved carrier time slots (e.g., in a D-AMPS mode).

Next described are two possible configurations for the uplink channelizer 350. Though only two embodiments are described in detail, those skilled in the art will appreciate that other equivalent configurations are contemplated herein. Additionally, although the embodiments are described specifically with respect to the uplink channelizer 350, analogous embodiments for the downlink channelizer 355 are also contemplated.

Figure 5 depicts an uplink channelizer implemented using a bank of digital receivers 520. As shown, multiple radio heads (each depicted as a combination of the radio head uplink components described with respect to Figure 2) are connected via high speed data transports (not shown) to an uplink channel selector 315 which is in turn connected to a multi-channel demodulator 325. The multi-channel demodulator 325 is coupled to an uplink time switch 330 which is in turn coupled via a T1 communication link to an MSC (not shown). Within the uplink channel selector 315, a primary cross-point switch 515 is connected to a bank of digital receivers 520 and to a digital RSSI unit 525. Additionally, within the multi-channel demodulator 325, a secondary cross-point switch 530 is connected to a bank of digital signal processors 535. The primary cross-point switch 515, the secondary cross-point switch 530, and the uplink time switch 330 are coupled to a resource manager (not shown). Also, although no connection is explicitly shown, it will be understood that the resource manager has access to information output by the RSSI unit 525.

In operation, N digital wideband FDM signals, received from N distributed radio heads, are selectively coupled through the Nx(M*N) primary cross-point

switch 515 to M*N digital receivers (N and M integers). The primary cross-point switch 515, under control of the resource manager, enables a wideband FDM signal received from any radio head to be coupled to any one, or more, of the N*M digital receivers 520. Note that M represents the nominal, or average, number of digital receivers 520 available per radio head. Advantageously, because the radio heads and the digital receivers 520 are not fixedly coupled, the number of digital receivers 520 can be changed as capacity requirements evolve. In practice, the number M of digital receivers 520 used per radio head is bounded by the number of channels available in the system (e.g., 416 in an IS-136 system). Each digital receiver 520 accepts a time-sampled wideband FDM input and produces a single-carrier output.

An exemplary digital receiver 520 is depicted in Figure 6. As shown, a digital wideband FDM input is mixed, at mixers 610, with the output of an NCO 620 which is set to downconvert a particular channel within the FDM spectrum to baseband. In-phase (I) and quadrature (Q) components of the down-converted signal, arising at the outputs of the mixers 610 and representing one FDM channel from one radio head, are input to a high-decimation FIR filter 630. The FIR filter 630 removes unwanted images generated during the mixing process and reduces the sample rate from the relatively high wideband FDM rate to one that is more appropriate for the single baseband carrier. The down-sampled I and Q components which are output by the FIR filter 630 can be time multiplexed to form a single sample stream using a parallel-to-serial converter (not shown). Digital receivers 520 such as that shown in Figure 6 are low cost, widely available, and can be adaptively programmed to select and process any single channel within the FDM spectrum.

As shown in Figure 5, the M*N outputs from the M*N digital receivers 520 are input to the (M*N)xL secondary cross-point switch 530. The secondary cross-point switch 530, under the control of the resource manager, selectively couples the digital receiver outputs to L digital signal processors (DSPs) 535 (L an integer). The DSPs 535 demodulate the single-carrier signals received from the digital receivers 520 and may perform additional signal processing (e.g., channel coding). Demodulated outputs from the DSPs 535 (i.e., time-domain information signals such as voice signals) are input to the uplink time switch 330 where they are TDM formatted for delivery to the MSC.

Again, because the DSPs 535 are not fixedly coupled to the digital receivers 520, the number L of DSPs 535 can be readily changed depending upon system capacity requirements. Also, note that up to four digital receiver outputs may be input to one DSP 535 for purposes of diversity processing. In other words, a signal emitted by one local mobile station can be received at multiple radio heads, and the redundant signals can be combined, for example in a weighted summing operation, to provide an optimized signal. The number of diversity branches (i.e., the number of outputs of the (M*N)xL cross-point switch 530 directed to a single DSP 535) can be adjusted dynamically in accordance with changing traffic demands to achieve "soft" trade-offs between system performance and system capacity.

The embodiment of Figure 5 allows the hub station to provide flexible capacity per geographic coverage area. Using the primary and secondary cross-point switches 515, 530, the resource manager can dynamically assign the M*N digital receivers 520 and the L DSPs 535 to any of the N geographic coverage areas as traffic densities in those areas change over time. The resource manager can monitor system activity, for example, via the RSSI receiver 525. As known, the RSSI receiver 525 can measure signal level, signal activity, and signal quality. Channels are measured to determine whether a signal is present, and, if so, to assess the strength of the signal and to determine whether the signal is analog or digital, voice or control, valid in the indoor system or originating from an outdoor system, etc. Channels at each radio head can be monitored in cyclic fashion, and the resource manager can process the resulting data to create and maintain a channel status matrix which the resource manager can then use to assign channels when calls are set up.

Because the digital receivers 520 in the embodiment of Figure 5 are so efficiently utilized, fewer receivers need be employed for given capacity and coverage area requirements as compared to conventional systems. Also, because the digital receivers 520 are easily programmable, the embodiment of Figure 5 is readily configured to operate in compliance with virtually any air-interface standard (e.g., GSM, DECT, AMPS, D-AMPS, etc.). Therefore, a combination of the embodiments of Figures 3 and 5 represents, in many ways, a "universal" hub station. The architecture of Figure 5 is particularly attractive when a relatively

small number of carriers are to be processed (as discussed below, the embodiment of Figure 7 is, perhaps, more efficient for large numbers of system users).

Again, though the embodiment of Figure 5 has been described with respect to an uplink channelizer, those skilled in the art will appreciate that an analogous embodiment can be constructed to implement a downlink channelizer. Also, those skilled in the art will appreciate that the present invention encompasses many variations on the embodiment of Figure 5. For example, it may be desirable in certain contexts to give up some flexibility, in exchange for reduced cost and complexity, by constructing a system similar to the embodiment of Figure 5, wherein either one or both of the cross-point switches 515, 530 are excluded. Such a system would still provide significant advantages over presently available analog systems.

Figure 7 depicts another embodiment of an uplink channelizer in which the required signal processing is accomplished using a bank of DFT-type multi-channel demultiplexers 705. As shown, multiple radio heads (each depicted as a combination of the radio head uplink components described with respect to Figure 2) are connected via high speed data transports (not shown) to an uplink channel selector 315 which is in turn connected to a multi-channel demodulator 325. The multi-channel demodulator 325 is coupled to an uplink time switch 330 which is in turn coupled via a T1 communication link to an MSC (not shown).

Within the uplink channel selector 315, there are N signal processing circuits, each circuit corresponding to one of the N radio heads (N an integer). Each circuit includes a DFT demultiplexer 705, an MxM cross-point switch 710 (M an integer), a time multiplexer (MUX) 715, and an RSSI processor 720. Each DFT demultiplexer 705 produces M outputs which are input to the corresponding MxM cross-point switch 710. A subset of the M outputs from each MxM cross-point switch 710 are input to the corresponding time MUX 715 and the remaining outputs from each MxM cross-point switch 710 are input to the corresponding RSSI processor 720.

Within the multi-channel demodulator 325, N outputs produced by the N signal processing circuits are input to an NxL cross-point switch 730, and L outputs from the NxL cross-point switch 730 are input to L DSPs 535. Outputs from the

DSPs 535 are input to the uplink time switch 330. As shown, the MxM cross-point switches 710, the NxL cross-point switch 730, and the uplink time switch 330 are connected to a resource manager (not shown). Though, for convenience, only one MxM cross-point switch 710 is shown connected to the resource manager, it will be appreciated that all of the MxM cross-point switches 710 are connected to the resource manager. Also, though the connections are not explicitly shown, it will be understood that the resource manager controls the time MUXes 715 and monitors the RSSIs 720.

In operation, each wideband, multi-carrier FDM signal received from a radio head is translated, as described below, by a DFT demultiplexer 705 to yield the individual channel signals which are received at the radio head. Since each wideband signal contains M carriers (e.g., 416 for typical cellular applications), each DFT demultiplexer 705 produces M individual channel signals. Active radio head channels will contain, for example, one or more local user voice signals, and inactive channels may contain noise or signals picked up from other surrounding systems. The MxM cross point switches 710, under control of the resource manager, then separate the active and non-active channels. Active channels are input directly to the time MUXes 715, and inactive channels are coupled through the RSSI processors 720 to the time MUXes 715. The time MUXes 715 then format the time-domain signals, either as a single TDM signal or as parallel streams of time data, for input to the multi-channel demodulator 325. Signal processing performed at the multi-channel demodulator 325 is similar to that described with respect to the multi-channel demodulator of the embodiment of Figure 5. Note that, although only one input is shown for each DSP 535, several inputs may actually be coupled to each DSP 535, as is described with respect to Figure 5, for purposes of diversity processing.

DFT demultiplexers such as those shown in Figure 7 are described, for example, in M. Bellanger and J. Daguet, "TDM-FDM Transmultiplexer: Digital Polyphase and FFT", *IEEE Transactions on Communications*, September 1974, which is incorporated herein by reference. In brief, a DFT-based demultiplexer translates a wideband FDM signal using a standard DFT algorithm (or a DCT algorithm for purely real signals) to produce corresponding individual channel

signals. However, because direct computation of DFTs is numerically intensive and inefficient, DFT demultiplexers are typically implemented in practice using a fast Fourier transform (FFT) algorithm in combination with a polyphase weighting network. Therefore, the DFT blocks 705 of Figure 7 may be implemented as shown in Figure 8.

In Figure 8, a wideband digital FDM signal is input to a switch 830 which alternately connects the FDM signal to multiple weighting blocks 840. Outputs from the weighting blocks are input to an FFT block 820. In operation, the wideband samples input to the switch 830 are multiplied, at the weighting blocks 840, by appropriate weighting coefficients $H_n(z)$ which correspond to taps of a polyphase filter. The resulting weighted samples are processed, as is well known in the art, through an FFT algorithm at the FFT block 820 to produce the desired individual-channel samples. Of course, Figure 8 is a schematic representation only, and the switching and computational functions are carried out in practice using appropriate DSP hardware.

As with the embodiment of Figure 5, the embodiment of Figure 7 enables the hub station to provide flexible capacity per geographic coverage area. Using the cross-point switches 710, 730, the resource manager can dynamically access any channel from any geographic coverage area and adaptively utilize the DSPs 535 as traffic densities change with time. The resource manager can monitor system activity, for example, by monitoring output of the RSSI processors 720 and the DSPs 535 as is described above with respect to Figure 5.

The embodiment of Figure 7 is extremely cost efficient in contexts where there are often large numbers of active channels. However, the cost and availability of high speed, wideband FFT processors may make the embodiment of Figure 5 the preferred choice in contexts involving lower system capacity. Though the embodiment of Figure 7 has been described with respect to an uplink channelizer, those skilled in the art will appreciate that an analogous embodiment can be constructed to implement a downlink channelizer using IDFT-type multi-channel multiplexers. Also, those skilled in the art will appreciate that the present invention encompasses many variations on the embodiment of Figure 7. For example, it may be advantageous in certain contexts, from a cost standpoint, to construct a system

similar to the embodiment of Figure 7, but excluding the cross-point switch 730. Additionally, note in Figure 7 that there are gaps in the connections between the uplink channelizer 315 and the multi-channel demodulator 325. These gaps indicate that the DFT signal processing circuits can be physically located either at the hub station or at the individual radio heads, as appropriate.

In sum, the present invention teaches a highly flexible and efficient wideband radio architecture. Those skilled in the art will appreciate that the present invention is not limited to the specific exemplary embodiments which have been described herein for purposes of illustration. The scope of the invention, therefore, is defined by the claims which are appended hereto, rather than the foregoing description, and all equivalents which are consistent with the meaning of the claims are intended to be embraced therein.

CLAIMS:

1. A radio communications system, comprising:

a plurality of distributed radio transceivers, wherein each of said transceivers includes a wideband radio transmitter for transmitting multiple information signals on multiple frequency channels to multiple system users, and wherein each of said transceivers includes a wideband radio receiver for receiving multiple information signals on multiple frequency channels from the multiple system users;

a plurality of high speed data transports, each one of said data transports connected to a corresponding one of said transceivers, for carrying wideband signals containing multiple information signals; and

a hub station, connected to each one of said data transports and exchanging wideband signals with each of one said transceivers, wherein said hub station includes a) a downlink channelizer for coupling information signals received from a mobile switching center to said data transports, b) an uplink channelizer for coupling information signals received at said data transports to the mobile switching center, and c) a resource manager for monitoring system activity and for controlling said downlink channelizer and said uplink channelizer to adaptively allocate and utilize channelizer resources in selecting and processing information signals.

2. The system of claim 1, wherein said system provides radio-communication support for a pico-cell in a cellular radio communications system.

3. The system of claim 1, wherein said system provides radio-communication support for an indoor cell in a cellular radio communications system.

4. The system of claim 1, wherein at least one of said high speed data transports is implemented using a fiber optic link.

5. The system of claim 1, wherein at least one of said high speed data transports is implemented using an ethernet link.

6. A radio transceiver, comprising:

a wideband radio transmitter for simultaneously transmitting multiple information signals on multiple frequency channels to multiple mobile stations in a radio communications system;

a wideband radio receiver for simultaneously receiving multiple information signals on multiple frequency channels from the multiple mobile stations in the system; and

a high speed data transport interface for exchanging, through a high speed data transport, wideband signals containing multiple information signals with a hub station in the radio communications system.

7. The radio transceiver of claim 6, further comprising an uplink channelizer for converting wideband frequency-division multiplexed signals received at the transceiver to time-division multiplexed signals which are delivered to the hub station.

8. The radio transceiver of claim 6, further comprising a downlink channelizer for converting time-division multiplexed signals received from the hub station to wideband frequency-division multiplexed signals which are transmitted to the mobile stations.

9. A hub station, comprising:

a plurality of high speed data transport interfaces for receiving a plurality of wideband uplink signals, each wideband uplink signal containing multiple uplink information signals, from a plurality of distributed radio transceivers and for transmitting a plurality of wideband downlink signals, each wideband downlink signal containing multiple downlink information signals, to the plurality of distributed radio transceivers;

a communication interface for transmitting a formatted uplink signal containing multiple uplink information signals to a mobile switching center and for receiving a formatted downlink signal containing multiple downlink information signals from the mobile switching center;

an uplink channelizer disposed between said high speed data transport interfaces and said communication interface for processing uplink information signals received from the distributed radio transceivers and for arranging selected uplink information signals to form a formatted uplink signal which is delivered to the mobile switching center;

a downlink channelizer disposed between said communication interface and said high speed data transport interfaces for processing downlink information signals received from the mobile switching center and for arranging selected downlink information signals to form a plurality of wideband downlink signals which are delivered to the distributed radio transceivers; and

a resource manager coupled to said uplink and downlink channelizers for monitoring system activity and for controlling said uplink and downlink channelizers to adaptively allocate and utilize channelizer components in selecting, processing, and arranging the uplink and downlink information signals.

10. The hub station of claim 9, wherein the uplink channelizer comprises:

an uplink channel selector for accepting the wideband uplink signals received at said high speed data transport interfaces and for selectively generating, under control of said resource manager, a plurality of single-channel uplink signals, each single-channel uplink signal corresponding to a selected channel within one of the wideband uplink signals;

a multi-channel demodulator coupled to said uplink channel selector for receiving the single-channel uplink signals and for selectively processing the single-channel uplink signals, under control of said resource manager, to produce a plurality of demodulated uplink signals; and

an uplink time switch coupled to said multi-channel demodulator for arranging the demodulated uplink signals, under control of said resource manager, to form a formatted uplink signal which is delivered to the mobile switching center.

11. The hub station of claim 10, wherein said uplink channel selector includes at least one receive signal strength indicator generating output which is used

by said resource manager to monitor activity on channels within the wideband uplink signals received from the distributed radio transceivers.

12. The hub station of claim 10, wherein said uplink channel selector comprises:

a plurality of digital receivers, each of said digital receivers accepting a wideband uplink signal and downconverting a selected channel within the wideband uplink signal to produce a single-channel uplink signal which is delivered to said multi-channel demodulator; and

a cross-point switch coupled to said resource manager for selectively directing wideband uplink signals received from the distributed radio transceivers to inputs of said digital receivers.

13. The hub station of claim 10, wherein said uplink channel selector comprises a plurality of processing circuits, each of said processing circuits including a discrete Fourier transform demultiplexer and a cross-point switch which is coupled to said resource manager, wherein each of said processing circuits receives a wideband uplink signal from a distributed radio transceiver and produces, under control of said resource manager, a plurality of single-channel uplink signals which are delivered to said multi-channel demodulator.

14. The hub station of claim 13, wherein each of said processing circuits further comprises a multiplexer for arranging the plurality of single-channel uplink signals generated by the processing circuit to form a time-division multiplexed signal which is delivered to said multi-channel demodulator.

15. The hub station of claim 10, wherein said multi-channel demodulator comprises:

a plurality of digital signal processors, each of said processors processing at least one of the single-channel uplink signals generated by said uplink channel selector to produce a demodulated uplink signal; and

a cross-point switch coupled to said resource manager for selectively directing the single-channel uplink signals received from said uplink channel selector to inputs of said digital signal processors.

16. The hub station of claim 15, wherein each of said processors processes more than one of the single-channel uplink signals generated by said uplink channel selector to provide channel diversity.

17. The hub station of claim 9, wherein the downlink channelizer comprises:

a downlink time switch for accepting a formatted downlink signal from the mobile switching center and for parsing the formatted downlink signal, under control of said resource manager, to produce a plurality of unmodulated downlink signals;

a multi-channel modulator coupled to said downlink time switch for receiving the unmodulated downlink signals and for selectively processing the unmodulated downlink signals, under control of said resource manager, to create a plurality of single-channel downlink signals; and

a downlink channel selector coupled to said multi-channel modulator for accepting the single-channel downlink signals and for selectively generating, under control of said resource manager, a plurality of wideband downlink signals which are delivered to the distributed radio transceivers.

18. The hub station of claim 17, wherein said downlink channel selector comprises a bank of digital upconverters, each of said upconverters upconverting a single-channel downlink signal to a selected channel within a wideband downlink signal which is delivered to a distributed radio transceiver.

19. The hub station of claim 17, wherein said downlink channel selector comprises a bank of inverse discrete Fourier transform multiplexers, each of said multiplexers translating a plurality of single-channel downlink signals to form a wideband downlink signal which is delivered to a distributed radio transceiver.

20. A method for conducting radio communications in a system including a centralized hub station and a plurality of distributed radio transceivers, comprising the steps of:

using a plurality of high speed data transports to pass wideband signals, each wideband signal containing a plurality of information signals, between the hub station and the distributed radio transceivers;

continually measuring system activity; and

dynamically allocating, based on said step of measuring, hub station resources in processing and directing the information signals.

FIG. 1

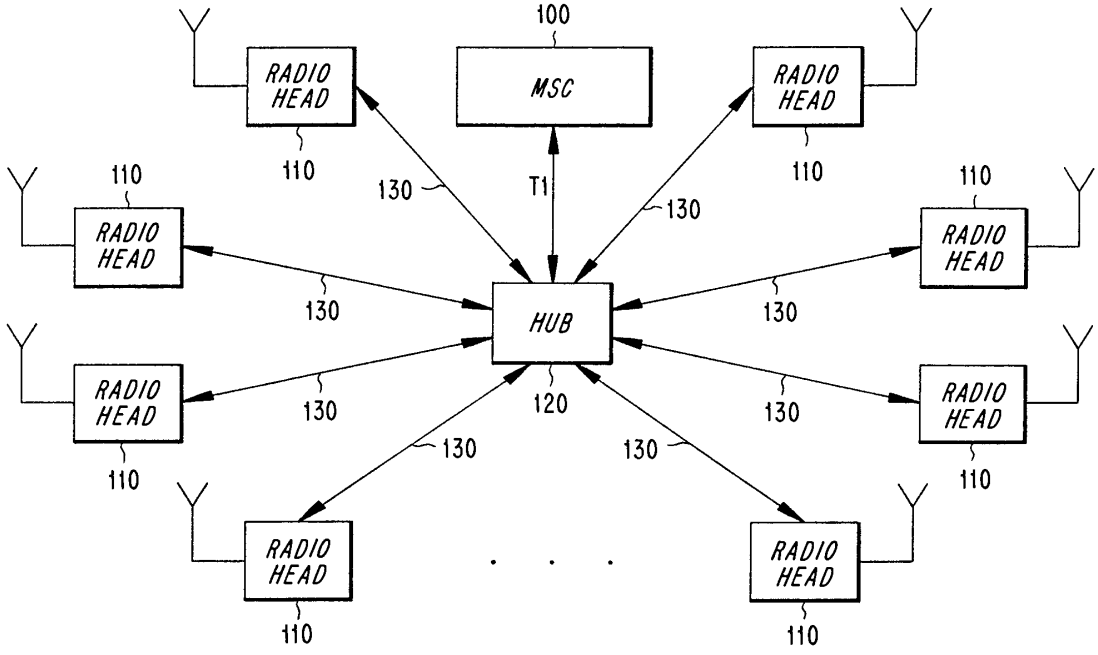
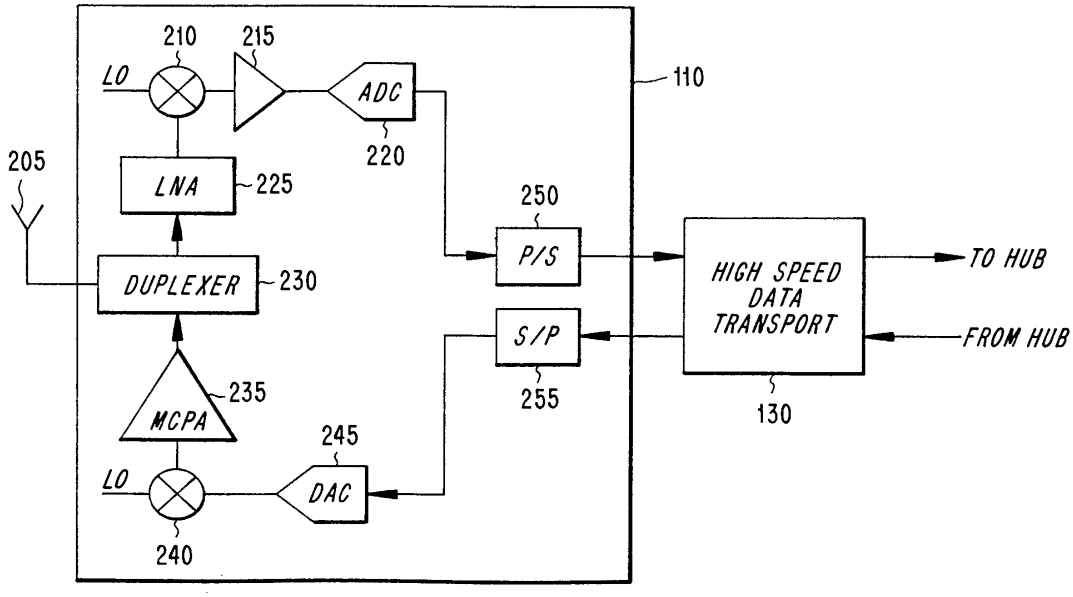

100
MSC
RADIO HEAD
110
T1
130
HUB
120

FIG. 2


110
210
215
LO
ADC
220
205
LNA
225
250
P/S
DUPLEXER
230
HIGH SPEED DATA TRANSPORT
TO HUB
FROM HUB
S/P
255
MCPA
235
245
LO
DAC
240
130

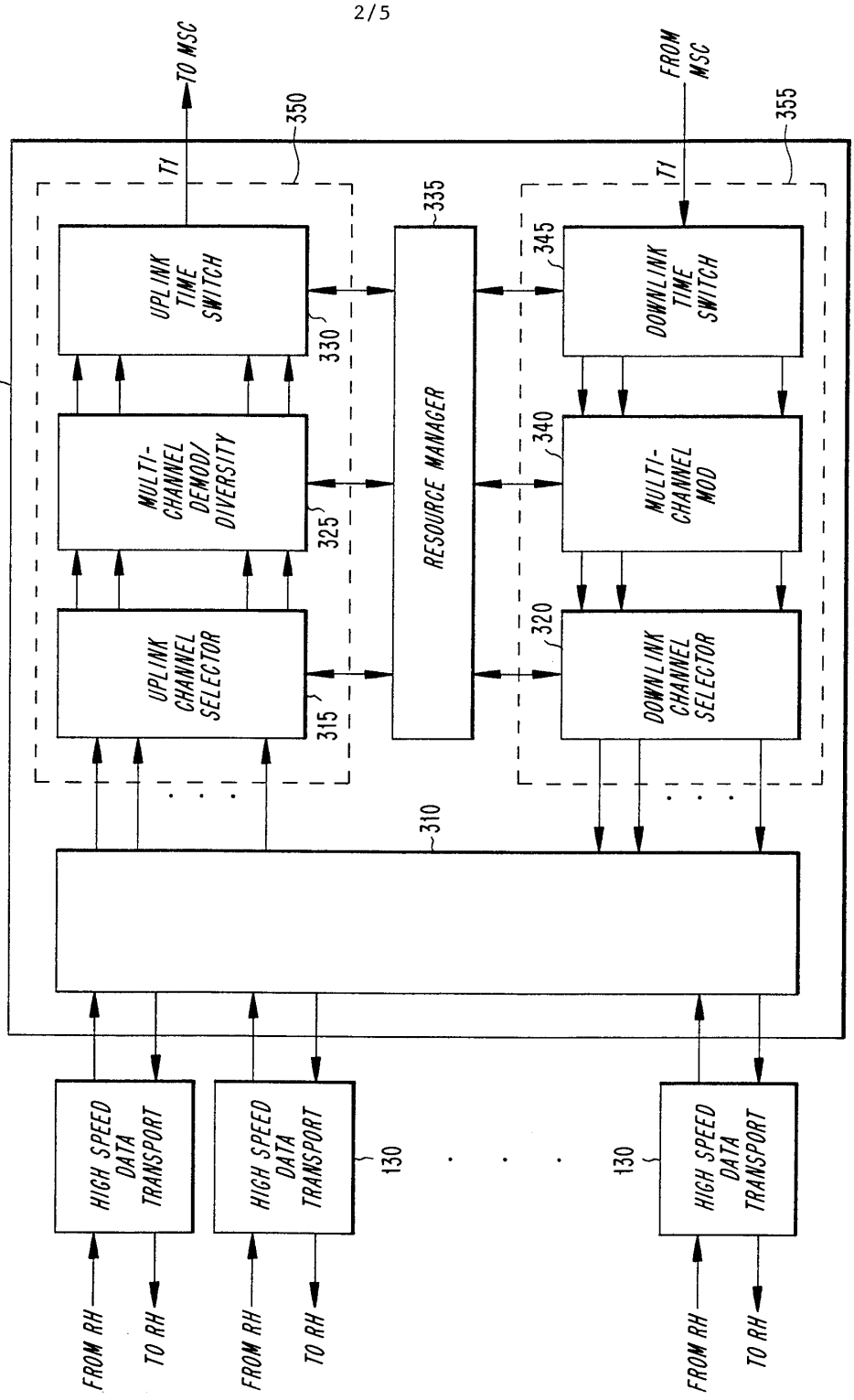

120
TO MSC
FROM MSC
350
355
T1
T1
335
345
UPLINK TIME SWITCH
DOWNLINK TIME SWITCH
330
RESOURCE MANAGER
340
MULTI-CHANNEL DEMOD/ DIVERSITY
MULTI-CHANNEL MOD
325
320
UPLINK CHANNEL SELECTOR
DOWNLINK CHANNEL SELECTOR
315
310
HIGH SPEED DATA TRANSPORT
HIGH SPEED DATA TRANSPORT
HIGH SPEED DATA TRANSPORT
130
130
FROM RH
TO RH
FROM RH
TO RH
FROM RH
TO RH

FIG. 3

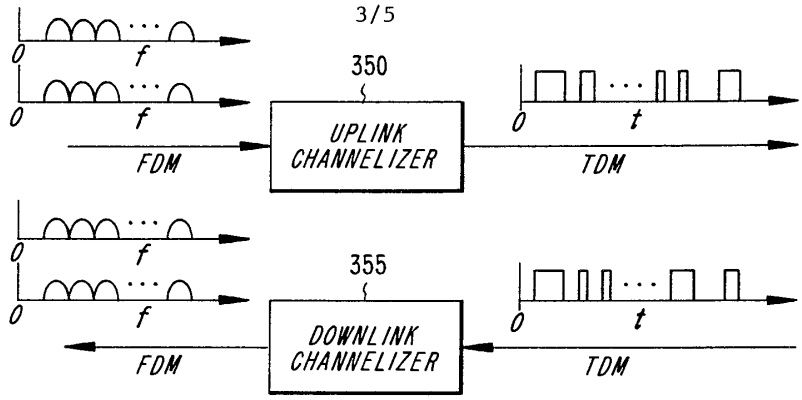


FIG. 4

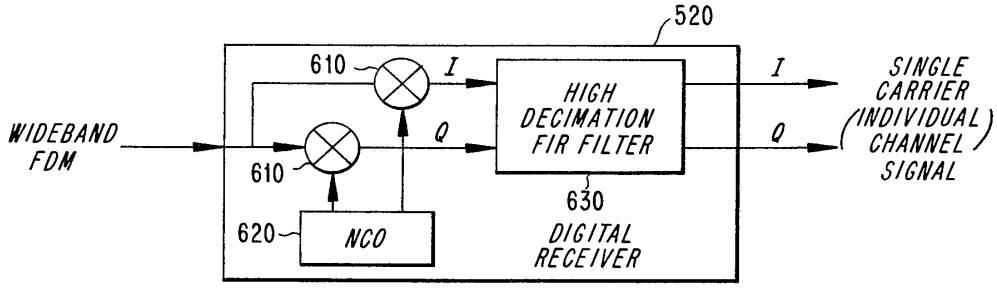


FIG. 6

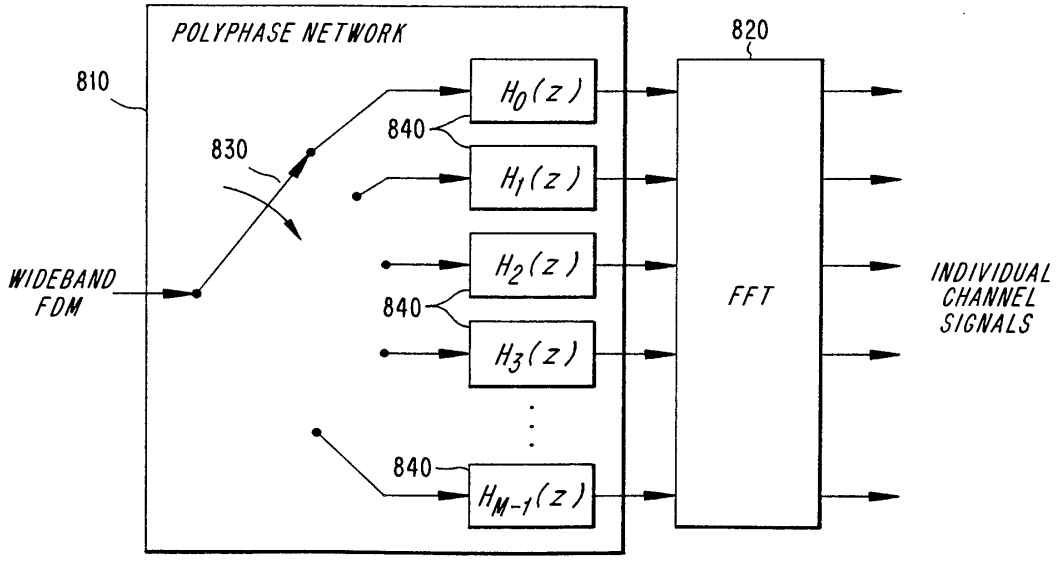


FIG. 8

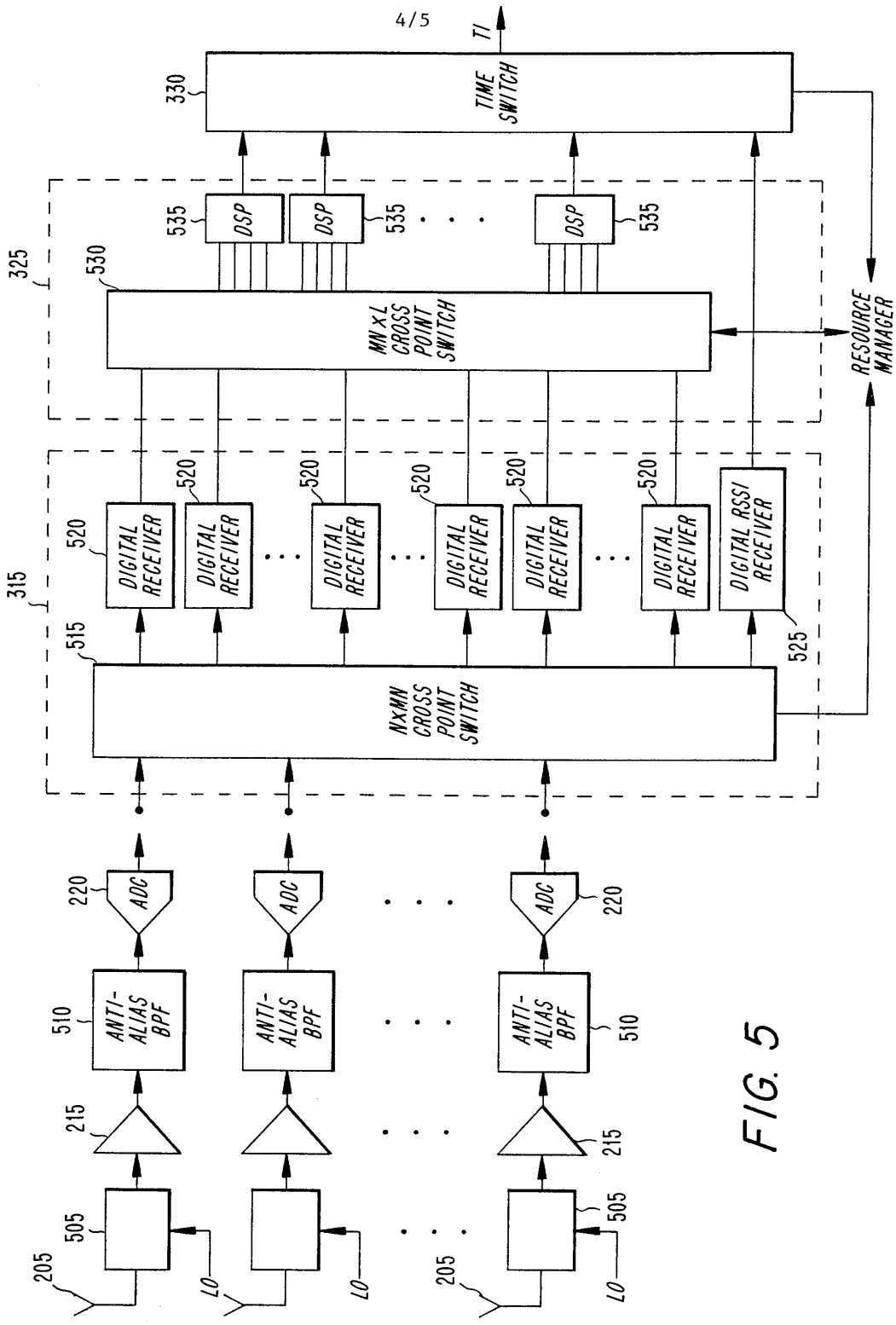

T1
TIME SWITCH
330
325
530
MN x L CROSS POINT SWITCH
535
DSP
RESOURCE MANAGER
315
520
DIGITAL RECEIVER
DIGITAL RSSI RECEIVER
525
515
N x MN CROSS POINT SWITCH
220
ADC
510
ANTI-ALIAS BPF
215
505
205
LO

FIG. 5

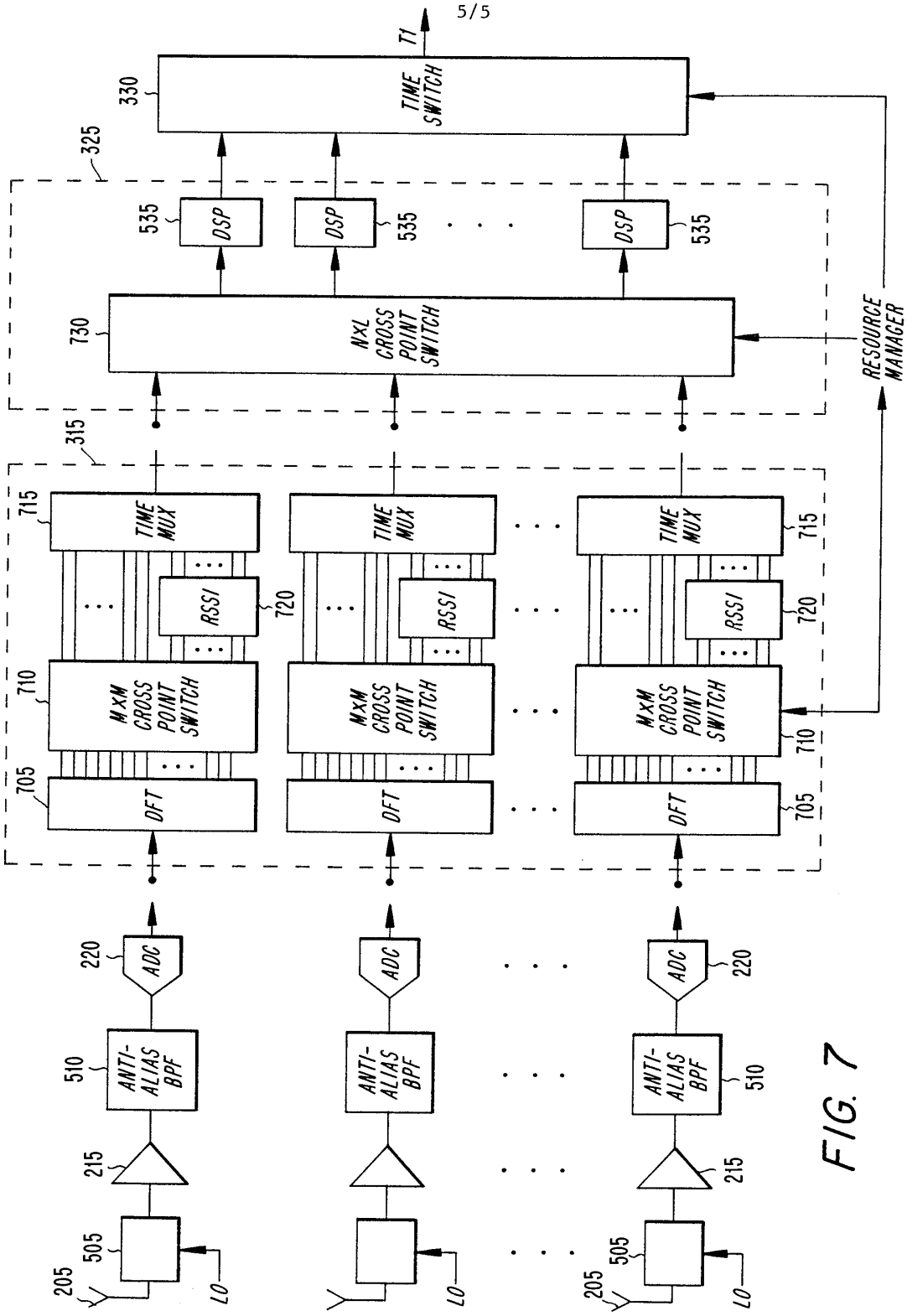

T1
TIME SWITCH
330
325
535
DSP
NxL CROSS POINT SWITCH
730
RESOURCE MANAGER
315
715
TIME MUX
RSSI
720
MxM CROSS POINT SWITCH
710
705
DFT
220
ADC
510
ANTI-ALIAS BPF
215
505
205
LO

FIG. 7

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 642 243 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **93114225.1**

(51) Int. Cl.[6]: **H04J 13/00**, H04B 7/005

(22) Date of filing: **04.09.93**

(43) Date of publication of application:
08.03.95 Bulletin 95/10

(84) Designated Contracting States:
DE FR IT SE

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(54) **Rake receiver for CDMA system.**

(57) Code Division Multiple Access (CDMA) based on Direct Sequence Spread Spectrum (DSSS) permits good multipath diversity by the use of the so-called rake receiver. When multipath codes are sent over the same link (to increase the transmission rate for that link without altering the basic transmission format) multiple rake receivers would normally be required. This invention involves the rake combining operation prior to code correlation in order to make only a single rake processor necessary. This affords significant savings in complexity.

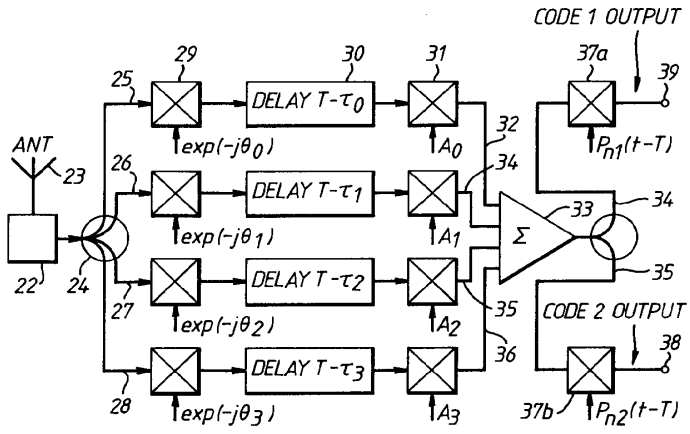


Fig.3

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This invention relates to radio communication systems, and more especially it relates to 'code division multiple access' (CDMA) systems.

Many CDMA systems are based on "direct sequence spread spectrum" (DSSS), wherein different system users are each assigned a unique spreading code thereby to achieve multiple access. In order to make beneficial use of significant multipath components, DSSS systems may use a so called rake receiver. This involves relatively simple technology which permits multipath propagation to be exploited fully. Essentially, in a rake receiver significant multipath components are each resolved by a separate correlator and combined in some fashion prior to detection. This process allows significant multipath diversity, which is inherent in wideband spread spectrum signals, to be fully exploited. In general rake receivers are much simpler than equalisers, because the signal energy of different paths can be combined without the need for eliminating multipath interference or inter symbol interference. This arises because multipath interference is suppressed by the processing gain associated with the spreading process. However, achieving adequate processing gain whereby multipath interference can be ignored requires significant spreading factors, e.g. gains of 50 or more.

In flexible CDMA systems, it may be necessary to allow some users more capacity than the capacity provided by a single channel running with a normal spreading factor. It is clearly desirable that all transmissions should occupy the full bandwidth from the viewpoint of commonalty of RF hardware and interference spectra. In view of this constraint there are two principle options available to achieve increased capacity.

(a) To increase the transmission rate whilst retaining the same spread bandwidth (reduce the spreading factor); or

(b) To transmit a plurality of different codes over the same link, one code for each channel, whereby the link is afforded increased capacity.

Option (a) cannot in general be considered because a significant reduction in the spreading factor would introduce multipath interference at an unacceptable level. The only viable option therefore, is option (b). This however, with known systems involves the use of a multiplicity of rake receivers one for each code which would introduce undesirable complexity.

The present invention has for an object to provide a radio communication system which uses DSSS, CDMA, and which in operation will support a multiplicity of codes over the same link without substantially increased complexity.

According to the present invention, a CDMA radio communication system using DSSS for channel discrimination wherein a different spreading code is used for each channel, comprises a rake receiver for combining received multipath signals to produce a single combined signal and despreading means responsive to the combined signal for producing output signals one for each channel, a plurality of channels being used for one link.

The despreading means may comprise a correlator.

By the expedient of effecting the combination of multipath signals before correlation is carried out to effect despreading, a considerable saving in complexity can be effected in a system wherein link capacity is increased by the provision of one or more additional channels.

One embodiment of the invention will be now described by way of example only with reference to the accompanying drawings, in which;

FIGURE 1 is a block schematic diagram of a known rake receiver;

FIGURE 2 is a generally schematic block diagram of a twin rake receiver; and,

FIGURE 3 is a generally schematic block diagram of a CDMA, DSSS system.

Referring now to Figure 1, a known rake receiver comprises an input amplifier 1, fed from an aerial 2. The input amplifier 1 is arranged to feed a signal splitter 3, which feeds four signal paths 4, 5, 6 and 7. Each of the paths 4, 5, 6 and 7 is similar and thus the path 4 only will be described. The path 4 comprises mixers 8 and 9, arranged to feed a delay device 10 and a further mixer 11, thereby, to provide an output signal on a line 12 for a signal combiner 13. The paths 5, 6 and 7 similarly provide output signals on lines 14, 15 and 16 respectively for the signal combiner 13. In operation of the rake receiver, the mixers in each path, such as the mixers 8, 9 and 11 in path 4 and the delay devices such as the delay device 10 in path 4, are fed/controlled such that multipath signals appear on the lines 12, 14, 15 and 16 suitably modified so that they can be additively combined by the signal combiner 13. The values of the parameters T, θ and A, as shown in the drawing, must clearly be set to achieve this, and the standard approach to effect this is to transmit a pilot sequence of known data. This can either be time interleaved with transmitted data or sent simultaneously using a different code. As an example, the case of a continuous pilot signal which is transmitted over the data will be assumed. Determination of the parameters T, θ and A is achieved by assigning correlators to the pilot sequence under instruction from a search correlator, the search correlator scans the period of time uncertainty (delay uncertainty plus delay spread) and identifies those peaks in energy which correspond to the significant multipath components. Correlators are set up with code phases according to the code phases applying on the

search correlator when the multipath components were found. The phase of each path can be derived by averaging the phase of the output of a complex correlator. Similarly the amplitude is found by averaging the absolute value of the output of the complex correlator.

The foregoing techniques are well understood by those skilled in the art and will not be further described herein. It will be apparent, however, that for two codes in one link, a twin rake receiver would normally be required using known technology as shown in Figure 2, wherein parts corresponding to Figure 1 bear the same numerical designations. Thus, it will be apparent that signals from the amplifier 1 are fed to a signal splitter 17, and thence to two rake receivers 18 and 19, each of which corresponds to the arrangement as hereinbefore described with reference to Figure 1, thereby to provide two output signals on lines 20 and 21, each of which corresponds to a different unique channel. It will be clear that this type of combining requires considerable complexity.

In order to avoid the aforesaid complexity a precombiner rake system is proposed, as hereinafter described with reference to Figure 3.

Referring now to Figure 3, a precombining rake comprises an input amplifier 22, fed from an aerial antenna 23. The amplifier 22 is arranged to feed a signal splitter 24, which feeds lines 25, 26, 27 and 28 in parallel. The paths fed from the lines 25 to 28 are substantially similar and so path 25 only will be described. Path 25 comprises a mixer 29, a delay device 30, and a further mixer 31, serially coupled and providing an output signal on a line 32 for a signal combiner 33. In a similar manner the lines 26, 27 and 28 provide output signals on lines 34, 35 and 36, which feed the signal combiner 33. Parameters, as shown in the drawing, appertaining to the mixers 29 and 31 and the delay device 30, are computed as hereinbefore described with reference to Figure 1, whereby summation of multipath signals is effected in the signal combiner 33. Thereafter, however, signals are fed via lines 34 and 35 to correlators 37a and 37b respectively, thereby to provide output signals on lines 38 and 39 respectively which correspond to different signal channels. It will be appreciated that one correlator, which serves to correlate the receive signal against predetermined sync sequences for despreading purposes will be required for each signal channel. It will also be appreciated that the complexity of the precombining rake arrangement, just before described with reference to Figure 3, is small compared with an alternative known system as described with reference to Figure 2, and that by using a system of this kind several channels can be assigned to one link thereby to increase the link capacity.

Claims

1. A CDMA radio communication system using DSSS for channel discrimination wherein a different spreading code is used for each channel, comprising a rake receiver for combining received multipath signals to produce a single combined signal and despreading means responsive to the combined signal for producing output signals one for each channel, a plurality of channels being used for one link.

2. A system as claimed in claim 1, wherein the despreading means comprises a correlator.

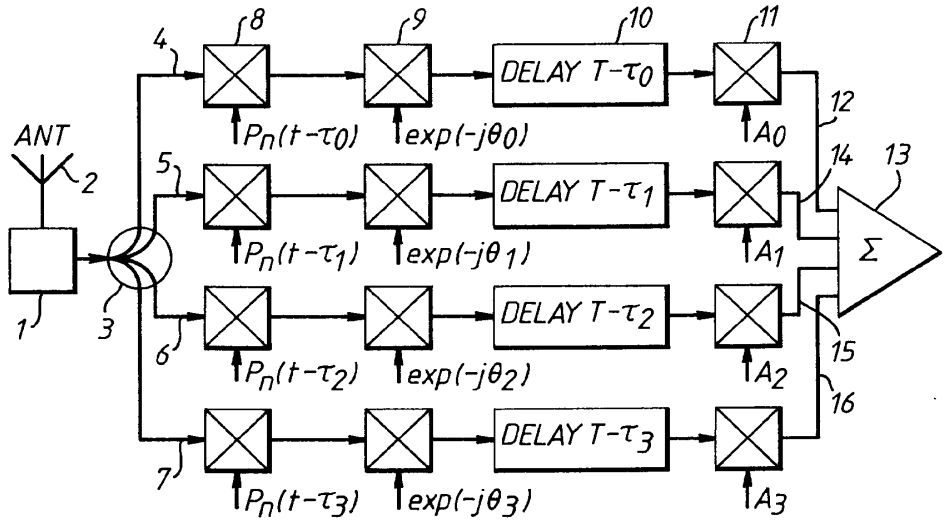

ANT
DELAY T-τ0
DELAY T-τ1
DELAY T-τ2
DELAY T-τ3
Pn(t-τ0)
exp(-jθ0)
A0
Pn(t-τ1)
exp(-jθ1)
A1
Pn(t-τ2)
exp(-jθ2)
A2
Pn(t-τ3)
exp(-jθ3)
A3
Σ

Fig. 1

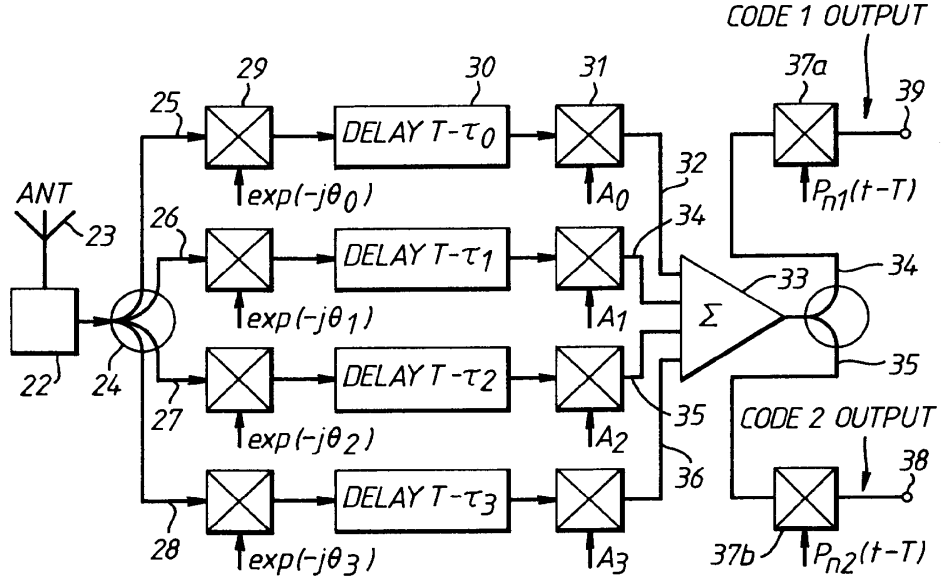

CODE 1 OUTPUT
CODE 2 OUTPUT
ANT
DELAY T-τ0
DELAY T-τ1
DELAY T-τ2
DELAY T-τ3
exp(-jθ0)
A0
exp(-jθ1)
A1
exp(-jθ2)
A2
exp(-jθ3)
A3
Pn1(t-T)
Pn2(t-T)
Σ

Fig. 3

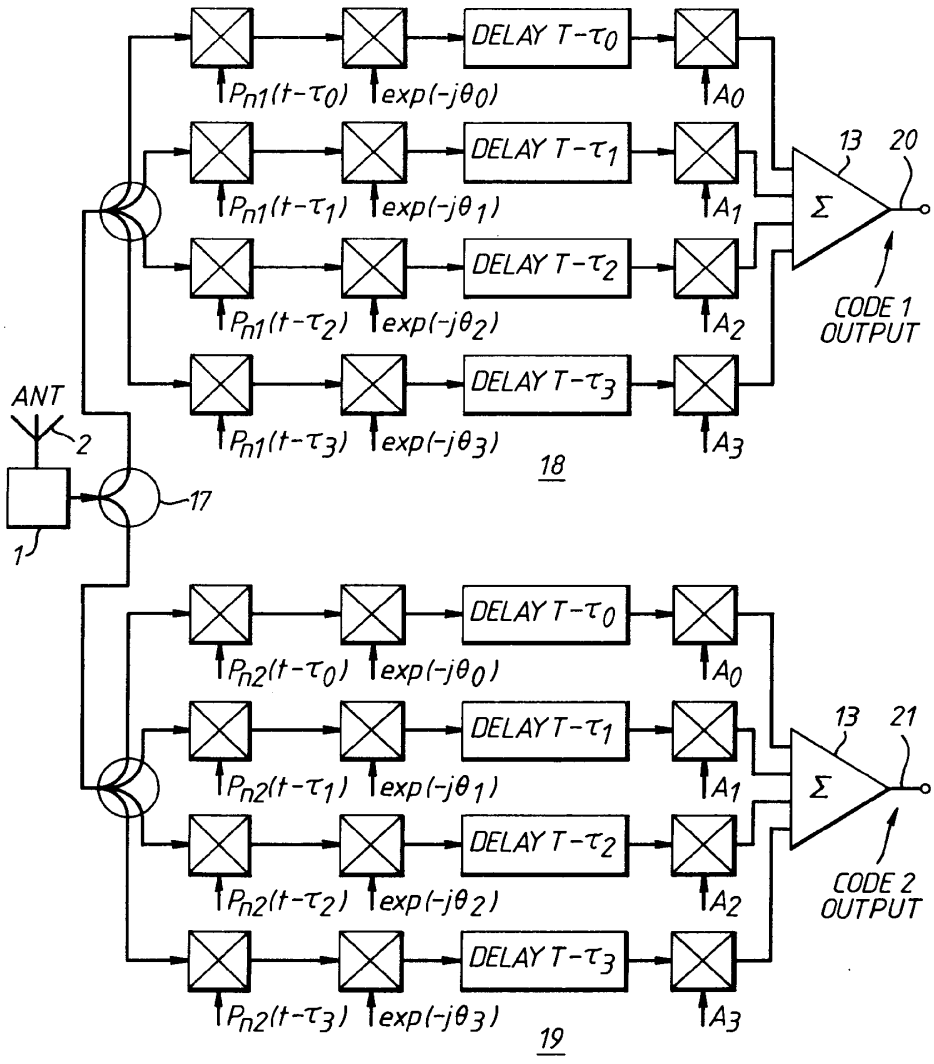

DELAY T-τ0
DELAY T-τ1
DELAY T-τ2
DELAY T-τ3
Pn1(t-τ0)
Pn1(t-τ1)
Pn1(t-τ2)
Pn1(t-τ3)
exp(-jθ0)
exp(-jθ1)
exp(-jθ2)
exp(-jθ3)
A0
A1
A2
A3
Σ
13
20
CODE 1 OUTPUT
18
ANT
2
1
17
Pn2(t-τ0)
Pn2(t-τ1)
Pn2(t-τ2)
Pn2(t-τ3)
21
CODE 2 OUTPUT
19

Fig.2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 11 4225

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-3 524 136 (WALTER J. ALBERSHEIM) * column 5, line 4 - column 7, line 18 * ---	1,2	H04J13/00 H04B7/005
A	IEICE TRANSACTION ON COMMUNICATIONS vol. E76B, no. 8 , August 1993 , NEW YORK (US) pages 1008 - 1014 XP396906 RIAZ ESMAILZADEH ET AL. 'Pre-RAKE diversity combination for direct sequence spread spectrum mobile communications systems.' * page 1009, column 2, paragraph 3 * * page 1010, column 1, paragraph 4 * -----	1,2	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H04J
H04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 February 1994	Van den Berg, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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Espacenet

Bibliographic data: JP2002158615 (A) — 2002-05-31

ROAD-SIDE COMMUNICATION NETWORK

Inventor(s): NITORI KAZUHIKO ± (NITORI KAZUHIKO)

Applicant(s): NAT INST LAND & INFRASTRUCTURE ± (NATL INST FOR LAND & INFRASTRUCTURE MANAGEMENT MLIT)

Classification: **- international:** ***G08G1/09; H04B10/035; H04B10/27; H04B10/275; H04B7/26; H04L12/42; H04W56/00;*** (IPC1-7): G08G1/09; H04B10/20; H04B7/26; H04L12/42; H04Q7/22

- cooperative:

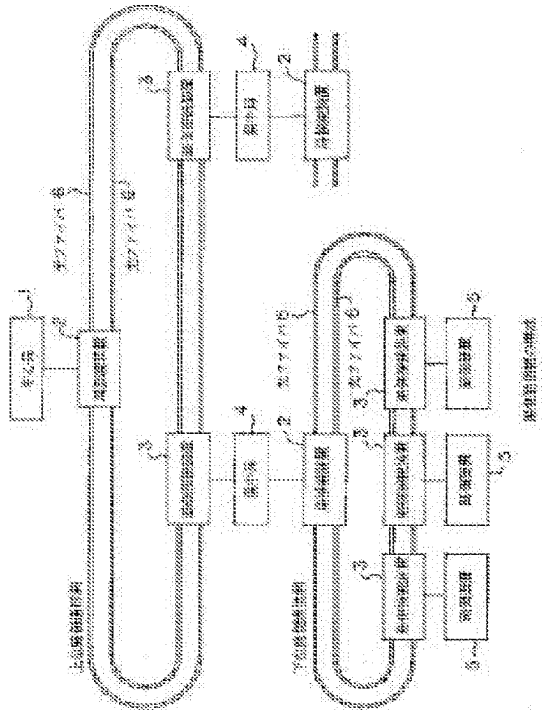
Application number: JP20000355246 20001122 Global Dossier

Priority number(s): JP20000355246 20001122

Also published as: JP3388409 (B2)

Abstract of JP2002158615 (A)

PROBLEM TO BE SOLVED: To provide a road-side communication network that has high immunity from faults, high reliability and can reduce the cost without the need for temporary interruptions and corrections of a communication line, in the case of hand-over. SOLUTION: A road side unit and a central station are interconnected by an optical fiber via a road side connection device and a station connection device, the road side unit and the central station respectively include a road side clock and a central station clock, the station connection device includes two transmitters, that transmits a synchronizing signal indicating a border of time frames through the optical fiber and two receivers that receive the synchronizing signal from the optical fiber, the road side connection device includes two receivers that detect the synchronizing signal from the optical fiber; the central station clock indicates the time when the synchronizing signal is to be generated, measures the time when the receivers of the station connection device detect the synchronizing signal; and the road side clock has a subordinate oscillator that is oscillated synchronously with the synchronizing signal detected by one of the receiver of the road side connection device, uses a pulse counter of the subordinate oscillator to measure the time when the two receivers detect the synchronizing signal and advances or delays the count state of the pulse counter, on the basis of the times and the time measured by the central station clock.



(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号
特開2002－158615
（P2002－158615A）
(43)公開日　平成14年５月31日(2002.5.31)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
Ｈ０４Ｂ　7/26		Ｃ０８Ｇ　1/09	Ｆ	５Ｈ１８０
Ｈ０４Ｑ　7/22		Ｈ０４Ｂ　7/26	Ｈ	５Ｋ００２
Ｈ０４Ｂ　10/20			１０８Ｂ	５Ｋ０３１
Ｈ０４Ｌ　12/42		9/00	Ｎ	５Ｋ０６７
// Ｇ０８Ｇ　1/09		Ｈ０４Ｌ　11/00	３３０	

審査請求　有　請求項の数４　ＯＬ　（全　８　頁）

(21)出願番号　特願2000－355246(P2000－355246)

(22)出願日　平成12年11月22日(2000.11.22)

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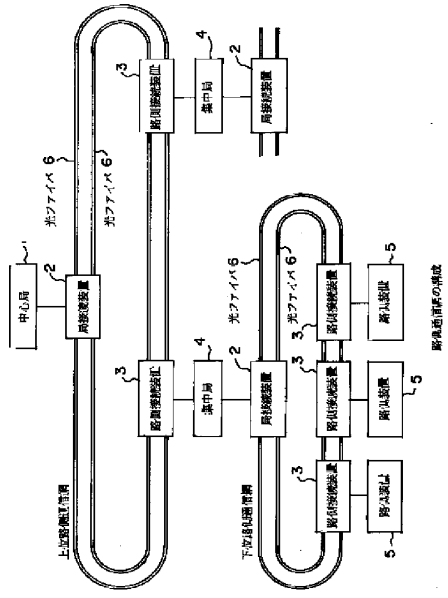
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Ｆターム(参考)　5H180 AA01 BB02 BB15
5K002 AA05 DA01 DA05 DA11 FA01
5K031 AA06 AA10 DA06 DA11 DA19
5K067 AA33 AA41 BB36 CC08 DD25
DD57 EE10 EE16 EE37 EE71
JJ39

(54)【発明の名称】　路側通信網

(57)【要約】
【課題】　ハンドオーバの際に通信路の一時的切断や修正が生じることがないうえ、障害に強く、信頼性が高く、しかもコスト低減が可能になる路側通信網を提供する。
【解決手段】　路側装置と集中局は路側接続装置と局接続装置を介して互いに光ファイバに接続され、路側装置、集中局はそれぞれ、路側クロック、集中局クロックを含み、局接続装置は時間フレームの境界を示す同期信号を光ファイバから送信する２つの送信器と、この同期信号を光ファイバから検出する２つの受信器を含み、路側接続装置は同期信号を光ファイバから検出する２つの受信器を含み、集中局クロックは同期信号を発生すべき時刻を示し、局接続装置の受信器が同期信号を検出した時刻を計測し、路側クロックは路側接続装置の受信器の一方が検出した同期信号に同期して発振する従属発振器と、この従属発振器のパルスカウンタにより２つの受信器が同期信号を検出した時刻を計測し、これらの時刻と集中局クロックが計測した時刻によりパルスカウンタの状態を前進または後退させる。



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【特許請求の範囲】
【請求項１】　路側に設置された路側装置と集中局との間に伝送路を提供する路側通信網において、前記路側装置と集中局は、それぞれ、路側接続装置と局接続装置を介して互いに逆方向に信号を伝送する２重光ファイバ・リングに接続され、前記路側装置、集中局は、それぞれ、路側クロック、集中局クロックを含み、前記局接続装置は、時間フレームの境界を示す同期信号を前記２重光ファイバ・リングの送信端から送信する２つの送信器と、この同期信号を前記２重光ファイバ・リングの受信端から検出する２つの受信器を含み、前記路側接続装置は、前記同期信号を前記２重光ファイバ・リングの中継点から検出する２つの受信器を含み、前記集中局クロックは、前記同期信号を発生すべき時刻を示すと共に、前記局接続装置の受信器が同期信号を検出した時刻を計測し、前記路側クロックは、前記路側接続装置の受信器の一方が検出した同期信号に同期して発振する従属発振器と、この従属発振器により駆動されるパルスカウンタを含み、このパルスカウンタにより前記路側接続装置の２つの受信器が同期信号を検出した時刻を計測し、これらの時刻と前記集中局クロックが計測した時刻に基づき前記パルスカウンタの状態を前進または後退させることを特徴とする路側通信網。
【請求項２】　請求項１に記載の路側通信網において、前記路側接続装置が、２つのクロスバスイッチを含み、２重光ファイバ・リングを切断して折り返す機能を持つことを特徴とする路側通信網。
【請求項３】　請求項１に記載の路側通信網において、前記集中局クロックが前記路側クロックの機能をも併せ持ち、第２の路側接続装置、第２の２重光ファイバ・リング、第２の局接続装置を介して中心局クロックに接続され、それに従属同期することを特徴とする路側通信網。
【請求項４】　請求項１に記載の路側通信網において、前記路側装置が無線基地局とセンサ等を含み、無線基地局と前記集中局との間のデータ伝送とセンサ等と前記集中局との間のデータ伝送が重複する時間スロットにおいて行われることを特徴とする路側通信網。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、将来の高速道路などで必要とされる、危険警告、運転支援、自動運転などに共通に使用される情報通信基盤の実現を目的とし、道路上を走行する車両と路側の情報通信システムとの間および路側の情報通信システムと路側に設置されるセンサシステム等との間の情報伝達を仲介する路側通信網に関するものである。
【０００２】
【従来の技術】従来、車両と路側の情報通信システムとの間に通信路を提供するものとしては、例えば、文献１（西川正明他著、「ＶＩＣＳ（道路交通情報通信システム）」、沖電気研究開発、Vol.63, No.3, pp.7-12, 1996年7月。）や文献２（有住正人、山田豊著、「ＡＨＳと車間側方コントロールシステム」、沖電気研究開発、Vol.63, No.3, pp.39-46, 1996年7月。）に記載されているＶＩＣＳ及び車間側方コントロールシステムが知られている。このうち、前者は路側に数km間隔で電波ビーコンを配置してスポット的な無線ゾーンを形成し、電波ビーコンと車両の間に間欠的な通信路を提供するものである。また、後者は、路側に漏洩同軸ケーブルを敷設し、この漏洩同軸ケーブルと車両の間に連続的な通信路を提供するものである。
【０００３】
【発明が解決しようとする課題】しかしながら、上述した従来の通信路を提供するシステム（以下、『路側通信網』とする。）の場合、１つの電波ビーコンまたは漏洩同軸ケーブルが形成する無線ゾーンの大きさに限界があるため、道路上の全域にわたり連続的な通信路を提供しようとすると、多数の電波ビーコンまたは漏洩同軸ケーブルを配列し、車両の移動と共にそれらを順次切り替えるハンドオーバを行う事が必要となる。このため、このハンドオーバの際に通信路の一時的切断が生じる問題があった。この問題は、隣接する電波ビーコンまたは漏洩同軸ケーブルを通して送信および受信される多重データ信号の時間基準を一致させることにより解決されると考えられるため、この手段による問題解決の実現が望まれている。
【０００４】そこで、この発明の目的は、前記のような従来の路側通信網のもつ問題を解消し、ハンドオーバの際に通信路の一時的切断や修正が生じることがないうえ、障害に強く、信頼性が高く、しかもコスト低減が可能になる路側通信網を提供するにある。
【０００５】
【課題を解決するための手段】この発明は、前記のような目的を達成するために、請求項１に記載の発明は路側に設置された路側装置と集中局との間に伝送路を提供する路側通信網において、前記路側装置と集中局は、それぞれ、路側接続装置と局接続装置を介して互いに逆方向に信号を伝送する２重光ファイバ・リングに接続され、前記路側装置、集中局は、それぞれ、路側クロック、集中局クロックを含み、前記局接続装置は、時間フレームの境界を示す同期信号を前記２重光ファイバ・リングの送信端から送信する２つの送信器と、この同期信号を前記２重光ファイバ・リングの受信端から検出する２つの受信器を含み、前記路側接続装置は、前記同期信号を前記２重光ファイバ・リングの中継点から検出する２つの受信器を含み、前記集中局クロックは、前記同期信号を発生すべき時刻を示すと共に、前記局接続装置の受信器が同期信号を検出した時刻を計測し、前記路側クロックは、前記路側接続装置の受信器の一方が検出した同期信

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号に同期して発振する従属発振器と、この従属発振器により駆動されるパルスカウンタを含み、このパルスカウンタにより前記路側接続装置の２つの受信器が同期信号を検出した時刻を計測し、これらの時刻と前記集中局クロックが計測した時刻に基づき前記パルスカウンタの状態を前進または後退させることを特徴とするものである。

【０００６】また、請求項２に記載の発明は請求項１に記載の発明において、前記路側接続装置が、２つのクロスバスイッチを含み、２重光ファイバ・リングを切断して折り返す機能を持つことを特徴とするものである。

【０００７】また、請求項３に記載の発明は請求項１に記載の発明において、前記集中局クロックが前記路側クロックの機能をも併せ持ち、第２の路側接続装置、第２の２重光ファイバ・リング、第２の局接続装置を介して中心局クロックに接続され、それに従属同期することを特徴とするものである。

【０００８】また、請求項４に記載の発明は請求項１に記載の発明において、前記路側装置が無線基地局とセンサ等を含み、無線基地局と前記集中局との間のデータ伝送とセンサ等と前記集中局との間のデータ伝送が重複する時間スロットにおいて行われることを特徴とするものである。

【０００９】

【発明の実施の形態】図１は本発明における路側通信網の実施形態を示すブロック構成図であり、１は中心局、２は局接続装置、３は路側接続装置、４は集中局、５は路側装置、６は光ファイバである。ここで、道路上に連続的な無線通信ゾーンと障害物等の探知エリアを実現するために、多数の路側装置５が道路に沿ってほぼ等間隔に配列される。これらの路側装置５と集中局４の間でデータ伝送を実現するために、路側装置５に対応して路側接続装置３を、集中局４に対応して局接続装置２を設け、多数の路側接続装置３と１つの局接続装置２を２条の互いに逆方向に信号を伝送する光ファイバ６によりリング状に接続し、下位の路側通信網を構成する。また、多数の集中局４と中心局１の間でデータ伝送を実現するために、集中局４に対応して路側接続装置３を、中心局１に対応して局接続装置２を設け、多数の路側接続装置３と１つの局接続装置２を２条の互いに逆方向に信号を伝送する光ファイバ６によりリング状に接続し、上位の路側通信網を構成する。局接続装置２は光ファイバ・リングの送信端と受信端に接続され、路側接続装置３は光ファイバ６により構成される光ファイバ・リングの中継点に接続される。

【００１０】図２は図１における中心局1の構成を示すブロック図であり、11はパケット交換機、12はサーバ、13は中心局クロックである。ここで、パケット交換機11は、サーバ12、局接続装置２、バックボーン網の相互間でのメッセージ伝達の経路を提供する。サーバ12は、サービスを提供する。中心局クロック13は、路側通信網全体の時間基準を発生する。また、局接続装置２の内部には後述するがマルチプレクサ21（ＭＵＸ）、送信器26、27（ＲＸ）、セレクタ28（ＳＥＬ）がそれぞれ設けられている。

【００１１】図３は図１における集中局４の構成を示すブロック図であり、41はパケット交換機、42はサーバ、43は情報表示板接続部、44はセンサ処理部、45は無線回線処理部、46は路側網管理部、47は集中局クロックである。ここで、パケット交換機41は、サーバ42、情報表示板接続部43、センサ処理部44、無線回線処理部45、路側接続装置3の相互間でのメッセージ伝達の経路を提供する。情報表示板接続部43、センサ処理部44、無線回線処理部45、路側網管理部46は、それぞれ、後述の路側装置5の中の情報表示板51、センサ52、無線基地局53、システム管理部54とメッセージをやり取りする。集中局クロック47は、この集中局４に接続される下位路側通信網全体の時間基準を発生する。

【００１２】図４は図１における局接続装置２の構成を示すブロック図であり、21はマルチプレクサ（ＭＵＸ）、22、23はデマルチプレクサ（ＤＥＭＵＸ）、24、25は送信器（ＴＸ）、26、27は受信器（ＲＸ）、28はセレクタ（ＳＥＬ）である。マルチプレクサ21は、中心局１または集中局４から送られるメッセージを時分割多重化し、送信器24、25に送り、送信器24、25は多重化されたメッセージを光信号に変換して光ファイバ６に送り出す。受信器26、27は、光ファイバ６から取り出した光信号を電気信号に変換し、それぞれ、デマルチプレクサ22、23に送ると共に、電気信号の中から同期信号を検出し、中心局クロック13または集中局クロック47に送る。中心局クロック13または集中局クロック47は、時間基準をマルチプレクサ21に送る。セレクタ28は、デマルチプレクサ22、23のいずれか一方の出力を選択して、中心局１または集中局４に送る。

【００１３】図５は図１における路側装置５の構成を示すブロック図であり、51は道路交通情報を表示する情報表示板、52は路上の障害物等を検出するセンサ、53は移動局との間に路車間無線通信回線を実現する無線基地局、54は路側装置の動作を管理するシステム管理部、55は路側クロックである。これら情報表示板51、センサ52、無線基地局53、システム管理部54は、路側接続装置３とデータのやり取りすることができる。路側クロック55は、路側接続装置3から送られる同期信号に基づき時間基準を発生し、これをセンサ52、無線基地局53に提供する。

【００１４】図６は図１における路側接続装置３の構成を示すブロック図であり、31はマルチプレクサ（ＭＵＸ）、32はデマルチプレクサ（ＤＥＭＵＸ）、33、34はクロスバスイッチ（ＸＳＷ）、35、36は送信器（ＴＸ）、37、38は受信器（ＲＸ）である。ここで、受信器

37、38は、光ファイバ6から取り出した光信号を電気信号に変換し、クロスバスイッチ34に送ると共に、電気信号の中から同期信号を検出して集中局4（路側装置5）の集中局クロック47または路側クロック55に送る。クロスバスイッチ34は、受信器37、38のいずれか一方をデマルチプレクサ32に、他方をクロスバスイッチ33に継ながれている。デマルチプレクサ32は、受信器37、38のいずれかの出力信号の中から本路側接続装置3（図5）に接続されている集中局4または路側装置5宛のもののみを抜き出し、これらの宛先に送ると共に、残りのものをマルチプレクサ31に送る。次いで、マルチプレクサ31は、上記集中局4または路側装置5から送られてくるメッセージを、これらの集中局4または路側装置5に割り当てられたタイムスロット内に時分割多重化し、デマルチプレクサ32から直接送られてきた残りのものと合成し、クロスバスイッチ33に送る。クロスバスイッチ33は、マルチプレクサ31、クロスバスイッチ34の出力のいずれかを送信器35、36のいずれかに接続する。送信器35、36は、入力信号を光信号に変換し、光ファイバ6に送り出す。

【００１５】図7は、図1におけるフレーム同期系の構成を示すものであり、71、72、73は、それぞれ、中心局クロック16の主発振器、パルスカウンタ、時間レジスタ、81、82は、それぞれ、集中局クロック47の従属発振器、パルスカウンタ、83、84、85は集中局クロック47の時間レジスタ、91、92は、それぞれ、路側クロック55の従属発振器、パルスカウンタ、93、94は路側クロック55の時間レジスタである。ここで、主発振器71はパルスカウンタ72を駆動し、パルスカウンタ72はフレーム同期信号を発生して上位路側通信網の局接続装置2のマルチプレクサ21に送り、マルチプレクサ21はこの同期信号を送信器24および25に送り、送信器24および25はこの同期信号を光信号に変換して光ファイバ6に送り出す。そして、上位路側通信網の路側接続装置3の受信器37はこの同期信号の一方を受信し、集中局クロック47の従属発振器81と時間レジスタ84に送る。路側接続装置3の受信器38はこの同期信号の一方が途中で折り返されたものまたは他方を受信し、集中局クロック47の時間レジスタ85に送る。従属発振器81はパルスカウンタ82を駆動する。

【００１６】また、時間レジスタ84、85は、それぞれ、受信器37、38から信号が送られた時点でパルスカウンタ82の内容を読み込む。局接続装置2の受信器26または27は、前記受信器38を通過した同期信号を受信し、時間レジスタ73に送る。時間レジスタ73は、この信号が送られた時点でパルスカウンタ72の内容を読み込む。以上が上位路側通信網におけるフレーム同期系の構成である。また、下位路側通信網におけるフレーム同期系の構成も上記と同様である。

【００１７】図8は、本発明の実施形態における路側通信網のフレーム構成を示す図である。すなわち、本発明ではある固定の時間を基本周期とする時間フレームを定め、このフレームを多数の時間スロットに分割している。下位路側通信網では、1つの路側通信網に接続される路側装置5の最大数をM（図8の例では12）、無線基地局53の上り回線と下り回線のチャネル数の和をN（図8の例では8）の場合には、「M×N個」の時間スロットを設ける。この各時間スロットが、1つの移動局と集中局4の間および各路側装置5の情報表示板51、センサ52、システム管理部54と集中局4の間の片方向の通信リンクを形成するために割り当てられる。ただし、センサのような高速伝送を必要とする装置には複数の時間スロットを割り当てることもできる。ここで、無線回線がTDD(time division duplex)方式で実現される場合には、図8に示すように、無線回線の下り回線（無線基地局から移動局に向かう回線）と上り回線（下り回線とは逆方向の回線）の時間スロットと路側通信網において無線基地局53と集中局4の間の接続に用いられる時間スロットの時間のずれが最小になるように配置することにより、無線基地局53における伝送遅延時間を最小に抑えることができる。この場合には、無線基地局53と集中局4の間の接続には光ファイバ・リングの片側（集中局4から路側装置5まで、または路側装置5から集中局4まで）しか用いられないので、残りの片側を情報表示板51、センサ52、システム管理部54と集中局4との間の接続に使用することができる。

【００１８】上位路側通信網では、1つの路側通信網に接続される集中局4の最大数をL（図8の例では12）とすると、L個の時間スロットを設けるようにしている。この時間スロットは中心局1と各集中局4の間に両方向の通信リンクを形成するために割り当てられる。フレームの開始点を表すために伝送路にフレーム同期信号が送出される。局接続装置2および路側接続装置3の受信器26、27、37、38は、この同期信号を検出し、中心局クロック13、集中局クロック47、路側クロック55に送り、伝送路の遅延時間の計測を可能にする。ここで、上位および下位の路側通信網のそれぞれは、「通常モード」と「折り返しモード」との2つの動作モードのいずれかで運用される。ここで、「通常モード」とは、光ファイバの2重リングをそれぞれ独立の伝送路として構成し、そのうちの一方をデータと同期信号の伝送に、他方を同期信号のみの伝送に用いるモードのことであり、「折り返しモード」とは、路側接続装置3または光ファイバ6のどこかに障害が生じた場合には、障害点の両隣りの路側接続装置3において2重リングを切断し、2つの往復伝送路を構成するもので、各往復伝送路では、データと同期信号を伝送するモードのことである。そして、これら2つの動作モードの切換えは、路側接続装置3のクロスバスイッチ33、34の切換えと局接続装置2のセレクタ28の選択動作により実現される。

【００１９】そして、すべての集中局クロック47は、以下のようにして中心局クロック13に従属同期される。す

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なわち、中心局のパルスカウンタ72の基準点において、マルチプレクサ21は周期的に同期信号を発生し、送信器24、25に送る。送信器24、25は、互いに逆方向に信号を伝送する２条の光ファイバ６に、この同期信号を伝送する。路側接続装置3の受信器37は一方の伝送路で送られたこの同期信号を検出し、集中局クロック47の従属発振器81に入力して従属発振器81の発振周波数を中心局クロック13の主発振器71の発振周波数に同期させる。それと同時に、その同期信号の検出時刻におけるパルスカウンタ82の内容「T1」を時間レジスタ84に読み取らせる。一方、路側接続装置3の受信器38および局接続装置の受信器26または27は、他方の伝送路で送られたこの同期信号を検出し、その検出時刻におけるパルスカウンタ82および72の内容「T2」および「T3」を、それぞれ、時間レジスタ85および73に読み取らせる。次いで、内容「T3」の値を中心局１から集中局４に伝送し、集中局４において前記「T1「T2」「T3」の各値を基に、以下の「数１」に示す演算式により「ΔT」を求める。

【００２０】

【数１】ΔT = （T3 － T1 － T2）／2

【００２１】すなわち、中心局１と集中局４の間の往復の伝送路の伝送遅延が等しいと仮定すると、「ΔT」は中心局クロック13に対する集中局クロック47の遅れを表すこととなる。このため、この「ΔT」値だけパルスカウンタ82の状態を進めることにより、中心局クロック13と集中局クロック47の時刻を同期させることができる。同様にして、集中局クロック47と路側クロック55の時刻を同期させることができるので、上位および下位路側通信網で相互接続された全ての路側クロック55の時刻を同期させることができる。以下、路側クロック55からセンサ52、無線基地局53に時刻が正確に同期されたクロックが提供され、このクロックに同期してセンサ52は出力信号を送り出し、無線基地局53は送信信号を送り出す。

【００２２】

【発明の効果】本発明の場合、路側に設置される多数の路側装置のクロックの時刻を正確に同期させることができるため、無線基地局から送信される信号の時間基準を正確にあわせることができ、ハンドオーバの際に移動局のクロックの時刻を大幅に修正することがなくなり、伝送遅延時間の増加や伝送パケットの消失を防ぐことができるという効果がある。また、センサにも正確なクロックを提供できるので、センサのフレームと伝送路のフレームのずれにより生ずる遅延を防止できるという効果がある。さらに、本発明では路側に敷設された８条の光ファイバを用いて上位および下位の２重光ファイバ・リングからなる路側通信網を構成し、多数の路側装置を集中局および中心局に接続できるので、各路側装置と集中局の間を個別の光ファイバで接続する場合に比べて大幅なコスト低減が可能になる。そして、光ファイバおよび路側接続装置からなる伝送路の一部に障害が発生した場合には、２重リング型から折り返し型に網を再構成することにより運用を続けることができるので、障害に強く、且つ信頼性の高い路側通信網を実現することができるという優れた効果がある。

【図面の簡単な説明】

【図１】本発明における路側通信網の概要を示す全体構成図である。

【図２】図１における中心局の構成を示すブロック図である。

【図３】同集中局の構成を示すブロック図である。

【図４】同局接続装置の構成を示すブロック図である。

【図５】同路側装置の構成を示すブロック図である。

【図６】同路側接続装置の構成を示すブロック図である。

【図７】同路側通信網のフレーム同期系の構成を示す図である。

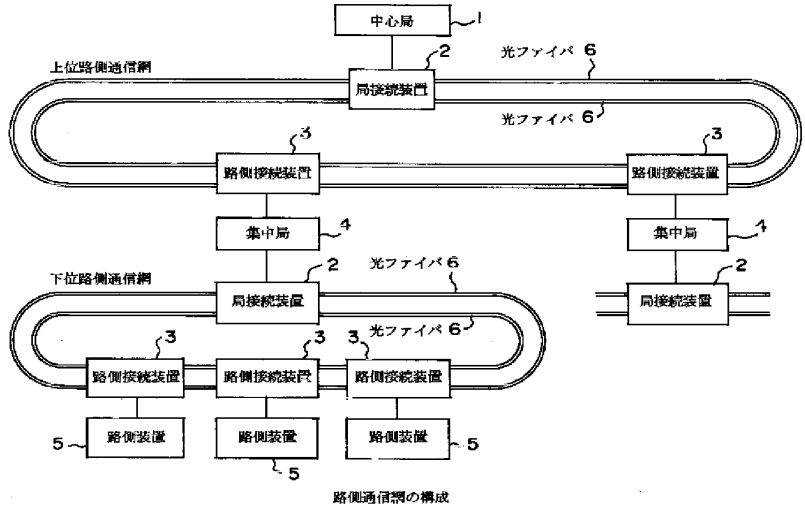
【図８】路側通信網のフレーム構成を示す図である。

【符号の説明】

1　中心局
2　局接続装置
3　路側接続装置
4　集中局
5　路側装置
6　光ファイバ
11，41　パケット交換機
12，42　サーバ
13　中心局クロック
21，31　マルチプレクサ（ＭＵＸ）
22、23，32　デマルチプレクサ（ＤＥＭＵＸ）
24、25、35、36　送信器（ＴＸ）
26、27、37、38　受信器（ＲＸ）
28　セレクタ（ＳＥＬ）
41　パケット交換機、
42　サーバ、
43　情報表示板接続部
44　センサ処理部
45　無線回線処理部
46　路側網管理部
47　集中局クロック
51　情報表示板
52　センサ
53　無線基地局
54　システム管理部
55　路側クロック
72、82、92　パルスカウンタ
81、91　従属発信器
73、83、84、85、93、94　時間レジスタ

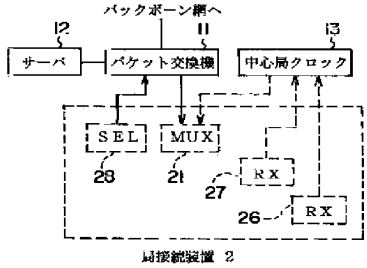
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【図１】



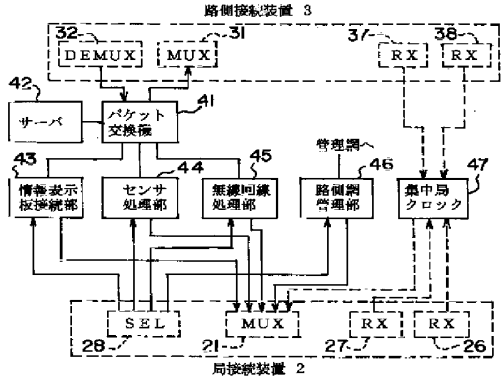
路側通信網の構成

【図２】



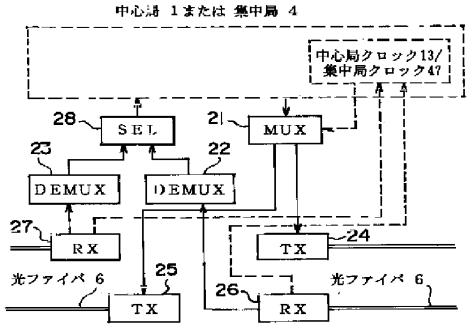
中心局の構成

【図３】



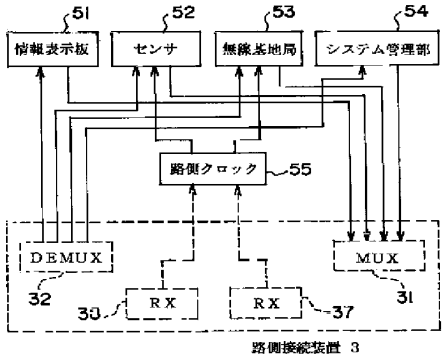
集中局の構成

【図4】



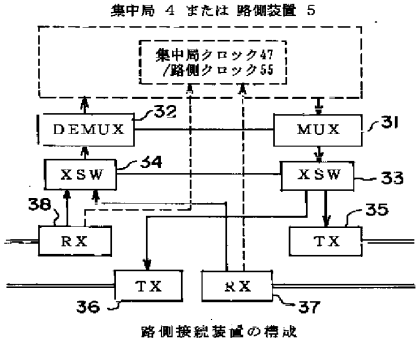
局接続装置の構成

【図5】



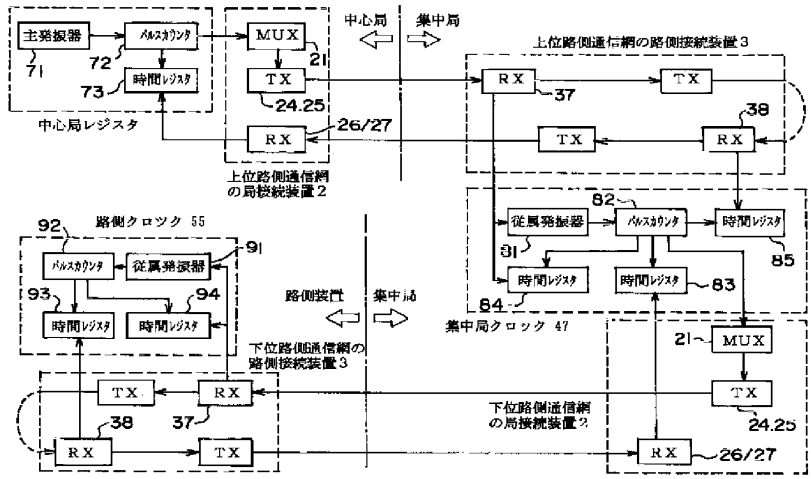
路側装置の構成

【図6】



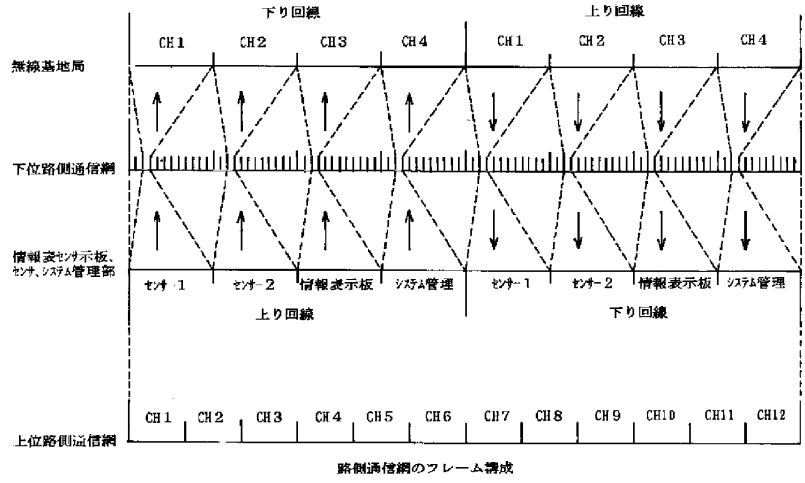
路側接続装置の構成

【図7】



路側通信網のフレーム同期系の構成を示す図

【図8】



路側通信網のフレーム構成

Espacenet

Bibliographic data: JP2008135955 (A) — 2008-06-12

ROF SYSTEM AND SLAVE DEVICE INSTALLATION METHOD

Inventor(s): TAKAMI MASAYUKI; KUSAMA KATSUMI ± (TAKAMI MASAYUKI, ; KUSAMA KATSUMI)

Applicant(s): TOSHIBA CORP ± (TOSHIBA CORP)

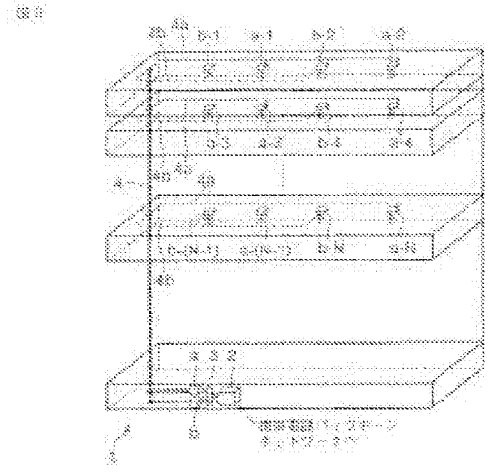
Classification: **- international:** ***H04B7/24; H04B7/26; H04W24/04***
- cooperative:

Application number: JP20060320372 20061128 Global Dossier

Priority number(s): JP20060320372 20061128

Abstract of JP2008135955 (A)

PROBLEM TO BE SOLVED: To avoid the whole interruption of services when master station devices of a ROF (radio over fiber) system installed for a dead area countermeasure of a portable telephone base station fails or is subjected to maintenance. ;SOLUTION: In the ROF system 1, a radio communication signal from the portable telephone base station 2 is branched into two systems and output to the master station stations a and b. The radio communication signal is converted into optical signals by the master station devices a and b and transmitted to slave station devices a-1 to a-N and b-1 to b-N of respective floors through an optical fiber 4. The slave station devices reconvert the optical signal into a radio communication signal and radiate the radio communication signal from antennas a1-1 to al-N and b1-1 to b1-N installed in the slave station devices. Thus, the radio communication signal of the two systems is independently operated in each floor. ;COPYRIGHT: (C)2008,JPO&INPIT



(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2008-135955
(P2008-135955A)
(43)公開日　平成20年6月12日(2008.6.12)

(51)Int.Cl.			F I			テーマコード（参考）
H04Q	***7/36***	***(2006.01)***	H04B	7/26	104A	5K067
H04B	***7/24***	***(2006.01)***	H04B	7/24	A	
H04B	***7/26***	***(2006.01)***	H04B	7/26	K	

審査請求 未請求　請求項の数 4　OL　（全 8 頁）

(21)出願番号　特願2006-320372 (P2006-320372)
(22)出願日　平成18年11月28日 (2006.11.28)

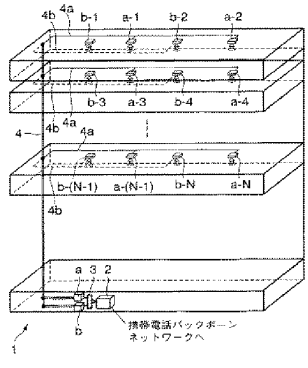
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最終頁に続く

(54)【発明の名称】ＲＯＦシステムおよび子局装置設置方法

(57)【要約】
【課題】携帯電話基地局の不感エリア対策に設置されるＲＯＦシステムの親局装置の障害時やメンテナンスを行う際のサービスの全断を回避する。
【解決手段】ＲＯＦシステム１において、携帯電話基地局２からの無線通信信号を２系統に分岐して親局装置ａ，ｂに出力する。無線通信信号は、親局装置ａ，ｂにて光信号に変換され、光ファイバ４を介して各フロアの子局装置ａ－１～ａ－Ｎ、ｂ－１～ｂ－Ｎに伝送される。子局装置は、光信号を無線通信信号に再変換し、子局装置に設置されたアンテナａ１－１～ａ１－Ｎ、ｂ１－１～ｂ１－Ｎから無線通信信号を放射する。このようにして、各フロアにおいて２系統の無線通信信号を独立して運用できるようにしている。
【選択図】　図２

図２



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【特許請求の範囲】
【請求項1】
移動端末との間で通信する無線信号を送受信する基地局と、
　前記無線信号を第１及び第２の系統に分岐する分岐部と、
　前記第１及び第２の系統の無線信号それぞれを複数の光信号に変換して入出力する第１及び第２の親局装置と、
　前記第１及び第２の親局装置との間でそれぞれが入出力する複数の光信号それぞれを無線信号に変換し、それぞれのアンテナを介して前記移動端末との間で無線通信する複数の子局装置とを具備し、
　前記基地局と前記移動端末との間の通信を可能とする空間を、前記第１の親局装置からの光信号を入出力する子局装置と前記第２の親局装置からの光信号を入出力する子局装置とを混在して設置することにより構成することを特徴とするＲＯＦシステム。
【請求項2】
前記空間は、前記第１の親局装置からの光信号を入出力する子局装置のカバーエリアと前記第２の親局装置からの光信号を入出力する子局装置のカバーエリアとを交互に設置して構成することを特徴とする請求項１に記載のＲＯＦシステム。
【請求項3】
移動端末との間で通信する無線信号を送受信する基地局と、前記無線信号を第１及び第２の系統に分岐する分岐部と、前記第１及び第２の系統の無線信号それぞれを複数の光信号に変換して入出力する第１及び第２の親局装置と、前記第１及び第２の親局装置との間でそれぞれが出力する複数の光信号それぞれを無線信号に変換してそれぞれのアンテナを介して前記移動端末との間で無線通信する複数の子局装置とを具備するＲＯＦシステムで用いられる前記子局装置の設置方法であって、
　前記基地局と前記移動端末との間の通信を可能とする空間を、前記第１の親局装置からの光信号を入出力する子局装置と前記第２の親局装置からの光信号を入出力する子局装置とを混在して設置することにより構成することを特徴とする子局装置設置方法。
【請求項4】
前記空間は、前記第１の親局装置からの光信号を入出力する子局装置のカバーエリアと前記第２の親局装置からの光信号を入出力する子局装置のカバーエリアとを交互に設置して構成することを特徴とする請求項３に記載の子局装置設置方法。

【発明の詳細な説明】
【技術分野】
【0001】
　この発明は、携帯電話システムの不感エリアをカバーするＲＯＦ（Radio Over Fiber）システムおよび子局装置設置方法に関する。
【背景技術】
【0002】
　近時、携帯電話システムの不感地対策、あるいは携帯電話基地局のカバーエリアの拡大等を目的として、携帯電話基地局とアンテナとの間をＲＯＦシステムにて接続する技術の適用が進んでいる。
【0003】
　光ファイバは伝送損失が小さいため、ＲＯＦ技術を用いることにより、数ｋｍの範囲にわたってアンテナを配置することが可能になる。さらにＲＯＦ技術は、高層ビルやイベントホール等の電波不感エリアをカバーするために、カバーエリアが狭いアンテナを複数分散配置して不感エリア対策を行う場合などにおいても有効に利用できる。
【0004】
　従来、高層ビルにおける電波不感エリアをカバーするためのＲＯＦシステムは、携帯電話端末との間で送受信される無線通信信号を送受信する携帯電話基地局に接続され、その無線通信信号を光信号に変換して子局装置との間で通信する親局装置と、光信号を無線通信信号へ再変換してアンテナを介して携帯電話端末との間で無線通信を行う子局装置とを

具備している。

【0005】

このシステムでは、ビルの地下等に設置された携帯電話基地局の近傍に、親局装置が設置され、この親局装置には無線通信信号が上り／下り方向で接続される。親局装置には光ファイバを介して複数の子局装置がスター状に接続されており、無線通信信号は親局装置により光信号に変換されて光ファイバに伝送されている。これらの光信号は、光ファイバを介してビルの各フロアに分散配置された子局装置との間で入出力され、子局装置により無線通信信号へ再度変換される。その後、この無線通信信号は、子局装置に設置されたアンテナを介して携帯電話端末との間で送受信される。このように、小さなカバーエリアの子局装置を複数設置して組み合わせたＲＯＦシステムにより、高層ビル等における携帯電話の不感エリア対策を行っている。

【0006】

しかしながら、このシステムでは、親局装置の障害時やメンテナンスを行う際にシステム全体の機能が停止するという問題がある。例えば、カバーエリアを拡大するために子局装置を増設する場合等には、電波強度に関する規制により一旦サービスを停止して、言い換えれば電波の送信を停止して、基準信号によるレベル調整等を行うことが必要となる。この作業中にはサービスを提供することができなくなる。

【0007】

なお、基地局に障害が発生したときの通信不能を回避するため、隣接する基地局が、通信不能となった基地局のカバーエリアを補完する方法が提案されている（例えば、特許文献１参照。）。この文献１では、隣接する基地局のカバーエリアの形状を変形して、通信不能となった基地局のカバーエリアを補完している。しかし、上述するシステム全体の機能停止を回避する限りにおいては、文献１に示すようなカバーエリアの形状を変形する必要は無く、カバーエリア全体の中で部分的にサービスが継続していれば十分である。また、カバーエリアの形状を変化させる機能を基地局に持たせると、そのコストが高くなる。

【特許文献1】特開２００２－１１２３２３号公報

【発明の開示】

【発明が解決しようとする課題】

【0008】

以上のように、従来のＲＯＦシステムでは、親局装置の障害時やメンテナンスを行う際にはＲＯＦシステム全体の機能が停止してしまい、この間のサービスの提供ができなかった。

【0009】

そこで、本発明の目的は、従来のシステムと比較してシステムのコストを上げること無しに、障害時のインパクトを回避することが可能なＲＯＦシステムおよび子局装置設置方法を提供することである。

【課題を解決するための手段】

【0010】

上記目的を達成するために本発明は、移動端末との間で通信する無線信号を送受信する基地局と、前記無線信号を第１及び第２の系統に分岐する分岐部と、前記第１及び第２の系統の無線信号それぞれを複数の光信号に変換して入出力する第１及び第２の親局装置と、前記第１及び第２の親局装置との間でそれぞれが入出力する複数の光信号それぞれを無線信号に変換し、それぞれのアンテナを介して前記移動端末との間で無線通信する複数の子局装置とを具備し、前記基地局と前記移動端末との間の通信を可能とする空間を、前記第１の親局装置からの光信号を入出力する子局装置と前記第２の親局装置からの光信号を入出力する子局装置とを混在して設置することにより構成される。

【0011】

このようにして、基地局からの１系統の無線信号を２系統に分岐して２台の親局装置に出力する。これら２台の親局装置にて変換した光信号を、光ファイバを介して同一エリア内の子局装置に伝送することにより、同一エリア内を２系統の信号で独立に運用できるよ

うにしている。

【発明の効果】

【0012】

本発明によれば、２系統に分岐した無線信号を２台の親局装置との間で入出力することにより、同一フロア内を２系統の信号で独立に運用できるため、片方の系統に障害が発生したときやメンテナンス時にも、当該フロアにおいてサービスの提供を継続することが可能となる。また、光ファイバ、子局装置、アンテナの数は変わらないため、システムの費用が従来のシステムと比較して高額にはならない。

【発明を実施するための最良の形態】

【0013】

以下、図面を参照しながら本発明の実施の形態について詳細に説明する。

【0014】

図１は、本発明の一実施形態に係るＲＯＦシステム１の概略構成を示すブロック図である。図１におけるＲＯＦシステム１は、無線信号の一つである無線通信信号を送受信する携帯電話基地局２と、送受信する無線通信信号の分岐および結合を行う分岐結合器３と、分岐結合部３でａ，ｂ系統に分岐された各無線通信信号を複数の光信号に変換する親局装置ａ，ｂと、光信号を伝送する光ファイバ４と、光信号を受信して無線通信信号へ変換する子局装置ａ－１～ａ－Ｎ，ｂ－１～ｂ－Ｎと、子局装置ａ－１～ａ－Ｎ，ｂ－１～ｂ－Ｎで変換された無線通信信号を放射するアンテナａ１－１～ａ１－Ｎ，ｂ１－１～ｂ１－Ｎとを具備する。

【0015】

携帯電話端末Ｔ１～ＴＮは、アンテナａ１－１～ａ１－Ｎ，ｂ１－１～ｂ１－Ｎのいずれかを介し、子局装置ａ－１～ａ－Ｎ，ｂ－１～ｂ－Ｎのいずれかとの間で無線通信を行う。

【0016】

図２は、本発明の一実施形態に係るＲＯＦシステム１を高層ビルに設置したときの概略構成を示す模式図である。図２に示すＲＯＦシステム１において、ビルの地下等に設置された一台の携帯電話基地局２が、分岐結合器３を介して第１及び第２の親局装置ａ，ｂと接続され、高層階まで設置された光ファイバ４により、各フロアに配置した子局装置ａ－１～ａ－Ｎ，ｂ－１～ｂ－Ｎと接続されている。各子局装置には、アンテナａ１－１～ａ１－Ｎ，ｂ１－１～ｂ１－Ｎが設置される。このとき、光ファイバ４は、複数の細い光ファイバが束ねられた構成をしており、親局装置ａからのａ系統の光信号を伝送する光ファイバ４ａと、親局装置ｂからのｂ系統の光信号を伝送する光ファイバ４ｂとが存在する。子局装置ａ－１～ａ－Ｎは、光ファイバ４ａによって親局装置ａに対してスター状に接続される。子局装置ｂ－１～ｂ－Ｎと親局装置ｂとの接続トポロジも同様である。また、親局装置ａ，ｂから光ファイバを各フロアに分配するに際して、各フロアにおいて親局装置ａと接続する子局装置ａ－１～ａ－Ｎのカバーエリアと、親局装置ｂと接続する子局装置ｂ－１～ｂ－Ｎのカバーエリアとが交互になるよう配置される。

【0017】

携帯電話基地局２から送信された無線通信信号は、分岐結合器３によりａ，ｂの２系統に分岐され、第１及び第２の親局装置ａ，ｂに入力される。このとき、分岐結合器３と第１及び第２の親局装置ａ，ｂとには、無線通信信号が上り／下り方向で接続される。

【0018】

以下、説明の便宜上、下り方向の無線通信信号を出力（送信）する場合を例に動作を説明する。

【0019】

親局装置ａ，ｂにおいて無線通信信号は光信号に変換され、親局装置ａからは光ファイバ４ａを介してａ系統の光信号が各フロアの子局装置ａ－１～ａ－Ｎに伝送され、親局装置ｂからは光ファイバ４ｂを介してｂ系統の光信号が各フロアの子局装置ｂ－１～ｂ－Ｎに伝送される。この光ファイバは上り／下り２本で接続する場合も、波長多重により一本

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の光ファイバの場合もある。子局装置ａ－１～ａ－Ｎに出力された光信号は、無線通信信号に再度変換され、子局装置ａ－１～ａ－Ｎに設置されたアンテナａ１－１～ａ１－Ｎから放射される。同様に、子局装置ｂ－１～ｂ－Ｎに出力された光信号は、無線通信信号に再度変換され、子局装置ｂ－１～ｂ－Ｎに設置されたアンテナｂ１－１～ｂ１－Ｎから放射される。

【0020】

図３は、本発明の一実施形態に係るＲＯＦシステム１の、図２におけるａ系統のカバーエリアとｂ系統のカバーエリアの模式図である。各フロアでのサービス提供範囲において、アンテナａ１－１～ａ１－Ｎから放射されるａ系統のカバーエリアと、アンテナｂ１－１～ｂ１－Ｎから放射されるｂ系統のカバーエリアとを空間に交互に配置するようにする。

【0021】

以上のように、上記一実施形態では、携帯電話基地局２からの出力１系統が２系統となるよう親局装置ａ，ｂの２台を接続して分岐することにより、それぞれの系統の信号を独立して運用できるようにしている。この構成では、同一エリアにおいて２系統の親局装置ａ，ｂからの光信号が、子局装置ａ－１～ａ－Ｎ，ｂ－１～ｂ－Ｎにて無線通信信号に変換され、アンテナａ１－１～ａ１－Ｎ，ｂ１－１～ｂ１－Ｎから放射される。これにより、親局装置ａ，ｂは、従来の親局装置と比較して半分のチャネル容量となるものを２台準備すれば十分である。すなわち、チャネル容量が半分の親局装置でよいため、親局装置が２台必要になるとはいえ、そのコストは、１台のときと比較して単純に２倍となることはない。また、光ファイバ、子局装置、およびアンテナの数は従来のシステムと同じである。つまり、従来のシステムと比較してコストが増加するのは親局装置のコストのみなので、極端なシステムコストの増大をきたさない。

【0022】

したがって、ａ系統の親局装置ａのシステムのメンテナンスや修理をするときには、ｂ系統の親局装置ｂが作動しており、停止した親局装置ａのカバーエリアが櫛状に抜けるだけなので、サービスを提供できるエリアを残しておくことができる。また逆に、ｂ系統の親局装置ｂがシステム作業の際には、ａ系統の親局装置ａでサービスを継続することが可能になり、全断を発生させることがない。これにより、携帯電話端末Ｔ１～ＴＮのユーザは、使用中のカバーエリアがサービス停止となっても、少し移動するだけでサービスが継続されている片系のカバーエリアにて、携帯電話端末Ｔ１～ＴＮによる無線通信を継続することが可能となる。また、基地局に障害が生じる確率は低く、基地局自体が高額であるため、基地局を複数台用意して高層ビル等におけるＲＯＦシステム全体の機能停止に備えるよりも経済的である。なお、上述のように従来のシステムと比較して、多少のコストの増大はあるが、メンテナンス負担の軽減、システム変更時のインパクト軽減の効果の方がはるかに大きいため、経済的なシステムであることには変わりない。

【0023】

図４は、従来の方法によるＲＯＦシステム１の概略構成例を示すブロック図である。また、図５は、従来の方法によるＲＯＦシステム１を高層ビルに設置したときの概略構成例を示す模式図である。なお、図４及び５において、図１及び２と同一部分には同一符号を付して示し、ここでは重複する説明を省略する。

【0024】

図５に示すＲＯＦシステム１において、一台の携帯電話基地局２から送信される無線通信信号は、親局装置ｃで１系統の光信号に変換され、光ファイバ４を介して複数の子局装置ｃ－１～ｃ－Ｎへ伝送される。このとき、親局装置ｃからの光信号を各フロアに伝送するに際して、光信号は、各フロアにおいて空間的に均等に設置された子局装置に伝送される。

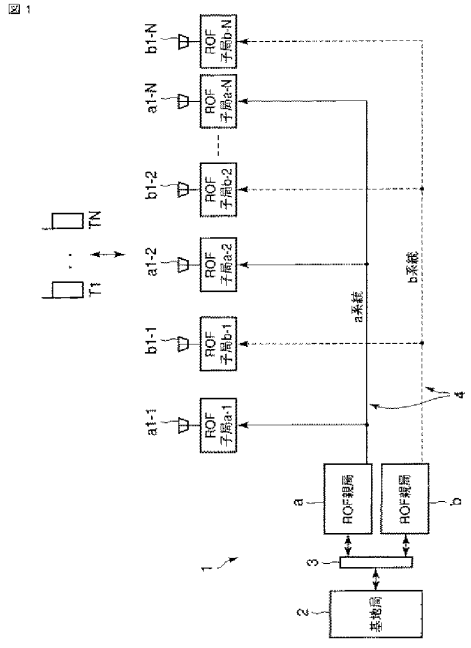
【0025】

従来技術では、親局装置ｃが１系統であるため、親局装置ｃの障害時やメンテナンスを行う際にはＲＯＦシステム１全体の機能が停止してしまう。

【0026】
これに対し、本発明では、２系統の親局装置ａ，ｂを接続しているため、片方の親局装置に障害がある場合やメンテナンスのときにサービスが全断されることはない。
【0027】
なお、本発明は上記実施形態に限定されるものではない。例えば上記実施形態では、ａ系統の子局装置ａ－１～ａ－Ｎのカバーエリアと、ｂ系統の子局装置ｂ－１～ｂ－Ｎのカバーエリアとが交互になるよう配置される例について説明したが、交互配置ではなく、ａ系統の子局装置のカバーエリアとｂ系統の子局装置のカバーエリアとが分散されて配置される場合でも同様に実施可能である。この場合における無線信号を必要とする空間の実施例としては、例えば、イベントホールや地下街等の一層に広い空間への設置が挙げられる。
【0028】
また、上記実施形態では、基地局２からの信号が２系統に分岐される例について説明したが、この系統の数に制限は無く、複数の系統である場合でも同様に実施可能である。
【0029】
さらに、本発明は上記実施形態そのままに限定されるものではなく、実施段階ではその要旨を逸脱しない範囲で構成要素を変形して具体化できる。また、上記実施形態に開示されている複数の構成要素の適宜な組み合わせにより、種々の発明を形成できる。例えば、実施形態に示される全構成要素から幾つかの構成要素を削除してもよい。
【図面の簡単な説明】
【0030】
【図1】本発明の一実施形態に係るＲＯＦシステムの概略構成を示すブロック図。
【図2】本発明の一実施形態に係るＲＯＦシステムを高層ビルに設置したときの概略構成を示す模式図。
【図3】本発明の一実施形態に係るＲＯＦシステムのａ系統のカバーエリアとｂ系統の親局装置のカバーエリアの模式図。
【図4】従来の方法によるＲＯＦシステムの概略構成例を示すブロック図。
【図5】従来の方法によるＲＯＦシステムを高層ビルに設置したときの概略構成例を示す模式図。
【符号の説明】
【0031】
１…ＲＯＦシステム、２…携帯電話基地局、３…分岐結合器、４，４ａ，４ｂ…光ファイバ、ａ，ｂ…親局装置、ａ－１～ａ－Ｎ，ｂ－１～ｂ－Ｎ…子局装置、ａ１－１～ａ１－Ｎ，ｂ１－１～ｂ１－Ｎ…アンテナ、Ｔ１～ＴＮ…携帯電話端末

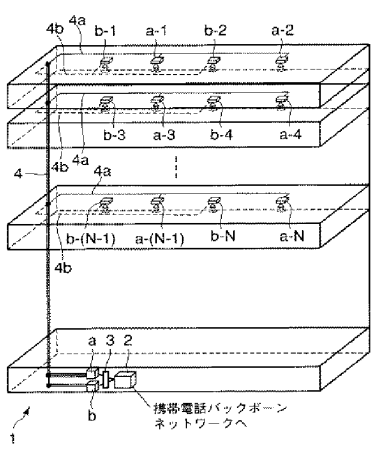
【図1】

図 1



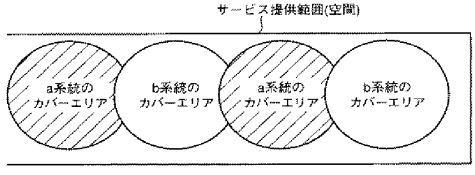
【図2】

図 2



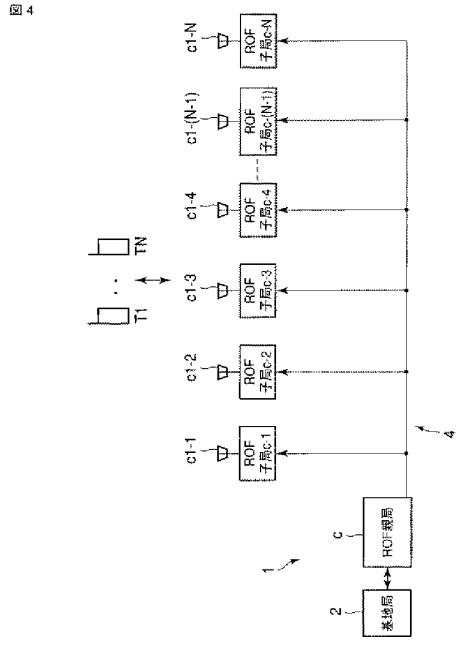
【図3】

図 3



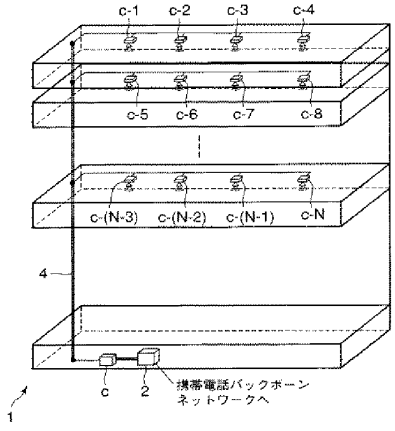
【図4】

図 4



【図5】

図 5



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Ｆターム(参考) 5K067 AA33　BB04　BB21　DD11　DD51　DD57　EE02　EE06　EE10　EE16
EE37　FF02

Electronic Acknowledgement Receipt	
EFS ID:	29196927
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull/Brian Kanter
Filer Authorized By:	Kelvin B. Catmull
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	12-MAY-2017
Filing Date:	29-JUL-2016
Time Stamp:	15:30:34
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		IDS_102440US.pdf	162001 d1b5efeaaf7f059009ca31d34a6f5089423c0de4	yes	7

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	Transmittal Letter		1		2	
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2	Foreign Reference	EP368673.pdf	527726 1a026f6bb81af5fd4966ecb0645905b1b3ddacb3	no	11	
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3	Foreign Reference	WO0156197.pdf	616300 e58d2d268951c1828141199249649264 13d80daa	no	18	
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12	Non Patent Literature	CPRI_v_3_0_2006-10-20_UPL.pdf	23172954 499286732 0f8bbd243d9ba6ccce1ca68a30abd68	no	89
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14	Non Patent Literature	CPRI_v_4_1_2009-02-18_UPL.pdf	17862976 22ecbcb6da1f7e367ba31c4cbbc0f343669dc5b2	no	109
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15	Non Patent Literature	Grundmann_An_empirical_1677.pdf	394460 a38ca9a121213a947121fe944193d92bb2bdd7f5	no	5
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21	Non Patent Literature	CYR_The-digital-age-is-here_1947.pdf	436977 954ed2645c27a383864e9c0a5be278baa3174878	no	5
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22	Non Patent Literature	CityCell_824_RemoteSiteManual_1952_pp1-50.pdf	19229913 e249f7b8f0b879a0c130b635dc435ca5429ae040	no	50
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26	Non Patent Literature	BRUNNER_On-space-time-rake-receiver_2203.pdf	361564 e15ad1b99ba858f6c7a578b787a016b1225463e2	no	6
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27	Non Patent Literature	GRAF_Modern-Dictionary-of-electronics_2215.pdf	3471274 f63bb53dbc87a13d66166b51a40e608c57d1e691	no	9
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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on May 12, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton	Examiner: ZHAO, WEI
Application No.: 15/223,819	Technology Center/Art Unit: 2475
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

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

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

This IDS is being filed before the mailing date of the first Office Action on the merits.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

/Kelvin B. Catmull/

Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-8,583,100	B2	11-12-2013	Koziy et al.	
	2.	US-8,346,160	B2	01-01-2013	Kummetz	
	3.	US-8,032,148	B2	10-04-2011	Hettstedt et al.	
	4.	US-8,010,099	B2	08-30-2011	Ma et al.	
	5.	US-7,650,112	B2	01-19-2010	Utsumi et al.	
	6.	US-7,639,982	B2	12-29-2009	Wala	
	7.	US-7,339,897	B2	03-04-2008	Larsson et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	8.	US-2012/0127938	A1	05-24-2012	Lv et al.	
	9.	US-2012/2057572	A1	03-08-2012	Evans et al.	
	10.	US-2011/0135308	A1	06-09-2010	Tarlazzi et al.	
	11.	US-2010/0278530	A1	11-04-2010	Kummetz et al.	
	12.	US-2010/0177759	A1	07-15-2010	Fischer et al.	
	13.	US-2010/0157901	A1	06-24-2010	Sanderovitz et al.	
	14.	US-2010/0002661	A1	01-07-2010	Schmidt et al.	
	15.	US-2009/0286484	A1	11-19-2009	Phung et al.	
	16.	US-2009/0252136	A1	10-08-2009	Mahany et al.	
	17.	US-2008/0107014	A1	05-08-2009	Huang et al.	
	18.	US-2007/0066234	A1	03-22-2007	Lastinger et al.	
	19.	US-2002/0187809	A1	12-12-2002	Mani et al.	

FOREIGN PATENT DOCUMENTS

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Craig C. Largent/	Date (YYYY-MM-DD)	2017-05-22
Name/Print	Craig C. Largent	Registration Number	56,400

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

Electronic Acknowledgement Receipt	
EFS ID:	29279527
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Craig Cody Largent/Brian Kanter
Filer Authorized By:	Craig Cody Largent
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	22-MAY-2017
Filing Date:	29-JUL-2016
Time Stamp:	18:29:58
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		69384746_1.pdf	146622 10316bfc4b7550fd889ceb3a4bc98523c42407c8	yes	5

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	2
	Information Disclosure Statement (IDS) Form (SB08)	3	5
Warnings:			
Information:			
	Total Files Size (in bytes):	146622	

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.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on May 22, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

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

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

This IDS is being filed before the mailing date of the first Office Action on the merits.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

/Craig C. Largent/

Craig C. Largent
Registration No. 56,400

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

20350 7590 06/05/2017

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

NOTIFICATION DATE	DELIVERY MODE
06/05/2017	ELECTRONIC

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

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

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

ipefiling@kilpatricktownsend.com
KTSDocketing2@kilpatrick.foundationip.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 15/223,819	Applicant(s) STAPLETON ET AL.	
	Examiner WEI ZHAO	Art Unit 2473	AIA (First Inventor to File) Status No

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

Period for Reply

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

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

Status

1)☒ Responsive to communication(s) filed on *7/29/2016*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *2-21* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *2-21* is/are rejected.

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

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

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

Application Papers

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

11)☒ The drawing(s) filed on *7/29/2016* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

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

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

4) ☐ Other: _____.

DETAILED ACTION

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

Priority

2. Acknowledgment is made of this is a continuation of U.S. Patent Application No. 14/800,515 filed July 15, 2015, now US 9,419,837, which is a continuation of U.S. Patent Application No. 14/260,145 filed April 23, 2014, now US 9,137,078, which is a continuation of U.S. Patent Application No. 13/211,247 filed August 16, 2011, now US 8,737,300, which claims the benefit of U.S. Provisional Patent Application No. 61/439,940, filed February 7, 2011.

Information Disclosure Statement

3. The information disclosure statement (IDS) submitted on November 21, 2016, May 12, 2017, and May 22, 2017 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Specification

4. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required:

The term “Common Public Interface Standard (CPRI)” is used in paragraph [0056]. It is suggested amending the term to “Common Public Interface Standard (CPIS),” since the acronym “CPRI” is commonly used for “Common Public Radio Interface”.

Claim Objections

5. Claims 2-15 and 21 are objected to under 37 CFR 1.75(c) because of the following informalities:

Regarding claim 2, the examiner objects to the usage of the term “capable of” in both lines 7 and 9, because “capable of” can be interpreted as “operable to” which is a non-positive claim limitation or optional claim limitation. The examiner recommends either amending the claim to “configured to” or applicant arguing on the record that “capable of” should be interpreted as positive claim limitation with the same meaning as “configured to”.

The same objection applies to the term “capable of” in claims 9-12.

Regarding claim 10, the examiner object the usage of the ending term “Common Public Interface Standard (CPRI) standard” and suggests amending the term to “Common Public Interface Standard (CPIS),” since the acronym “CPRI” is commonly used for “Common Public Radio Interface”. Same objection applies to claim 21.

Claims 3-8 and 13-15 are objected to since they either depend from claim 2 or 11.

Double Patenting

6. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

7. Claim 2 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

Regarding claim 2, it recites, “A host unit for use in the transport of wireless communications, comprising:

at least one *interface to communicatively couple* the host unit to at least one signal source;

at least one *interface to communicatively couple* the host unit to a plurality of remote units, including at least a first remote unit;

wherein *the host unit* is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time; and

wherein the first set of downlink channel signals is different from the second set of downlink channel signals."

Claim 1 of U.S. Patent No. 8,737,300 recites, "1. A method for routing and switching signals, the method comprising:

providing a plurality of digital remote units, each configured to transmit one or more downlink channel signals and to receive one or more uplink channel signals;

providing at least one *digital access unit* configured to communicate with at least two of the plurality of digital remote units;

linking in a loop configuration the plurality of digital remote units and the at least one digital access unit, whereby the plurality of digital remote units and the at least one digital access unit are daisy-chained in the loop configuration such that each digital remote unit is linked to a next digital remote unit or the digital access unit by a single bi-directional optical fiber and each digital remote unit is configured to be accessed in either direction around the loop configuration; and

routing and switching packetized signals among the plurality of digital remote units and the at least one digital access unit, wherein a first digital remote unit of the plurality of digital remote units receives a first number of downlink channel signals on *a*

first bi-directional optical fiber from the at least one digital access unit, and a second digital remote unit of the plurality of digital remote units receives a second number of downlink channel signals on *a second bi-directional optical fiber* from the at least one digital access unit, where the first number of downlink channel signals is different from the second number of downlink channel signals."

Based on the limitations presented above, claim 2 of the instant application claims similar limitations that are a part of the elements in claim 1 of U.S. Patent No. 8,737,300, by using different wordings, such as using "host unit" instead of "digital access unit" and using "interface to" instead of "linking" in claim 1 of the Patent.

As a matter of fact, claim 2 is merely a broader version of the claim 1 of U.S. Patent No. 8,737,300 by eliminating some terms, i.e., "whereby the plurality of digital remote units and the at least one digital access unit are daisy-chained in the loop configuration such that each digital remote unit is linked to a next digital remote unit or the digital access unit by a single bi-directional optical fiber and each digital remote unit is configured to be accessed in either direction around the loop configuration," etc.

It has been held that the omission of an element and its function is an obvious expedient if the remaining elements perform the same function as before. In re Karlson, 136 USPQ 184 (CCPA).

The same rationale applies to claims 5, 6, 8, 9, 11-16, 18, and 20 as follows:

8. Claims 5 and 6 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 6 and 5 of U.S. Patent No. 8,737,300, individually.

9. Claims 8 and 9 are both rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

10. Claims 11-15 are all rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

11. Claim 16 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

12. Claim 18 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 6 of U.S. Patent No. 8,737,300.

13. Claim 20 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

Claim Rejections - 35 USC § 102

14. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

15. Claims 2-4, 8-17, 20, and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by Sulzberger et al. (US 2005/0152695).

Regarding claim 2, Sulzberger et al. teach the host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source (paragraph [0017] lines 1-17; Examiner's Notes: BB depicted in FIG. 2 of the prior art teaches the limitation of "host unit" in the instant application);

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit (paragraph [0018] lines 1-20; Examiner's Notes: RH1, RH2, … depicted in FIG. 2 of the prior art teaches the limitation of "a plurality of remote units" in the instant application);

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source (paragraph [0017] lines 1-17);

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units (paragraph [0019] lines 1-15);

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time (paragraph [0018] lines 1-20);

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time (paragraph [0017] lines 1-17); and

wherein the first set of downlink channel signals is different from the second set of downlink channel signals (paragraph [0018] lines 1-20).

Regarding claim 3, Sulzberger et al. further teach the host unit, wherein the host unit is configurable to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0018] lines 1-20).

Regarding claim 4, Sulzberger et al. further teach the host unit, wherein the host unit is configurable, based on a change in network conditions, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0019] lines 1-15).

Regarding claim 8, Sulzberger et al. further teach the host unit, wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface (paragraph [0017] lines 1-17).

Regarding claim 9, Sulzberger et al. further teach the host unit, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal (paragraph [0019] lines 1-15).

Regarding claim 10, Sulzberger et al. further teach the host unit, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal in compliance with the Common Public Interface Standard (CPRI) standard (paragraph [0005] lines 1-13).

Regarding claim 11, Sulzberger et al. teach the system for transporting wireless communications, comprising:

a host unit (paragraph [0017] lines 1-17; Examiner's Notes: BB depicted in FIG. 2 of the prior art teaches the limitation of "host unit" in the instant application);

a plurality of remote units, including at least a first remote unit and a second remote unit (paragraph [0018] lines 1-20; Examiner's Notes: RH1, RH2, … depicted in FIG. 2 of the prior art teaches the limitation of "a plurality of remote units" in the instant application);

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source (paragraph [0017] lines 1-17);

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source (paragraph [0018] lines 1-20);

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units (paragraph [0019] lines 1-15);

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time (paragraph [0018] lines 1-20);

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time (paragraph [0017] lines 1-17);

wherein the first set of downlink channel signals is different from the second set of downlink channel signals (paragraph [0018] lines 1-20); and

wherein the host unit is capable of receiving digital signals from each of the plurality of remote units (paragraph [0018] lines 1-20).

Regarding claim 12, Sulzberger et al. further teach the system, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal (paragraph [0019] lines 1-15).

Regarding claim 13, Sulzberger et al. teach the system, wherein the host unit is connected to each of the plurality of remote units through a direct connection (paragraph [0018] lines 1-20).

Regarding claim 14, Sulzberger et al. further teach the system, wherein the host unit is connected to each of the plurality of remote units through an indirect connection (paragraph [0018] lines 1-20).

Regarding claim 15, Sulzberger et al. further teach the system, wherein each remote unit comprises at least one interface to communicatively couple the remote unit to another one of the plurality of remote units in a daisy-chain configuration (paragraph [0018] lines 1-20).

Regarding claim 16, Sulzberger et al. teach the method for providing digital signals in a Distributed Antenna System (DAS), comprising:

transmitting from a host unit, at a first point in time, a first set of downlink channel signals to a first remote unit (paragraph [0017] lines 1-17; Examiner's Notes: BB depicted in FIG. 2 of the prior art teaches the limitation of "host unit" and RH1 depicted in FIG. 2 of the prior art teaches the limitation of "first remote unit" in the instant application);

transmitting from the host unit, at a second point in time, a second set of downlink channel signals to the first remote unit (paragraph [0018] lines 1-20);

wherein the first set of downlink channel signals is different from the second set of downlink channel signals (paragraph [0018] lines 1-20).

Regarding claim 17, Sulzberger et al. further teach the method, wherein the host unit dynamically changes based on a change in network conditions from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0019] lines 1-15).

Regarding claim 20, Sulzberger et al. further teach the method, wherein the downlink channel signals are packetized (paragraph [0019] lines 1-15).

Regarding claim 21, Sulzberger et al. further teach the method, wherein the downlink channel signals are packetized in compliance with the Common Public Interface Standard (CPRI) standard (paragraph [0005] lines 1-13).

Claim Rejections - 35 USC § 103

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

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

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

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

18. Claims 5, 6, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sulzberger et al. (US 2005/0152695) in view of Casanova et al. (US 6,657,993).

Regarding claim 5, Sulzberger et al. teach the host, without explicitly teaching load balancing. However, Casanova et al. teaches a host, wherein the host unit is configurable, based on load balancing, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (column [3] lines 45-50). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. with those of Casanova et al. in order to provide variable bandwidth transmission facilities between a local telephone switch and a remote line unit.

Regarding claim 6, Sulzberger et al. teach the host, without explicitly teaching implementing based on a change in subscriber needs. However, Casanova et al. teaches a host, wherein the host unit is configurable, based on a change in subscriber needs, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (column [3] lines 45-50). It would have been obvious to one skilled in the art to combine

the teachings of Sulzberger et al. with those of Casanova et al. in order to provide variable bandwidth transmission facilities between a local telephone switch and a remote line unit.

Regarding claim 18, Sulzberger et al. teach the method, without explicitly teaching implementing based on a change in subscriber needs. However, Casanova et al. teaches the method, wherein the host unit dynamically changes based on load balancing from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (column [3] lines 45-50). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. with those of Casanova et al. in order to provide variable bandwidth transmission facilities between a local telephone switch and a remote line unit.

19. Claims 7 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sulzberger et al. (US 2005/0152695) in view of Zhang et al. (US 2010/0238904).

Regarding claim 7, Sulzberger et al. teach the host unit, without explicitly teaching dynamically changing based on a schedule. However, Zhang et al. teaches the subject matter, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0071] lines 1-20). It would have been obvious to one skilled in the art to

combine the teachings of Sulzberger et al. with those of Zhang et al. in order to enhance the mobility in multi-carrier high speed packet access.

Regarding claim 19, Sulzberger et al. teach the method, without explicitly teaching dynamically changing based on a schedule. However, Zhang et al. teaches the method, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0071] lines 1-20). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. with those of Zhang et al. in order to enhance the mobility in multi-carrier high speed packet access.

Conclusion

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

Callard et al. (US 2009/0060088) is cited to show a method for detecting the number of transmit antennas in a base station.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WEI ZHAO whose telephone number is (571)270-5672. The examiner can normally be reached on Monday-Friday, 7:30am-4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kwang B. Yao can be reached on 571-272-3182. 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.

/Wei Zhao/
Primary Examiner
Art Unit 2473

Notice of References Cited	Application/Control No. 15/223,819	Applicant(s)/Patent Under Reexamination STAPLETON ET AL.	
	Examiner WEI ZHAO	Art Unit 2473	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6,657,993 B1	12-2003	Casanova; Lynn Marie	H04L12/6418	370/230
*	B	US-2005/0152695 A1	07-2005	Sulzberger, Uwe	H04B10/25756	398/59
*	C	US-2010/0238904 A1	09-2010	Zhang; Danlu	H04L5/0037	370/333
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
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	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2475
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code [1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-4,775,795		07-05-1998	Page	
	2.	US-4,999,831		03-12-1991	Grace	
	3.	US-5,457,557	A	10-10-1995	Zarem et al.	
	4.	US-5,579,341	A	11-26-1996	Smith et al.	
	5.	US-5,619,202	A	04-08-1997	Wilson et al.	
	6.	US-5,621,730	A	04-15-1997	Kelley	
	7.	US-5,627,879	A	05-06-1997	Russell et al.	
	8.	US-5,644,622	A	07-01-1997	Russell et al.	
	9.	US-5,748,683	A	05-05-1998	Smith et al.	
	10.	US-5,818,883	A	10-06-1998	Smith et al.	
	11.	US-5,852,651	A	12-22-1998	Fischer et al.	
	12.	US-6,005,506	A	12-21-1999	Bazarjani et al.	
	13.	US-6,005,884	A	12-21-1999	Cook et al.	
	14.	US-6,014,366	A	01-11-2000	Ichiyoshi	
	15.	US-6,112,086	A	08-29-2000	Wala	
	16.	US-6,253,094	B1	06-26-2001	Schmutz	
	17.	US-6,356,369	B1	03-12-2002	Farhan et al.	
	18.	US-6,373,611	B1	01-16-2002	Farhan et al.	
	19.	US-6,594,496	B2	07-15-2003	Schwartz	
	20.	US-6,697,603	B1	02-24-2004	Lovinggood et al.	
	21.	US-6,704,545	B1	03-09-2004	Wala	
	22.	US-6,785,558	B1	08-31-2004	Stratford et al.	
	23.	US-6,826,164	B2	11-30-2004	Mani et al.	
	24.	US-6,831,901	B2	12-14-2004	Millar	
	25.	US-6,836,660	B1	12-28-2004	Wala	
	26.	US-7,257,328	B2	08-14-2007	Levinson et al.	
	27.	US-7,286,507	B1	10-23-2007	Oh et al.	
	28.	US-7,610,460	B2	10-27-2009	Wala	
	29.	US-7,787,854	B2	08-31-2010	Conyers et al.	
	30.	US-8,010,116	B2	08-30-2011	Scheinert	
	31.	US-8,346,091	B2	01-01-2013	Kummetz et al.	
	32.	US-8,446,530	B2	05-21-2013	Bellers	
	33.	US-8,737,454	B2	05-27-2014	Wala et al.	
	34.	US-8,958,789	B2	02-17-2015	Bauman et al.	
	35.	US-9,531,473	B2	12-27-2016	Lemson et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	36.	US-2005/0157675	A1	07-21-2005	Feder et al.	
	37.	US-2008/0119198	A1	05-22-2008	Hettstedt et al.	
	38.	US-2010/0128676	A1	05-27-2010	Wu et al.	
	39.	US-2006/0094470	A1	05-04-2006	Wake et al.	

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	Art Unit	2475
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

	40.	US-2009/0180426	A1	07-16-2009	Sabat et al.	
	41.	US-2010/0296816	A1	11-25-2010	Larsen	
	42.	US-2009/0238566	A1	09-24-2009	Boldi et al.	
	43.	US-2003/0143947	A1	07-31-2003	Lyu	
	44.	US-2009/0170543	A1	07-02-2009	Mostafa et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	45.	0368673	EP	A1	05-16-1990	British Telecommunications		
	46.	01/56197	WO	A2	08-02-2001	Scientific-Atlanta, Inc.		
	47.	98/24256	WO	A2	06-04-1998	Ericsson Inc.		
	48.	0642243	EP	A1	03-08-1995	Roke Manor Research Limited		
	49.	2002-158615	JP	A	05-31-2002	Nat Inst Land & Infrastru ture		
	50.	2008-135955	JP	A	06-12-2008	Toshiba Corp		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	51.	BICSI, "Network Design Basics for Cabling Professionals", 2002, 393 pages, McGraw-Hill, New York, NY, USA.	
	52.	"Common Public Radio Interface (CPRI) Specification V1.4", dated 2006-03-31, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 64 pages.	
	53.	"Common Public Radio Interface (CPRI) Specification V2.1", dated 2006-03-31, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 76 pages.	
	54.	"Common Public Radio Interface (CPRI) Specification V3.0", dated 2006-10-20, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 89 pages.	
	55.	"Common Public Radio Interface (CPRI) Specification V4.0", dated 2008-06-30, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 96 pages.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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	56.	"Common Public Radio Interface (CPRI) Specification V4.1", dated 2009-02-18, downloaded from http://www.cpri.info/spec.html on 03-28-2017, 109 pages.	
	57.	GRUNDMANN et al., "An empriacal comparison of a distrubuted antenna microcell system versus a single antennal microcell system for indooor spread spectrum communications at 1.8 GHz", ICUPC Conference, 1993, 5 pages.	
	58.	ZHAOHUI et al., " A rake type receiver structure for CDMA mobile communication systems using antenna arrays", IEEE, 1996, pages 528-530.	
	59.	"Mastering The Mix In Signal Processing", Mixed-Signal Design Seminar, 1991, Analog Devices, Inc., 3 pages.	
	60.	GRACE, Martin K., "Synchronous quantized subcarrier multiplexing for transport of video, voice, and data", IEEE Journal on Selected Areas in Communications, September 1990, Vol. 8, No. 7., pp. 1351-1358.	
	61.	Wala, Philip M., "A new microcell architecture using digital optical transport", 1993, IEEE, pp 585-588.	
	62.	CROFUT, Walter, "Remote monitoring of wireless base stations June 1, 1998"; http://urgentcomm.com/print/mag/remote-monitoring-wireless-base-stations, downloded on March 13, 2017, 4 pages.	
	63.	CYR et al., "The digital age is here, Digital radio frequency transport enhances cellular network performance", July 4, 1993, Telephony, pp 20-24.	
	64.	CityCell 824, "Remote Site Manual, How to use it, Preliminary Version"; February 1, 1993, 237 pages.	
	65.	CHEUN, Kyungwhoon, "Performance of direct-sequence spread-spectrum rake receives with randon spreading sequences", IEEE Transactions On Communication, September 9, 1997, Vol. 45, No. 9, pp. 1130-1143.	
	66.	BRUNNER et al., "On space-time rake receiver structure for WCDMA", 1999, IEEE, pp 1546-1551.	
	67.	GRAF, Rudolf F., "Modern Dictionary of Electronics, 7th Ed.", 1999, Newnes publishing, 9 pages.	
	68.	Office Action for Japanese Patent Application No. 2016-139702, mailed April 20, 2017, 7 pages.	

EXAMINER SIGNATURE

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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

PTO/SB/08a (01-10)
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Examiner Signature	/WEI ZHAO/		Date Considered	05/25/2017	

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CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2017-05-12
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-8,583,100	B2	11-12-2013	Koziy et al.	
	2.	US-8,346,160	B2	01-01-2013	Kummetz	
	3.	US-8,032,148	B2	10-04-2011	Hettstedt et al.	
	4.	US-8,010,099	B2	08-30-2011	Ma et al.	
	5.	US-7,650,112	B2	01-19-2010	Utsumi et al.	
	6.	US-7,639,982	B2	12-29-2009	Wala	
	7.	US-7,339,897	B2	03-04-2008	Larsson et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	8.	US-2012/0127938	A1	05-24-2012	Lv et al.	
	9.	US-2012/2057572	A1	03-08-2012	Evans et al.	
	10.	US-2011/0135308	A1	06-09-2010	Tarlazzi et al.	
	11.	US-2010/0278530	A1	11-04-2010	Kummetz et al.	
	12.	US-2010/0177759	A1	07-15-2010	Fischer et al.	
	13.	US-2010/0157901	A1	06-24-2010	Sanderovitz et al.	
	14.	US-2010/0002661	A1	01-07-2010	Schmidt et al.	
	15.	US-2009/0286484	A1	11-19-2009	Phung et al.	
	16.	US-2009/0252136	A1	10-08-2009	Mahany et al.	
	17.	US-2008/0107014	A1	05-08-2009	Huang et al.	
	18.	US-2007/0066234	A1	03-22-2007	Lastinger et al.	
	19.	US-2002/0187809	A1	12-12-2002	Mani et al.	

FOREIGN PATENT DOCUMENTS

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Examiner Signature /WEI ZHAO/		Date Considered 05/25/2017	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Craig C. Largent/	Date (YYYY-MM-DD)	2017-05-22
Name/Print	Craig C. Largent	Registration Number	56,400

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

PALM INTRANET

Day : Thursday
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Inventor Name Search Result

Your Search was:

Last Name = STAPLETON
First Name = SHAWN

Application#	Patent#	PG Pub#	Status	Date Filed	Title	Examiner Name	Inventor Name
15223819	Not Issued	20170055198	30	07/29/2016	DISTRIBUTED ANTENNA SYSTEM	ZHAO,WEI	STAPLETON, SHAWN PATRICK
15251295	Not Issued	20170118734	30	08/30/2016	TIME SYNCHRONIZED ROUTING IN A DISTRIBUTED ANTENNA SYSTEM	NGO,RICKY	STAPLETON, SHAWN PATRICK
15279136	Not Issued	20170146662	30	09/28/2016	FEEDBACK BASED INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	GREGORY,BERNARR	STAPLETON, SHAWN PATRICK
15358060	Not Issued	0	17	11/21/2016	VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	,	STAPLETON, SHAWN PATRICK
15380686	Not Issued	0	30	12/15/2016	POWER AMPLIFIER PROTECTION USING A CYCLIC REDUNDANCY CHECK ON THE DIGITAL TRANSPORT OF DATA	RIZK,SAMIR	STAPLETON, SHAWN PATRICK
15383121	Not Issued	20170104538	41	12/19/2016	HYBRID DATA TRANSPORT FOR A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	PHAN,HANH	STAPLETON, SHAWN PATRICK
15383431	Not Issued	0	30	12/19/2016	METHOD AND SYSTEM FOR SOFT FREQUENCY REUSE IN A DISTRIBUTED ANTENNA SYSTEM	CHERY,DADY	STAPLETON, SHAWN PATRICK
15391408	Not Issued	0	17	12/27/2016	REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	,	STAPLETON, SHAWN PATRICK
15448467	Not Issued		19	02/28/2017	DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
15448332	Not Issued		19	03/02/2017	DAS INTEGRATED DIGITAL OFF-AIR REPEATER	,	STAPLETON, SHAWN PATRICK
15492902	Not Issued		19	04/20/2017	WIDE BANDWIDTH DIGITAL PREDISTORTION SYSTEM WITH REDUCED SAMPLING RATE	,	STAPLETON, SHAWN PATRICK
15582776	Not Issued		19	05/01/2017	INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	,	STAPLETON, SHAWN PATRICK
61012388	Not Issued		159	12/07/2007	Baseband-Derived RF Digital Predistortion	,	STAPLETON, SHAWN PATRICK
61012416	Not Issued		159	12/07/2007	Baseband-Derived RF Digital Predistortion	,	STAPLETON, SHAWN PATRICK
61041164	Not Issued		159	03/31/2008	Efficient Peak Cancellation Method for Reducing the Peak-To-Average Power Ratio in Wideband Communication Systems	,	STAPLETON, SHAWN PATRICK
61288838	Not Issued		159	12/21/2009	MULTI-BAND WIDEBAND POWER AMPLIFIER DIGITAL PREDISTORTION SYSTEM AND METHOD	,	STAPLETON, SHAWN PATRICK
61288840	Not Issued		159	12/21/2009	REMOTE RADIO HEAD UNIT SYSTEM WITH WIDEBAND POWER AMPLIFIER AND METHOD	,	STAPLETON, SHAWN PATRICK
61288844	Not Issued		159	12/21/2009	MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	,	STAPLETON, SHAWN PATRICK
61288847	Not Issued		159	12/21/2009	HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	,	STAPLETON, SHAWN PATRICK
61374593	Not Issued		159	08/17/2010	NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61382836	Not Issued		159	09/14/2010	REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	,	STAPLETON, SHAWN PATRICK

61439846	Not Issued		159	02/07/2011	Daisy Chained Ring of Remote Units for A Distributed Antenna System	,	STAPLETON, SHAWN PATRICK
61530888	Not Issued		159	09/02/2011	SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	,	STAPLETON, SHAWN PATRICK
61538042	Not Issued		159	09/22/2011	SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	,	STAPLETON, SHAWN PATRICK
61556625	Not Issued		159	11/07/2011	SYSTEM AND METHOD FOR SOFT HANDOFF WITHIN A VIRTUAL DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61556689	Not Issued		159	11/07/2011	ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61556715	Not Issued		159	11/07/2011	VIRTUALIZED WIRELESS NETWORK	,	STAPLETON, SHAWN PATRICK
61556725	Not Issued		159	11/07/2011	VIRTUALIZED WIRELESS NETWORK WITH PILOT BEACONS	,	STAPLETON, SHAWN PATRICK
61564211	Not Issued		159	11/28/2011	SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR BANDWIDTH COMPRESSION AND TRANSPORT OF SIGNALS IN NONCONTIGUOUS FREQUENCY BLOCKS	,	STAPLETON, SHAWN PATRICK
61592190	Not Issued		159	01/30/2012	FREQUENCY TRANSLATION IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61592747	Not Issued		159	01/31/2012	DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61600530	Not Issued		159	02/17/2012	EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61604341	Not Issued		159	02/28/2012	HYBRID DATA TRANSPORT FOR A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61642143	Not Issued		159	05/18/2012	METHOD AND SYSTEM FOR SOFT FREQUENCY REUSE IN A DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61689572	Not Issued		159	07/09/2012	SELF-OPTIMIZING DISTRIBUTED ANTENNA SYSTEM USING SOFT FREQUENCY REUSE	,	STAPLETON, SHAWN PATRICK
61678016	Not Issued		159	07/31/2012	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61682632	Not Issued		159	08/13/2012	TIME SYNCHRONIZED ROUTING IN A DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61710391	Not Issued		159	10/05/2012	DAS Integrated Digital Off-Air Repeater	,	STAPLETON, SHAWN PATRICK
61733324	Not Issued		159	12/04/2012	POWER AMPLIFIER PROTECTION USING CYCLIC REDUNDANCY CHECK ON THE DIGITAL TRANSPORT OF DATA	,	STAPLETON, SHAWN PATRICK
61759229	Not Issued		159	01/31/2013	INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	,	STAPLETON, SHAWN PATRICK
61761183	Not Issued		159	02/05/2013	FEEDBACK BASED INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	,	STAPLETON, SHAWN PATRICK
61767731	Not Issued		159	02/21/2013	INDOOR LOCALIZATION USING ANALOG OFF-AIR ACCESS UNITS	,	STAPLETON, SHAWN PATRICK
61768539	Not Issued		159	02/26/2013	METHOD AND SYSTEM FOR WI-FI DATA TRANSMISSION	,	STAPLETON, SHAWN PATRICK
61918386	Not Issued		159	12/19/2013	DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	,	STAPLETON, SHAWN PATRICK
61920397	Not Issued		159	12/23/2013	DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	,	STAPLETON, SHAWN PATRICK
61924127	Not Issued		159	01/06/2014	NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	,	STAPLETON, SHAWN PATRICK
61939620	Not Issued		159	02/13/2014	SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN	,	STAPLETON, SHAWN PATRICK

					AND THROUGH A DISTRIBUTED ANTENNA SYSTEM		
61948484	Not Issued		159	03/05/2014	DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	,	STAPLETON, SHAWN PATRICK
62142689	Not Issued		159	04/03/2015	METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	,	STAPLETON, SHAWN PATRICK
62189113	Not Issued		159	07/06/2015	DISTRIBUTED ANTENNA NETWORK ANALYTICS	,	STAPLETON, SHAWN PATRICK

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	23	H04W40/$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:37
L2	18	H04W40/0$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:37
L3	16	H04W40/02$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:37
L4	0	H04W72/02$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:37
L5	23	H04W72/$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:37
L6	23	H04W72/0$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:37
L7	23	H04W72/04$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:37
L8	33	H04B7/$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:38
L9	32	H04B7/0$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:38
L10	30	H04B7/02$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:38

L11	19	H04B7/022$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 17:38
S3612	503	WiMAX same (multipath$1 or (multiple with paht$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:20
S3616	18	WiMAX same (multipath$1 or (multiple with paht$1)) and H04L45/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:23
S3617	163	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:23
S3618	48	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:23
S3619	42	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/12$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:24
S3621	91	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/2$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:24
S3622	76	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/24$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:24
S3623	73	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:24
S3624	14	WiMAX same (multipath$1 or (multiple with paht$1)) and H04L45/24.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:24
S3626	17	WiMAX same (multipath$1 or (multiple with paht$1)) and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:25
S3627	142	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:25

S3628	31	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:25
S3629	23	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/12$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:25
S3630	7	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/14$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/24 10:26
S3643	23	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/12$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/25 13:50
S3647	7	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/14$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/25 14:48
S3650	59	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/2$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 12:32
S3651	1	"15223819"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 12:32
S3652	28	"39563020".fmid.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 12:33
S3653	319	digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 13:39
S3654	30	digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain)) and (CPRI or (common with public with interfac$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 13:41
S3659	239	schedul$3 same (DL or downlink$1) with channel$1 and cpri	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 15:15
S3660	206	schedul$3 same (DL or downlink$1) with channel$1 and cpri and remot$3 and (bs or (base with station$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 15:16

S3661	26	schedul$3 same (DL or downlink$1) with channel$1 and cpri and remot$3 and (bs or (base with station$1)) and load with balanc$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/05/26 15:17

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L12	18	H04B7/022$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT	ADJ	OFF	2017/05/26 18:00
L13	21	H04W40/$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT	ADJ	OFF	2017/05/26 18:01
L14	16	H04W40/02$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT	ADJ	OFF	2017/05/26 18:01
L15	22	H04W72/0$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT	ADJ	OFF	2017/05/26 18:01
L16	22	H04W72/04$.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT	ADJ	OFF	2017/05/26 18:01
L17	17	H04W72/04.cpc. and digital with access$3 same remot$3 and (daisy-chain$1 or (daisy with chain))	US-PGPUB; USPAT	ADJ	OFF	2017/05/26 18:01
S3633	6	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/14$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:41
S3634	20	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/12$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:41
S3637	159	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:42
S3638	87	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/2$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:42
S3639	72	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/24$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:42
S3640	69	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/24.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:57
S3641	40	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/12$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:58
S3642	12	WiMAX and (multipath$1 or (multiple with paht$1)) and H04L45/121$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/24 19:58
S3648	6	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/14$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/05/25 14:48
S3649	20	WiMAX and (multipath$1 or (multiple with paht$1)) and H04W40/12$.cpc.	US-PGPUB;	ADJ	OFF	2017/05/25 14:48

			USPAT			

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BIB DATA SHEET

CONFIRMATION NO. 3273

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/223,819	07/29/2016	370	2473	091172-1017552-102440US

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Paul Lemson, Woodinvile, WA;
Bin Lin, Burnaby, CANADA;
Albert S. Lee, San Mateo, CA;

**** CONTINUING DATA **************************
This application is a CON of 14/800,515 07/15/2015 PAT 9419837
which is a CON of 14/260,145 04/23/2014 PAT 9137078
which is a CON of 13/211,247 08/16/2011 PAT 8737300
which claims benefit of 61/439,940 02/07/2011

**** FOREIGN APPLICATIONS **************************

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08/11/2016

Foreign Priority claimed	❑ Yes ☑ No	❑ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	❑ Yes ☑ No		CANADA	8	20	3
Verified and Acknowledged	/WEI ZHAO/ Examiner's Signature	Initials				

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KILPATRICK TOWNSEND & STOCKTON LLP
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Atlanta, GA 30309
UNITED STATES

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

BIB (Rev. 05/07).

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2414
	Examiner Name	
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-5,880,863	A	03-09-1999	Rideout et al.	
	2.	US-6,353,600	B1	03-05-2002	Schwartz et al.	
	3.	US-6,393,007	B2	05-21-2005	Haartsen	
	4.	US-6,493,335	B1	12-10-2002	Darcie et al.	
	5.	US-6,625,429	B1	09-23-2003	Yamashita	
	6.	US-6,657,993	B1	12-02-2003	Casanova et al.	
	7.	US-6,724,737	B1	04-20-2004	Boyden et al.	
	8.	US-6,801,767	B1	10-05-2004	Schwartz et al.	
	9.	US-7,102,442	B2	09-05-2006	Anderson	
	10.	US-7,145,704	B1	12-05-2006	Islam	
	11.	US-7,283,519	B2	10-16-2007	Girard	
	12.	US-7,362,776	B2	04-22-2008	Meier et al.	
	13.	US-7,489,632	B2	02-10-2009	Lakkakorpi	
	14.	US-7,496,367	B1	02-24-2009	Ozturk et al.	
	15.	US-7,634,536	B2	12-15-2009	Halasz	
	16.	US-7,765,294	B2	07-27-2010	Edwards et al.	
	17.	US-7,801,038	B2	09-21-2010	Liao et al.	
	18.	US-7,826,369	B2	11-02-2010	Filsfils et al.	
	19.	US-7,855,977	B2	12-21-2010	Morrison et al.	
	20.	US-8,036,226	B1	10-11-2011	Ma et al.	
	21.	US-8,098,572	B2	01-17-2012	Zhou et al.	
	22.	US-8,139,492	B1	03-20-2012	Peterson et al.	
	23.	US-8,363,628	B2	01-29-2013	Chi et al.	
	24.	US-8,451,735	B2	05-28-2013	Li	
	25.	US-8,478,331	B1	07-02-2013	Rogers	
	26.	US-8,520,603	B2	08-27-2013	Kozisek et al.	
	27.	US-8,527,003	B2	09-03-2013	Gupta et al.	
	28.	US-8,682,338	B2	03-25-2014	Lemson et al.	
	29.	US-8,682,338	B2	03-25-2014	Lemson et al.	
	30.	US-8,737,300	B2	05-27-2014	Stapleton et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	31.	US-2001/0034223	A1	10-25-2001	Rieser et al.	
	32.	US-2002/0075906	A1	06-20-2002	Cole et al.	
	33.	US-2002/0086675	A1	07-04-2002	Mansour	
	34.	US-2002/0093926	A1	07-18-2002	Kilfoyle	
	35.	US-2003/0021263	A1	01-30-2003	Lee	
	36.	US-2003/0181221	A1	09-25-2003	Nguyen	
	37.	US-2004/0053624	A1	03-18-2004	Frank et al.	
	38.	US-2005/0152695	A1	7/14/2005	Sulzberger et al.	
	39.	US-2005/0181812	A1	08-18-2005	Scheck	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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	Attorney Docket Number	091172-1017552-102440US

	40.	US-2005/0206564	A1	09-22-2005	Mao et al.	
	41.	US-2005/0220066	A1	10-06-2005	Wal et al.	
	42.	US-2006/0270366	A1	11-30-2006	Rozenblit et al.	
	43.	US-2007/0019598	A1	01-25-2007	Prehofer	
	44.	US-2007/0058742	A1	03-15-2007	Demarco et al.	
	45.	US-2007/0065078	A1	03-22-2007	Jiang	
	46.	US-2007/0116046	A1	05-24-2007	Liu et al.	
	47.	US-2007/0147488	A1	06-28-2007	Han	
	48.	US-2007/0177552	A1	08-02-2007	Wu et al.	
	49.	US-2008/0051129	A1	02-28-2008	Abe et al.	
	50.	US-2008/0146146	A1	06-19-2008	Binder et al.	
	51.	US-2008/0225816	A1	09-18-2008	Osterling et al.	
	52.	US-2008/0240036	A1	10-02-2008	Liu et al.	
	53.	US-2009/0274048	A1	11-05-2009	Sambhwani et al.	
	54.	US-2010/0087227	A1	04-08-2010	Francos et al.	
	55.	US-2010/0136998	A1	06-03-2010	Lott et al.	
	56.	US-2010/0202565	A1	08-12-2010	Abbasfar	
	57.	US-2010/0247105	A1	09-30-2010	Yu	
	58.	US-2010/0279704	A1	11-04-2010	Vachhani	
	59.	US-2010/0299173	A1	11-25-2010	Zampiello et al.	
	60.	US-2010/0311372	A1	12-09-2010	Bouyaud et al.	
	61.	US-2011/0103309	A1	05-05-2011	Wang et al.	
	62.	US-2012/0039254	A1	02-16-2012	Stapleton et al.	
	63.	US-2013/0272202	A1	10-17-2013	Stapleton et al.	
	64.	US-2014/0313884	A1	10-23-2014	Stapleton et al.	
	65.	US-2014-0286247	A1	09-25-2014	Lemson et al.	
	66.	US-2016/0014782	A1	01-14-2016	Stapleton et al.	
	67.	US-2016/0080082	A1	03-17-2016	Lemson et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	68.	103201958	CN	A	07-10-2013	Dali Systems Co. Ltd.		
	69.	2606576	EP	A0	06-26-2013	Dali Systems Co. Ltd.		
	70.	2008/154077	WO	A1	12-18-2008	Dali Systems Co. Ltd.		
	71.	2012/024343	WO	A1	02-23-2012	Dali Systems Co. Ltd.		
	72.	2012/024349	WO	A1	02-23-2012	Dali Systems Co. Ltd.		
	73.	101453799	CN	A	06-10-2009			
	74.	02/23956	WO	A2	03-21-2002	TELEDYNE LIGHTING AND DISPLAY PRODUCTS INC.		
	75.	02/47414	WO	A2	06-13-2002	SCIENCE APPLICATIONS INTERNATIONAL CORPORATION		

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	76.	101453799	CN	A	06-10-2009	Comba Telecom Sys China Co Ltd		
	77.	2008/146394	WO	A1	12-04-2008	Fujitsu Limited		
	78.	2007-235738	JP	A	09-13-2007	Sumitomo Electric Ind LTD		
	79.	2010-166531	JP	A2	07-29-2010	Hitachi Kokusai Electric Inc		
	80.	2008-516503	JP	A	05-15-2008	Jinquan Dai		
	81.	2008-099137	JP	A2	04-24-2008	Fujitsu Limited		
	82.	2007-529926	JP	A	10-25-2007	Wensheng He		
	83.	2007-523577	JP	A	08-16-2007	Telefonaktiebolaget Lm Ericssson		
	84.	2004-147009	JP	A2	05-20-2004	Hitachi Kokusai Electric Inc		
	85.	101521893	CN	A	09-02-2009	Comba Telecom System Holdings		
	86.	2009-296335	JP	A2	12-17-2009	Nippon Telegraph & Telephone		
	87.	101453799 (dupe)	CN	A	06-10-2009	Comba Telecom Sys China Co Ltd		
	88.	10-2009-0088083	KR	A	08-19-2009	Samsung Electronics Co Ltd		
	89.	00/23956	WO	A1	04-27-2000	Univ Maryland		
	90.	101453699	CN	A	06-10-2009	Huawei Tech Co Ltd.		
	91.	2008-506322	JP	A	02-28-2008	Utstarcom Telecom Co., Ltd.		
	92.	2010/087031	WO	A1	08-05-2010	Hitachi Ltd		

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	93.	U.S. Patent Application No. 15/205,820 filed on July 8,2016 by Lemson et al. (Unpublished. Copy available via USPTO's IFW System)	
	94.	Notification Of Transmittal Of The International Search Report And The Written Opinion Of The International Searching Authority, Or The Declaration and International Search Report and Written Opinion Of The International Searching Authority for International Application No. PCT/US2011/048004 mailed on January 5, 2012, 6 pages.	

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	Attorney Docket Number	091172-1017552-102440US

	95.	Notification Of Transmittal Of The International Search Report And The Written Opinion Of The International Searching Authority, Or The Declaration and International Search Report and Written Opinion Of The International Searching Authority for International Application No. PCT/US2011/047995 mailed on December 22, 2011, 7 pages.	
	96.	International Search Report and Written Opinion of the International Searching Authority for International Application No. PCT/US2011/047999 mailed on Dec. 19, 2011, 7 pages.	
	97.	Non-Final Office Action for U.S. Patent Application No. 13/211,247 mailed on October 10, 2012, 6 pages.	
	98.	Notice of Allowance for U.S. Patent Application No. 13/211,247 mailed on March 13, 2013, 11 pages.	
	99.	Non-Final Office Action for U.S. Patent Application No. 13/211,247 mailed on July 22, 2013, 11 pages.	
	100.	Final Office Action for U.S. Patent Application No. 13/211,247 mailed on November 26, 2013, 13 pages.	
	101.	Notice of Allowance for U.S. Patent Application No. 13/211,247 mailed on March 11, 2014, 10 pages.	
	102.	First Office Action for Chinese Patent Application No. 20118005066.6 mailed on August 4, 2014,	
	103.	Non-Final Office Action for U.S. Patent Application No. 13/913,207 mailed on November 20, 2014, 22 pages.	
	104.	Non-Final Office Action for U.S. Patent Application No. 14/260,145 mailed on January 27, 2015, 10 pages	
	105.	Second Office Action for Chinese Patent Application No. 20118005066.6 mailed on April 13, 2015, 7 pages.	
	106.	Final Office Action for U.S. Patent Application No. 13/913,207 mailed on April 15, 2015, 15 pages	
	107.	Notice of Allowance of May 8, 2015 for U.S. Patent Application No. 14/260,145 13 pages. (copy available via PAIR)	

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	Examiner Name	
	Attorney Docket Number	091172-1017552-102440US

	108.	Notice of Allowance of May 26, 2015 for U.S. Patent Application No. 13/913,207, 11 pages. (copy available via PAIR)	
	109.	Third Office Action for Chinese Patent Application No. 20118005066.6 mailed on January 4, 2015, 6 pages.	
	110.	Notice of Allowance for U.S. Application No. 14/800,515, mailed May 20, 2016, 13 pages.	

EXAMINER SIGNATURE			
Examiner Signature /WEI ZHAO/		Date Considered 05/25/2017	

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

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

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	Examiner Name	
	Attorney Docket Number	091172-1017552-102440US

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2016-11-16
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

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

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

CLAIM		DATE								
Final	Original	05/26/2017								
	1	-								
	2	✓								
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	16	✓								
	17	✓								
	18	✓								
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	20	✓								
	21	✓								

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	WEI ZHAO	2473

CPC- SEARCHED		
Symbol	Date	Examiner
H04W 40/02, 72/04; H04B 7/022	5/25/2017, 5/26	wz

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
searched in usocr, fprs, pgpub, uspat, ip.com, and ieee xplore	5/25/2017, 5/26	wz
fmid search	5/25/2017	wz
odp search in palm resource center	5/25/2017	wz

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H04W	72/04	5/26/2017	wz

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NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	1.	"Introduction to Receivers", downloded June 15, 2017 from http://www.ece.ucsb.edu/~long/ece145a/Introduction_to_Receivers.pdf, 28 pages.	
	2.	"Standardizing Digital IF Data Transfer with VITA 49", RTC Magazine, downloaded June 15, 2017 from http://rtcmagazine.com/articles/view/100460, 5 pages.	
	3.	LAN et al., "GSM Co-Channel and Adjacent Channel Interference Analysis and Optimization", Dec. 2011, Vol. 16, No. 6, Tsinghua Science And Technology, ISSN 1007-0214 04/12, pp 583-588.	

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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	Examiner Name	Wei Zhao
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[4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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☐ A certification statement is not submitted herewith.

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Signature	/Craig C. Largent/	Date (YYYY-MM-DD)	2017-06-23
Name/Print	Craig C. Largent	Registration Number	56,400

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Electronic Acknowledgement Receipt	
EFS ID:	29609050
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Craig Cody Largent/Brian Kanter
Filer Authorized By:	Craig Cody Largent
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	26-JUN-2017
Filing Date:	29-JUL-2016
Time Stamp:	16:09:55
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		102440US_IDS.pdf	143779 b910fdc15b59d5e8c9111753ae524d2f559d1295	yes	4

	Multipart Description/PDF files in .zip description			
	Document Description	Start	End	
	Transmittal Letter	1	2	
	Information Disclosure Statement (IDS) Form (SB08)	3	4	
Warnings:				
Information:				
2	Non Patent Literature	NPL_Introduction_to_Receivers_URLinChart.pdf	4491581 11f0034ca840656e0df7b4e962716b4574d6d8cc	no	28
Warnings:				
Information:				
3	Non Patent Literature	NPL_Standardizing_Digital_IF_DataTransfer_with_RTC_Magazine.pdf	2494216 135c7f9aeedb9de5468a5fd2e9b6ded1adf50347	no	5
Warnings:				
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4	Non Patent Literature	NPL_LANetal_2011_VOL16_Co-ChannelandAdjacent_ChannelInterfer.pdf	1991280 1bf59a4b7b2fcbdf18fb117a260abfcf76ddd519	no	6
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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on June 26, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
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Alexandria, VA 22313-1450

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

This IDS is being filed after the mailing of the first Office Action on the merits, but before the mailing date of the final Office Action, Notice of Allowance, or any other action that closes prosecution.

I hereby certify under 37 CFR §1.97(e)(2) that no item of information contained in the Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the Information Disclosure Statement.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

/Craig C. Largent/

Craig C. Largent
Registration No. 56,400

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

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

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-2002/0186436	A1	12-12-2002	Mani et al.	
	2.	US-2006/121944	A1	06-08-2006	Buscaglia et al.	
	3.	US-2007/0281643	A1	12-06-2007	Kawai	
	4.	US-2007/0064506	A1	03-22-2007	Bauman et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	5.	1992-207532	JP	A	07-29-1992	Nippon Telegr & Teleph Corp		
	6.	1993-136724	JP	A	01-06-1993	A T R Koudenpa Tsushin Kenkyush		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	7.	Extended European Search Report for European Application No. 11818697.2 mailed on August 17, 2017, 7 pages.	
	8.	Office Action for Japanese Application No. 2016-174930 mailed August 2, 2017, 4 pages.	

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

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

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☐ See attached certification statement.

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

☐ A certification statement is not submitted herewith.

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2017-08-29
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

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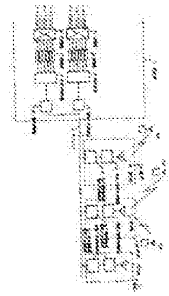
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JP,04-207532,A

PAJ Detail Image

(11)Publication number	04-207532
(43)Date of publication of application	29.07.1992
(51)Int.Cl.	H04B 7/26 H04B 10/20 H04J 14/08
(21)Application number	02-335792
(22)Date of filing	30.11.1990
(71)Applicant	NIPPON TELEGR & TELEPH CORP <NTT>
(72)Inventor	TAKANASHI HITOSHI KOMAKI SHOZO KOHIYAMA KENJI



(54)COMMUNICATION EQUIPMENT

(57)Abstract

PURPOSE: To reduce number of transmission lines by applying a high frequency signal from a base station to a remote master station and to economize the communication system by installing integrally transmission devices having been provided individually to master stations to the base station.

CONSTITUTION: A multiplexed modulation wave being a signal sent from master stations 5a-5c is generated by a base station 4 to convert the modulation wave into an optical signal and the signal is distributed to plural master stations 5 through the use of an optical fiber 9, the master station 5 converts the optical signal into an electric signal and extracts only the required signal and it is sent to a slave station. Thus, number of transmission lines interconnecting the base station 4 and the master station 5 is saved and a function having been implemented by the master station in a conventional system is concentrated onto the base station to establish the economical communication system.

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⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　平4−207532

⑤1Int.Cl.⁵	識別記号	庁内整理番号	⑬公開 平成4年(1992)7月29日
H 04 B 7/26	104 A	8523−5K	
10/20			
H 04 J 14/08			
		8426−5K H 04 B 9/00	D
		8426−5K	N

審査請求 未請求 請求項の数 1 (全5頁)

⑤4発明の名称　通信装置

⑳特　願 平2−335792
㉒出　願 平2(1990)11月30日

⑦2発明者　高梨　斉　東京都千代田区内幸町1丁目1番6号　日本電信電話株式会社内
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⑦4代理人　弁理士　澤井　敬史

明細書

1．発明の名称

通信装置

2．特許請求の範囲

一つの基地局と複数の子局が複数の親局を介して結ばれる無線通信用装置において、前記基地局には、複数の親局で送信しようとする複数の信号を一つ又は複数の出力に多重化する多重化装置と、該多重化装置の出力を入力として光信号に変換する電気／光変換器を備え、前記電気／光変換器の出力を前記親局に伝送する光ファイバを有し、親局では、前記光ファイバ出力を入力とし電気信号に変換する光／電気変換器と、該光／電気変換器の出力を入力とし必要な信号のみを分離する多重分離装置と、該多重分離装置の出力を入力とし電波を放射する送信手段及び子局からの信号を受信する手段と、受信信号を光信号に変換する電気／光変換器とを備え、該電気／光変換器の出力を前記光ファイバによって前記基地局に伝送することを特徴とする通信装置。

3．発明の詳細な説明

〔産業上の利用分野〕

本発明は、ゾーン方式をとる移動通信方式において、経済的かつ保守の容易な通信方法に関する。

〔従来の技術〕

自動車電話当移動通信方式では、サービス範囲を複数のゾーンに分け、一つのゾーンに親局を配し、子局（移動局）と通信する所謂ゾーン方式が採用されている。

〔発明が解決しようとする課題〕

周波数の有効利用を図り、出来るだけ多くの子局を収容するためにはゾーンを小さくすることが有効である。この場合、第4図に示すように、親局の数が著しく増大し、親局設置及び基地局と親局との伝送回線の経費が増大する。更に、親局では、基地局との通信用に変調装置、復調装置、送受信装置等の伝送機器を設置しなければならなかった。これらの機器は比較的大型で親局の小型・

T-Mobile Ex. 1037

経済化を阻害していた。また、これらの機器が多くの親局に分散されて設置されている為、保守が面倒であるという問題があった。また、従来は、呼の制御は各親局で行われていた為、子局が他のゾーンに移動したときの切替えが複雑という問題があった。

本発明は、伝送線路を削減すると共に、親局に個別に設けた伝送機器を基地局に集約して経済的な通信システム化を実現するものである。

〔課題を解決するための手段〕

本発明は、一つの基地局と複数の子局が複数の親局を介して結ばれる無線通信用装置において、前記基地局には、複数の親局で送信しようとする複数の信号を一つ又は複数の出力に多重化する多重化装置と、該多重化装置の出力を入力として光信号に変換する電気／光変換器を備え、前記電気／光変換器の出力を前記親局に伝送する光ファイバを有し、親局では、前記光ファイバ出力を入力とし電気信号に変換する光／電気変換器と、該光／電気変換器の出力を入力とし必要な信号のみを分離する多重分離装置と、該多重分離装置の出力を入力とし電波を放射する送信手段及び子局からの信号を受信する手段と、受信信号を光信号に変換する電気／光変換器とを備え、該電気／光変換器の出力を前記光ファイバによって前記基地局に伝送するもので、以下詳細に説明する。

〔作用〕

本発明は、親局から送信される信号である多重化された変調波を一つの基地局で作成し、変調波を光信号に変換し、光ファイバを用いて複数の親局に分配すると共に親局では光信号を電気信号に変換し必要な信号のみを抽出し子局に向けて送信するもので、基地局と親局を結ぶ伝送路を削減出来るとともに、従来親局で行っていた機能を基地局に集約できるという特有の効果を有するものである。

〔実施例〕

第１図は、本発明の構成を説明する図である。４は基地局、５ａ，５ｂ，．．．は、それぞれ子局である。１ａ，１ｂ，．．は、基地局から伝送しようとする信号の束を示し、１ａは親局５ａに対する信号群である。これらの多数の信号は交換機21を経た後、基地局内で変調器24で変調され、それらの変調波は多重化装置３で多重化される。多重化の方法として周波数多重、時分割多重等の周知技術が使用出来る。多重化された信号は電気／光変換器６に入力され、多重化信号を変調波、光を搬送波とする線型変調が行われる。変換された信号は光ファイバ９により伝送される。各親局は、光ファイバの光信号を分岐し、光／電気変換器１２によって基地局での変調信号に戻される。各親局は変換された信号の内自局に関するものを多重／多重分離装置１１によって抽出し、これらの信号は子局に無線で送信される。

子局からの信号は、多重／多重分離装置１１でゾーン内信号をまとめた後、電気／光変換器１２によって光信号に変換後、光ファイバ９によって基地局４に伝送される。各親局からの信号は光ファイバ中に合成される。基地局４では、光／電気変換器７によって電気信号に変換後多重分離装置８によって各信号が分離される。多重分離された信号は復調を行った後に必要に応じて交換機23で切り換えられる。即ち、全ての子局の回線切替え・変復調は基地局で集中して行える。

第２図は多重方式として周波数多重を用いた場合の構成図である。Ｓ１～Ｓｎは基地局で変調された入力信号、Ｓ１'～Ｓｎ'は出力信号である。基地局側ではその基地局内で送信するｎ個の信号を時分割多重装置３－１で多重化し、電気／光変換して光ファイバ９で伝送する。親局では光／電気変換した後にその親局で送信する信号を抽出する時分割多重信号分離装置１１で分離し、電力増幅し、空中線で送信する。受信信号は空中線１０で受信し、時分割多重を行った後に光ファイバ９で基地局へ伝送し、時分割多重分離装置で信号を分離し伝送する。

第３図は、多重化の手段として周波数多重を用いた場合の構成図である。基地局側では、その基地局内で送信するｎ個の信号（ｆ1～ｆn）をハイブリッド23で合成し、電気／光変換後、光ファイバ

9で伝送する。親局では光／電気変換した後に電力増幅し、空中線10で送信する。受信信号は空中線10で受信し、時分割多重を行った後に光ファイバで基地局へ伝送し、周波数分割スイッチで切り換えて伝送する。

〔発明の効果〕

以上説明したように、本発明によれば、基地局から遠隔地の親局へ高周波信号を供給できるので親局を小型・簡易化出来、親局より放射する電波の切替えも容易にでき、基地局の光／電気変換器が節減できる。親局の保守も簡易になる。また、光ファイバの敷設方法に対する制約が無くなる。

4．図面の簡単な説明

第1図は、本発明の構成を説明する図である。

第2図は、多重方式として周波数多重を用いた場合の本発明の構成図である。

第3図は、多重方式として時分割多重を用いた場合の本発明の構成図である。

第4図は、従来の構成を示す図である。

1a～1c…基地局からの信号

3…多重化装置，

3−1…時分割多重化装置

4…基地局，

5a～5c…親局

6…電気／光変換器，

7…光／電気変換器，

8…多重分離装置，

8−1…時分割多重分離装置，

9…光ファイバ，

10…空中線，

11…多重／多重分離装置，

12…光／電気変換器・電気／光変換器

12-1…光／電気変換器，

12-2…電気／光変換器，

14…電力増幅器，

15…送信／受信分波器，

16…周波数分割スイッチ，

17…選択器，

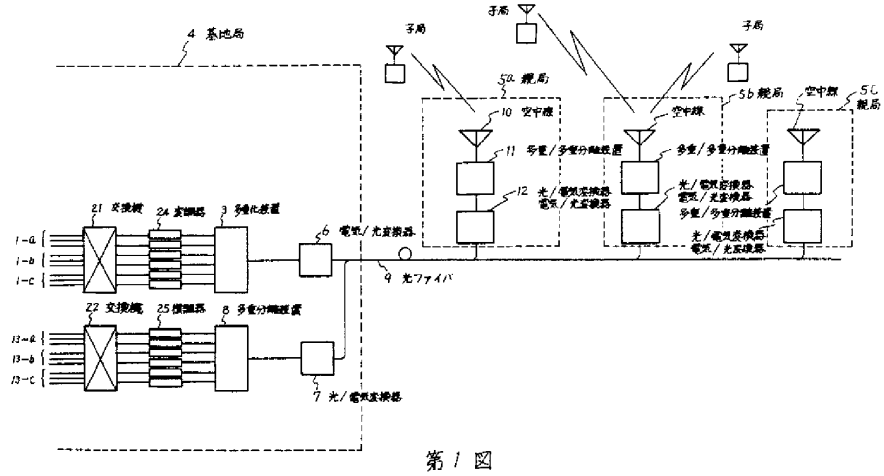
21，22…交換機，

23…ハイブリッド，

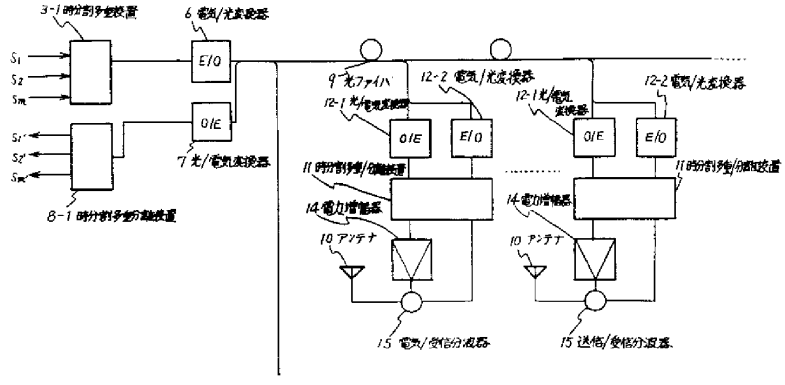
24…変調器，

25…復調器。

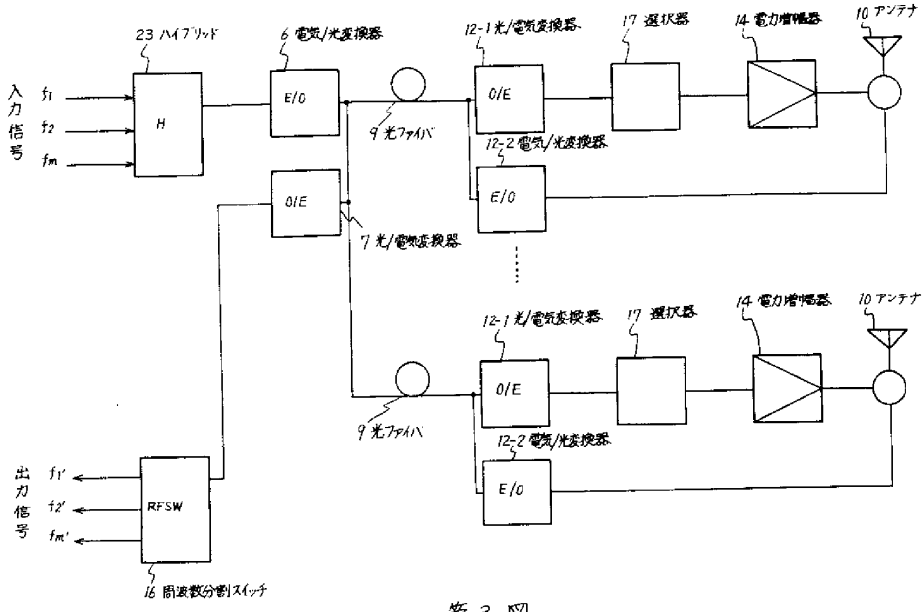
代理人
日本電信電話株式会社内
弁理士　澤井敬史


4 基地局
子局
子局
子局
5a 親局
5b 親局
5c 親局
10 空中線
空中線
空中線
11 多重/多重分離装置
多重/多重分離装置
12 光/電気変換器
電気/光変換器
光/電気変換器
電気/光変換器
多重/多重分離装置
光/電気変換器
電気/光変換器
21 交換機
24 変調器
3 多重化装置
1-a
1-b
1-c
6 電気/光変換器
9 光ファイバ
22 交換機
25 復調器
8 多重分離装置
13-a
13-b
13-c
7 光/電気変換器

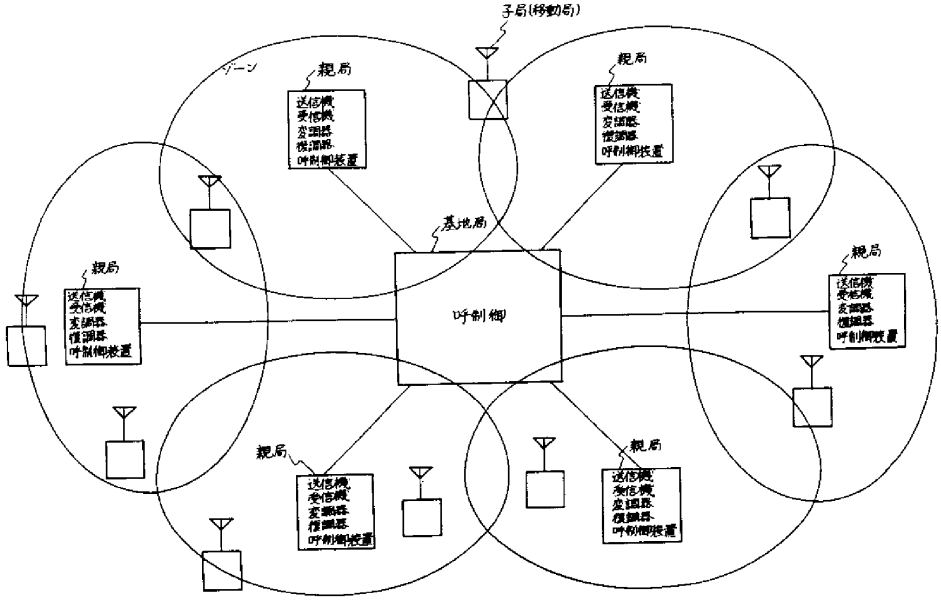
第 1 図


3-1 時分割多重装置
6 電気/光変換器
S1
S2
Sm
E/O
O/E
9 光ファイバ
12-2 電気/光変換器
12-1 光/電気変換器
O/E
E/O
O/E
E/O
11 時分割多重/分離装置
14 電力増幅器
10 アンテナ
7 光/電気変換器
8-1 時分割多重分離装置
15 電気/信号分波器
15 送信/受信分波器

第 2 図


23 ハイブリッド
6 電気/光変換器
12-1 光/電気変換器
17 選択器
14 電力増幅器
10 アンテナ
入力信号
f1
f2
fm
H
E/O
O/E
9 光ファイバ
12-2 電気/光変換器
7 光/電気変換器
出力信号
f1'
f2'
fm'
RFSW
16 周波数分割スイッチ

第３図


子局(移動局)
ゾーン
親局
送信機
受信機
変調器
復調器
呼制御装置
基地局
呼制御

第４図

JP1992-207532,A

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damages caused by the use of this translation.
1.This document has been translated by computer. So the translation may not
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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

In equipment for wireless communications by which one base station and a plurality of slave stations are connected via a plurality of master stations,

A communication apparatus which is provided with the following and characterized by transmitting an output of the electrical and electric equipment/phototransducer to the aforementioned base station by the aforementioned optical fiber.

A multiplexing device which multiplexes a plurality of signals which it is going to transmit to the aforementioned base station in a plurality of master stations to one or more outputs.

The light/electric transducer which is provided with the electrical and electric equipment/phototransducer which converts an output of the multiplexing device to a lightwave signal as an input, has an optical fiber which transmits an output of the aforementioned electrical and electric equipment/phototransducer to the aforementioned master station, and considers the aforementioned optical fiber output as an input in a master station, and it converts to an electrical signal

A demultiplexer which considers an output of this light/electric transducer as an input, and separates only a required signal.

A means to receive a transmission means and a signal from a slave station which consider an output of the demultiplexer as an input and emit an electric wave, and the electrical and electric equipment/phototransducer which converts a reception signal to a lightwave signal.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[Industrial Application]

In the mobile communication system which takes zoning, the present invention relates to the easy economical and correspondence procedure of maintenance.

[Description of the Prior Art]

In the car telephone this mobile communication system, the service range is divided into a plurality of zones, a master station is placed at one zone, and what is called zoning that communicates with a slave station (mobile station) is adopted.

[Problem(s) to be Solved by the Invention]

In order to aim at effective use of frequency and to store as many slave stations as possible, it is effective to make a zone small. In this case, as shown in Fig. 4, the number of master stations increases remarkably and the cost of the transmission line of master-station installation and a base station, and a master station increases. In the master station, transmission apparatus, such as a modulator, a demodulator, and transceiving equipment, had to be installed in communication with a base station. These apparatus was comparatively large-sized and was inhibiting the small size and economization of the master station. Since these apparatus was distributed and installed in many master stations, there was a problem that maintenance was troublesome. Since control of the call was performed conventionally in each master station, there was a problem that a change when a slave station moves to other zones was complicated.

The present invention reduces the transmission lines, and collects the transmission apparatus individually provided to the master station to a base station, and realizes economical communications system-ization.

[The means for solving a technical problem]

In the equipment for wireless communications tied via a plurality of master stations, one base station and a plurality of slave stations the present invention in the aforementioned base station, A multiplexing device which multiplexes a plurality of signals which it is going to transmit in a plurality of master stations to one or more outputs, Have the electrical and electric equipment/phototransducer which converts the output of the multiplexing device to a lightwave signal as an input, have an optical fiber which transmits the output of the aforementioned electrical and electric equipment/phototransducer to the aforementioned master station, and in a master station, The light/electric transducer which converts the aforementioned optical fiber output to an electrical signal as an input, A demultiplexer which considers the output of this light/electric transducer as an input, and separates only a required signal, It has a means to receive the transmission means and the signal from a slave station which consider the output of the demultiplexer as an input and emit an electric wave, and the electrical and electric equipment/phototransducer which converts a reception signal to a

lightwave signal, the output of the electrical and electric equipment/phototransducer is transmitted to the aforementioned base station by the aforementioned optical fiber, and it describes in details below.

[operation]

The present invention creates the multiplexed modulated wave which is a signal transmitted from a master station in one base station, It is what convert a modulated wave to a lightwave signal and it distributes to a plurality of master stations using an optical fiber, and converts a lightwave signal to an electrical signal in a master station, extracts only a required signal, and transmits towards a slave station, While the transmission lines which connect a base station and a master station are reducible, it has the characteristic effect that the function which was being performed conventionally in the master station can be collected to a base station.

[Example]

Fig. 1 is the figure which carries out a detailed description of the invention.

4 -- a base station, 5a and 5b, and ** -- it is a slave station, respectively. The bundle of the signal which it is going to transmit from la, lb, **, and a base station is shown, and la is a signal group to the master station 5a. After these many signals pass through the switchboard 21, they are modulated with the modulator 24 in a base station, and those modulated waves are multiplexed by multiplexing bag W3.

Well-knowns art, such as frequency multiplexing and Time Division Multiplexing, can be used as the method of multiplexing. Linear modulation which makes a multiplexed signal a modulated wave and for which the multiplexed signal is input into the electrical and electric equipment / phototransducer 6, and it makes light a subcarrier is performed. The converted signal is transmitted by the optical fiber 9. Each master station branches the lightwave signal of an optical fiber, and is returned to the modulating signal in a base station by light / electric transducer 12.

Each master station extracts the thing about the inner local station of the converted signal by multiplex / demultiplexer 11, and these signals are transmitted to a slave station on radio.

After the signal from a slave station packs the signal in a zone by multiplex / demultiplexer 11, it is transmitted after converting to a lightwave signal by the electrical and electric equipment / phototransducer 12, and is transmitted to the base station 4 by the optical fiber 9. The signal from each master station is synthesized in an optical fiber. In the base station 4, each signal is separated into an electrical signal by the after-conversion demultiplexer 8 with light / electric transducer 7. After the signal by which demultiplexing was carried out gets over, it is **(ed) by necessity and switched by the

switchboard 23. That is, it concentrates in a base station and can perform a circuit change and strange recovery of all the slave stations.

Fig. 2 is a configuration diagram at the time of using frequency multiplexing as a multiplex mode. 31 - Sn are the input signals modulated in the base station, and Sl'-Sn" is an output signal.

In a base station side, n signals transmitted in the base station are multiplexed with the time division multiplexer 3-1, the electrical and electric equipment/light conversion carries out, and it transmits by the optical fiber 9. In a master station, light / after carrying out electrical conversion, power amplification is separated and carried out with the time division multiplexing signal decollator 11 which extracts the signal transmitted in the master station, and it transmits with an antenna. The antenna 10 receives a reception signal, after it performs Time Division Multiplexing, it is transmitted to a base station by the optical fiber 9, and it separates and transmits a signal with a Time-Division-Multiplexing decollator.

Fig. 3 is a configuration diagram at the time of using frequency multiplexing as a means of multiplexing. In a base station side, n signals (fl-fn) transmitted in the base station are synthesized by the hybrid 23, and it transmits by the optical fiber 9 after the electrical and electric equipment/light conversion. In a master station, light / after carrying out electrical conversion, they are ********** and the antenna]. It transmits by 0. The antenna 10 receives a reception signal, after it performs Time Division Multiplexing, it is transmitted to a base station by an optical fiber, and it is switched and transmitted with a frequency division switch.

[Effect of the Invention]

As described above, according to the present invention, since a high frequency signal can be supplied to the master station of a remote place from a base station, small size and the change of an electric wave which can be simplified and is emitted from a master station can also make a master station easy, and it can reduce the light/electric transducer of a base station. Maintenance of a master station also becomes simple. The restrictions to the laying method of an optical fiber are lost.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

Fig. 1 is the figure which carries out a detailed description of the invention.

Fig. 2 is a constituent-of-the-present-invention figure at the time of using frequency multiplexing as a multiplex mode.

Fig. 3 is a constituent-of-the-present-invention figure at the time of using Time Division

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Multiplexing as a multiplex mode.

Fig. 4 is the figure showing the conventional composition.

The signal from 1a - 10-base station

3-multiplexing device,

3-1 Time division multiplexer

4-base station.

5a - a 5C-master station

6-electrical and electric equipment / phototransducer.

7-light / electric transducer 1

8-demultiplexer.

8-1-and - Time-Division-Multiplexing decollator.

9-optical fiber.

1O-antenna.

11-multiplex / demultiplexer.

12---light / electric transducer and the electrical and electric equipment / phototransducer 12-t --- Light/electric transducer.

12-2-electrical and electric equipment / phototransducer.

14, -, and a power amplifier.

15 and - transmission / received branching filter.

16-frequency division switch.

17-selector 1

21, 22- and a switchboard.

23- Hybrid.

24-modulator.

25-demodulator.

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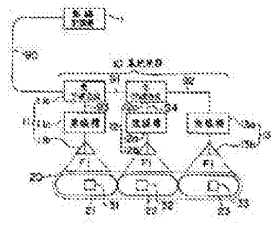
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(11)Publication number	05-136724
(43)Date of publication of application	01.06.1993
(51)Int.Cl.	H04B 7/26
(21)Application number	03-300230
(22)Date of filing	15.11.1991
(71)Applicant	A T R KOUDENPA TSUSHIN KENKYUSH O:KK
(72)Inventor	OGAWA HIROTSUGU



(54)MOBILE BODY RADIO COMMUNICATION SYSTEM

(57)Abstract

PURPOSE: To provide the mobile body radio communication system by forming a smaller radio zone than that of a conventional system and accommodating more mobile terminal equipments.

CONSTITUTION: A radio control station 1 and each radio base station 10 are connected through an optical transmission line 90, and the radio control station 1 uses an information signal to modulate signals of plural radio frequencies used by each radio base station 10 and to multiplex each modulation signal and to apply electro-optical conversion to the multiplexed optical signal and sends the result to each radio base station 10 via the optical transmission line 90 and each base station applies photoelectric conversion to the received optical signal and sends the result to each of mobile terminal stations 31 33 as a radio signal. In the mobile radio communication system as above, each radio base station 10 forms small radio zones 21-23 not overlapped with each other and each small radio zone forms one radio zone 20, and a radio signal of the same frequency group comprising plural frequencies is used between each radio base station 10 and each of mobile terminal stations 31-33 to implement radio communication in each small radio zone.

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(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平5－136724

(43)公開日　平成5年(1993)6月1日

(51)Int.Cl.[5]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０４Ｂ　7/26	１０５　Ａ	7304－5K		

審査請求　未請求　請求項の数2(全 11 頁)

(21)出願番号　特願平3－300230

(22)出願日　平成3年(1991)11月15日

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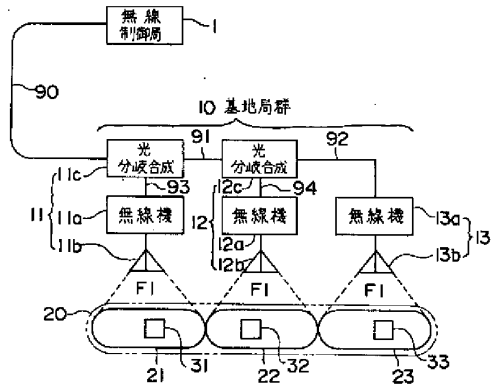
(74)代理人　弁理士　青山　葆　(外1名)

(54)【発明の名称】　移動体無線通信システム

(57)【要約】

【目的】　従来に比較してより小さな無線ゾーンを形成して、より多くの移動端末機を収容することができる移動体無線通信システムを提供する。

【構成】　無線制御局と各無線基地局とを光伝送路を介して接続し、上記無線制御局は、各無線基地局で用いる複数の無線周波数の信号を情報信号で変調した各変調信号を多重化した後光信号に電光変換して、上記光伝送路を介して上記各無線基地局に伝送し、上記各基地局は上記伝送された光信号を光電変換して無線信号として各移動端末局に放射する移動体無線通信システムであって、上記各無線基地局によってそれぞれ互いに重ならない小無線ゾーンを形成し、上記各小無線ゾーンによって1つの無線ゾーンを形成し、上記各小無線ゾーンにおいて上記各無線基地局と上記各移動端末機との間で複数の周波数からなる同一の周波数群の無線信号を用いて無線通信を行なう。



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【 特許請求の範囲】
【 請求項1 】　無線制御局と各無線基地局とを光伝送路を介して接続し、上記無線制御局は、各無線基地局で用いる複数の無線周波数の信号を情報信号で変調した各変調信号を多重化した後光信号に電光変換して、上記光伝送路を介して上記各無線基地局に伝送し、上記各基地局は上記伝送された光信号を光電変換して無線信号として各移動端末局に放射する移動体無線通信システムであって、
上記各無線基地局によってそれぞれ互いに重ならない小無線ゾーンを形成し、上記各小無線ゾーンによって1 つの無線ゾーンを形成し、上記各小無線ゾーンにおいて上記各無線基地局と上記各移動端末機との間で複数の周波数からなる同一の周波数群の無線信号を用いて無線通信を行なうことを特徴とする移動体無線通信システム。
【 請求項2 】　複数の上記無線基地局からなる無線基地局群を複数個備え、上記各無線基地局群によってそれぞれ、互いに重ならない無線ゾーンを形成し、上記各無線ゾーンにおいてそれぞれ、互いに異なる周波数群の無線信号を用いて無線通信を行なうことを特徴とする請求項1 記載の移動体無線通信システム。
【 発明の詳細な説明】
【 ０００１ 】
【 産業上の利用分野】本発明は、自動車電話システム、携帯電話システム、パーソナル通信システムなどの移動体無線通信システムに関する。
【 ０００２ 】
【 従来の技術】従来の自動車電話及び携帯電話システムなどの移動体無線通信システムにおいては、半径5ｋｍ程度の無線ゾーンを1 つの無線基地局で形成し、ＵＨＦの周波数帯を用いて無線通信を行っていた。
【 ０００３ 】
【 発明が解決しようとする課題】このような無線基地局の構成では、比較的高い送信出力電力が要求され、そのため、無線基地局装置の大型化になるとともに、製造コストが高くなるという問題点があった。また、ＵＨＦの周波数帯を用いて通信を行っているので、使用できる周波数の帯域にも限界があった。従って、膨大な数の携帯電話などを収容する移動体無線通信システムにおいては、使用する周波数帯域を従来に比較し拡大する必要がある。また、携帯電話機の小型化に伴って、送信出力電力の低下が見込まれるので、無線基地局と携帯電話機などの移動端末機との間の距離を大幅に小さくする必要がある。
【 ０００４ 】本発明の目的は以上の問題点を解決し、従来に比較してより小さな無線ゾーンを形成して、より多くの移動端末機を収容することができる移動体無線通信システムを提供することにある。
【 ０００５ 】
【 課題を解決するための手段】本発明に係る請求項1 記載の移動体無線通信システムは、無線制御局と各無線基地局とを光伝送路を介して接続し、上記無線制御局は、各無線基地局で用いる複数の無線周波数の信号を情報信号で変調した各変調信号を多重化した後光信号に電光変換して、上記光伝送路を介して上記各無線基地局に伝送し、上記各基地局は上記伝送された光信号を光電変換して無線信号として各移動端末局に放射する移動体無線通信システムであって、上記各無線基地局によってそれぞれ互いに重ならない小無線ゾーンを形成し、上記各小無線ゾーンによって1 つの無線ゾーンを形成し、上記各小無線ゾーンにおいて上記各無線基地局と上記各移動端末機との間で複数の周波数からなる同一の周波数群の無線信号を用いて無線通信を行なうことを特徴とする。
【 ０００６ 】また、請求項2 記載の移動体無線通信システムは、請求項1 記載の移動体無線通信システムは、複数の上記無線基地局からなる無線基地局群を複数個備え、上記各無線基地局群によってそれぞれ、互いに重ならない無線ゾーンを形成し、上記各無線ゾーンにおいてそれぞれ、互いに異なる周波数群の無線信号を用いて無線通信を行なうことを特徴とする。
【 ０００７ 】
【 作用】従来の自動車電話及び携帯電話システムにおいては、公知の通り、８００乃至９００ＭＨｚ 帯の周波数帯が用いられており、隣接する無線ゾーンでは干渉の防止のため互いに異なる周波数群を用い、互いに離れた各無線ゾーンで同一の周波数群を繰り返して使用して周波数の利用効率を向上させていた。一方、本発明においては、例えばコンクリートなどからなる建物や道路はミリ波の電波を反射せず、むしろ吸収するという特性を有することに着目し、1 つの無線ゾーン（例えば、図1 における２０）内に位置し分割されて互いに隣接するように形成される小無線ゾーン（例えば、図1 における２１，２２，２３）において、同一の周波数群Ｆ１を繰り返して用いる。このミリ波の吸収特性については、例えば、阿波加純ほか「ミリ波帯における建築物内装材の反射特性実験」電子情報通信学会技術報告，ＡＰ９０－１，１９９０年4 月において報告されている。
【 ０００８ 】請求項1 記載の移動体無線通信システムにおいては、上記無線制御局と上記各無線基地局との間の信号伝送路として、光伝送路を用いているので、副搬送波周波数はマイクロ波であろうが、ミリ波であろうが、信号の伝送特性が各無線ゾーンで用いる周波数によって影響されず、より多くの移動端末機を収容することができるとともに、テレビ信号などの広帯域信号をも伝送することができる。また、当該システムにおいては、各無線基地局はそれぞれ、例えば光分岐合成器のほかに、少なくとも光電変換器と電光変換器と送信用電力増幅器と受信用低雑音増幅器とアンテナとを備えるだけでよいので、従来の自動車電話及び携帯電話システムの無線基地局に比較して、装置を小型化することができ、当該各無

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線基地局装置を例えば電話局の鉄塔などに装備することができる。

【０００９】さらに、請求項2 記載の移動体無線通信システムにおいては、好ましくは、請求項1 記載の移動体無線通信システムは、複数の上記無線基地局からなる無線基地局群を複数個備え、上記各無線基地局群によってそれぞれ、互いに重ならない無線ゾーンを形成し、上記各無線ゾーンにおいてそれぞれ、互いに異なる周波数群の無線信号を用いて無線通信を行なう。これによって、当該システムのサービスエリアを増大させることができる。

【００１０】

【実施例】以下、図面を参照して本発明に係る実施例について説明する。

【００１１】＜第1 の実施例＞図1 は、本発明に係る第1 の実施例である移動体無線通信システムのブロック図である。

【００１２】この第1 の実施例の移動体無線通信システムは、各無線基地局１１，１２，１３によってそれぞれ互いに隣接する小無線ゾーン２１，２２，２３を形成し、従来の自動車電話システムにおける１つの無線基地局に対応しかつ3 個の無線基地局１１，１２，１３から構成されるある１つの無線基地局群１０によって、１つの無線ゾーン２０を形成し、各小無線ゾーン２１，２２，２３において例えばミリ波帯の複数の周波数からなる同一の周波数群Ｆ１を用い、当該移動体無線通信システムの交換局に接続される無線制御局1 は、光ファイバケーブル９０乃至９２を介して各無線基地局１１，１２，１３に接続されることを特徴としている。なお、本願の図面において、無線ゾーンを一点鎖線を用いて示し、当該無線ゾーンを分割した小無線ゾーンを実線で示している。本実施例において、各小無線ゾーン２１，２２，２３の半径は１００ｍ乃至２００ｍ程度であり、従来の自動車電話及び携帯電話システムの無線ゾーンに対応する本実施例の無線ゾーン２０の半径は１．５ｋｍ乃至５ｋｍ程度である。

【００１３】第1 図に示すように、無線基地局１１は、無線機１１ａとアンテナ１１ｂと光分岐合成器１１ｃとを備え、また、無線基地局１２は、無線機１２ａとアンテナ１２ｂと光分岐合成器１２ｃとを備え、さらに、無線基地局１３は、無線機１３ａとアンテナ１３ｂと光分岐合成器１３ｃとを備える。ここで、無線機１１ａ，１２ａ，１３ａは、少なくとも光電変換器と、電光変換器と、送信用電力増幅器と、受信用増幅器とを備える。

【００１４】無線制御局1 においては、各無線基地局１１，１２，１３の各無線機１１ａ，１２ａ，１３ａから送信される、無線周波数を有し通話信号でＦＭ変調された各高周波信号が周波数多重化して合成し、合成された多重化信号を電光変換して光信号とし、当該光信号を光ファイバケーブル９０を介して無線基地局１１の光分岐合成器１１ｃに伝送する。光分岐合成器１１ｃは伝送された光信号の一部を分岐して、光ファイバケーブル９３を介して無線機１１ａに出力する一方、上記伝送された光信号を光ファイバケーブル９１を介して無線基地局１２の光分岐合成器１２ｃに伝送する。光分岐合成器１２ｃは伝送された光信号の一部を分岐して、光ファイバケーブル９４を介して無線機１２ａに出力する一方、上記伝送された光信号を光ファイバケーブル９２を介して無線基地局１３の無線機１３ａに伝送する。各無線機１１ａ，１２ａ，１３ａはそれぞれ伝送された光信号を、周波数群Ｆ１の元の各高周波信号に光電変換した後電力増幅してアンテナ１１ｂ，１２ｂ，１３ｂから、互いに隣接するがオーバーラップしない所定の小無線ゾーン２１，２２，２３で各移動端末機３１，３２，３３に向けて放射する。一方、各移動端末機３１，３２，３３から放射される各高周波信号は、各無線基地局１１，１２，１３のアンテナ１１ｂ，１２ｂ，１３ｂを介して無線機１１ａ，１２ａ，１３ａで受信され、先の送信系の信号経路とは逆に、各無線基地局１１，１２，１３から光分岐合成器１１ｃ，１２ｃと光ファイバケーブル９０乃至９２を介して無線制御局1 に伝送される。この場合、無線機１１ａ，１２ａ，１３ａにおいて電光変換処理を行う一方、無線制御局1 において光電変換処理を行なうなど、送信系とは逆の信号処理が行われる。

【００１５】図2 は、図1 に図示した移動体無線通信システムの送信系の具体的なブロック図である。ここで、当該無線基地局群１０の各無線基地局１１，１２，１３が形成する小無線ゾーン２１，２２，２３では、例えばミリ波帯の3 つの周波数ｆ１，ｆ２，ｆ３からなる周波数群Ｆ１を用いる。なお、受信系における周波数は、例えば周波数ｆ１，ｆ２，ｆ３からそれぞれ所定の周波数だけシフトした例えばミリ波帯の周波数を用いる。

【００１６】図2 に示すように、無線制御局1 において、通話信号である各ベースバンド信号Ｂ１，Ｂ２，Ｂ３がそれぞれ各ＦＭ変調器５０ａ，５０ｂ，５０ｃに入力される。ＦＭ変調器５０ａは搬送波信号発生器５１ａで発生された周波数ｆ１の搬送波信号を入力されたベースバンド信号に従ってＦＭ変調し、当該ＦＭ変調信号を合成器５２に出力する。また、ＦＭ変調器５０ｂは搬送波信号発生器５１ｂで発生された周波数ｆ２の搬送波信号を入力されたベースバンド信号に従ってＦＭ変調し、当該ＦＭ変調信号を合成器５２に出力する。さらに、ＦＭ変調器５０ｃは搬送波信号発生器５１ｃで発生された周波数ｆ３の搬送波信号を入力されたベースバンド信号に従ってＦＭ変調し、当該ＦＭ変調信号を合成器５２に出力する。合成器５２は入力された各3 つのＦＭ変調信号を周波数多重化して合成した後、周波数群Ｆ１の多重化信号を電光変換素子であるレーザダイオード５３に出力する。レーザダイオード５３は、入力された多重化信号を光信号に電光変換した後、当該光信号を光ファイバ

ケーブル９０を介して、無線基地局１１の光分岐器４１ｃに伝送する。

【００１７】光分岐器４１ｃは伝送された光信号の一部を分岐して例えばフォトダイオードからなる光電変換器４１ａに出力するとともに、上記伝送された光信号を光ファイバケーブル９１を介して無線基地局１２の光分岐器４２ｃに伝送する。次いで、光分岐器４２ｃは伝送された光信号の一部を分岐して光電変換器４２ａに出力するとともに、上記伝送された光信号を光ファイバケーブル９２を介して無線基地局１３の光電変換器４３ａに伝送する。

【００１８】無線基地局１１において、光電変換器４１ａは入力された光信号を元の多重化信号に変換し、電力増幅器４１ｂとアンテナ１１ｂを介して小無線ゾーン２１内に放射し、放射された多重化信号は移動端末機３１で受信され、移動端末機３１は当該多重化信号のうち所定の手順で指定された例えば周波数ｆ１の高周波信号を選択的に取り出して受信する。また、無線基地局１２は、無線基地局１１と同様に、光分岐器４２ｃと光電変換器４２ａと電力増幅器４２ｂとアンテナ１２ｂとを備え、同様に動作する。さらに、無線基地局１３は、無線基地局１１と同様に、光電変換器４３ａと電力増幅器４３ｂとアンテナ１３ｂとを備え、同様に動作する。ここで、各無線基地局１１，１２，１３によって形成される小無線ゾーン２１，２２，２３においては、同一の周波数群Ｆ１を用いて各無線基地局１１，１２，１３と各移動端末機３１，３２，３３との間で無線通信が行われる。

【００１９】以上、図2を参照して移動体無線通信システムの送信系について説明したが、当該受信系は、送信系と逆の信号処理を行なう装置を用いて同様に構成できる。

【００２０】ところで、より多くの数の移動端末機を１つの無線ゾーン内で収容するためには、無線通信を行なうチャンネル数を増加させる必要がある。そして、チャンネル数を増加させるためには、広帯域な無線帯域が必要であり、そのために必然的に光伝送における副搬送波周波数が高くならざるをえない。例えば、１．５ＧＨｚ帯で4 MHz の帯域を必要とする映像信号をアナログで伝送する場合、必要な帯域を例えば３６ MHz とした場合、１００波の周波数多重では３６００MHz の帯域が必要となり、例えば１．５ＧＨｚ帯に副搬送波周波数を設定することはできない。さらに、副搬送波周波数の数を多くする場合には、マイクロ波からミリ波までの周波数帯を用いる必要がある。例えば、副搬送波周波数としてミリ波の６０ＧＨｚを使用した場合、使用できる帯域が5ＧＨｚ程度とすると、１４０波を伝送することができる。もちろん、信号の狭帯域化技術などを適用した場合には、当該条件が異なってくるが、狭帯域化によってさらに伝送できるチャンネル数を増大させることはいうまでもない。

【００２１】上述のように、各小無線ゾーン２１，２２，２３は従来の無線ゾーンを分割して形成されているので、各小無線ゾーン２１，２２，２３の半径は小さくなり、これによって、各移動端末局の送信出力電力を小さくし、各移動端末局の装置を小型化することができる。

【００２２】本実施例においては、無線制御局1と各無線基地局１１，１２，１３との間の信号伝送路として、光ファイバケーブル９０乃至９２を用いているので、副搬送波周波数はマイクロ波であろうが、ミリ波であろうが、信号の伝送特性が各無線ゾーンで用いる周波数によって影響されず、上述のように、より多くの移動端末機を収容することができるとともに、広帯域信号をも伝送することができるという利点がある。また、当該システムの送信系においては、各無線基地局１１，１２，１３はそれぞれ、光分岐器４１ｃ，４２ｃのほかに少なくとも光電変換器４１ａ，４２ａ，４３ａと電力増幅器４１ｂ，４２ｂ，４３ｂとアンテナ１１ｂ，１２ｂ，１３ｂとを備えるだけでよいので、従来の自動車電話及び携帯電話システムの無線基地局に比較して、装置を小型化することができ、当該各無線基地局装置を例えば電話局の鉄塔などに装備することができるという利点がある。

【００２３】以上の第1の実施例において、各高周波信号を周波数多重化しているが、これに限らず、各高周波信号を時分割多重してもよい。また、各小無線ゾーン２１，２２，２３において、時分割多重化方式を用いて周波数1波に複数の移動端末機を割り当ててもよい。

【００２４】図4は、図1に図示した第1の実施例における無線ゾーンの都市内の実施態様を示す平面図である。図4に示すように、都市内の建物２００間の道路上に各小無線ゾーン２１乃至２８からなる無線ゾーン２０が形成されている。当該各道路下に光ファイバケーブルが敷設されており、複数のポイントで光信号が分岐及び合成されている。無線ゾーン２０の形状は任意に設定することができ、図4はその一例である。

【００２５】＜第2の実施例＞図3は、本発明に係る第２の実施例である移動体無線通信システムのブロック図である。図3に示すように、無線制御局１０１に、光ファイバケーブル９５，９６，９７を介して3つの無線基地局群１１０，１２０，１３０が接続されている。第1の無線基地局群１１０は、周波数群Ｆ１を使用し、５個の小無線ゾーン１１２からなる無線ゾーン１１１を形成している。また、第2の無線基地局群１２０は、周波数群Ｆ１とは異なる周波数群Ｆ２を使用し、６個の小無線ゾーン１２２からなる無線ゾーン１２１を形成している。さらに、第3の無線基地局群１３０は、周波数群Ｆ１，Ｆ２とは異なる周波数群Ｆ３を使用し、５個の小無線ゾーン１３２からなる無線ゾーン１３１を形成している。ここで、各無線基地局群１１０，１２０，１３０に

よって形成される無線ゾーン１１１，１２１，１３１は互いにオーバーラップしないように形成される。

【００２６】なお、各無線ゾーン１１１，１２１，１３１では、それぞれ同一の周波数群を用いているが、干渉上問題がなければ、無線ゾーン１１１と無線ゾーン１３１とにおいて同一の周波数群を用いてもよい。これによって、周波数の有効利用を図り、フレキシブルなネットワークを構築することができる。

【００２７】図5は、図3に図示した第2の実施例における無線ゾーンの都市内の実施態様を示す平面図である。図5に示すように、都市内の建物２００間の道路上に、各小無線ゾーン（図5において図示せず。）からなる無線ゾーン１１１，１２１，１３１，１４１が形成されている。当該各道路下に光ファイバケーブルが敷設されており、複数のポイントで光信号が分岐及び合成されている。ここで、各無線ゾーン１１１，１２１，１３１，１４１は互いに異なる周波数群を用いるが、無線ゾーン１２１と無線ゾーン１３１は電波干渉上問題がなければ同一の周波数群を用いてもよい。

【００２８】＜第3の実施例＞図6は、本発明に係る第3の実施例である移動体無線通信システムのブロック図である。この第3の実施例は、本発明に係る移動体無線通信システムを4階建てのビル３００の各階のフロアに適用した場合である。

【００２９】図6に示すように、当該ビル３００の1階に無線基地局群３０１と光分岐合成器３１１とを設け、その2階に無線基地局群３０２と光分岐合成器３１２とを設け、その3階に無線基地局群３０３と光分岐合成器３１３とを設け、その4階に無線基地局群３０４を設ける。例えば、送信系においては、無線制御局1から出力される光信号は光ファイバケーブル３２１を介して1階の光分岐合成器3１１に伝送され、光分岐合成器3１１は伝送された光信号の一部を分岐して、光ファイバケーブル３３１を介して無線基地局群３０１に伝送する一方、上記伝送された光信号を光ファイバケーブル３２２を介して2階の光分岐合成器3１２に伝送する。ここで、光分岐合成器3１２は伝送された光信号の一部を分岐して、光ファイバケーブル３３２を介して無線基地局群３０２に伝送する一方、上記伝送された光信号を光ファイバケーブル３２３を介して3階の光分岐合成器3１３に伝送する。さらに、光分岐合成器3１３は伝送された光信号の一部を分岐して、光ファイバケーブル３３３を介して無線基地局群3０３に伝送する一方、上記伝送された光信号を光ファイバケーブル３２４を介して4階の無線基地局群３０４に伝送する。

【００３０】一方、受信系では、各基地局群３０１乃至３０４から出力される光信号は、光ファイバケーブル３３１乃至3３３，３２１乃至３２４と、光分岐合成器3１１乃至3１３とを介して無線制御局1に伝送される。この場合、先の送信系とは逆の信号処理が行われる。

【００３１】なお、各無線基地局群３０１乃至３０４は同一の周波数群Ｆ１を用いているが、電波干渉上問題があれば、図7に示すように、互いに隣接する階の無線基地局群の使用する周波数群を異ならせるようにしてもよい。図7の変形例においては、1階の無線基地局群４０１と3階の無線基地局群４０３はそれぞれ同一の周波数群Ｆ１を用い、一方、2階の無線基地局群４０２と4階の無線基地局群４０４はそれぞれ同一の周波数群Ｆ２を用いる。例えば、送信系においては、無線制御局１０１から出力される光信号は光ファイバケーブル４２１を介して1階の光分岐合成器４１１に伝送され、光分岐合成器4１１は伝送された光信号の一部を分岐して、光ファイバケーブル４２３を介して無線基地局群４０１に伝送する一方、上記伝送された光信号を光ファイバケーブル４２２を介して3階の無線基地局群４０３に伝送する。また、無線制御局１０１から出力される別の光信号は光ファイバケーブル４３１を介して2階の光分岐合成器4１２に伝送され、光分岐合成器４１２は伝送された光信号の一部を分岐して、光ファイバケーブル４３３を介して無線基地局群４０２に伝送する一方、上記伝送された光信号を光ファイバケーブル４３２を介して4階の無線基地局群４０４に伝送する。

【００３２】以上説明したように、各無線基地局群の装置は小型化することができるので、本発明に係る移動体無線通信システムを用いて建物内のネットワークを容易に構築することができるという利点がある。

【００３３】図8は、本発明に係る移動体無線通信システムを自動車電話システムに適用したときのブロック図である。図8に示すように、無線制御局５１０は、光ファイバケーブル５５１，５５２，５５３を介してそれぞれ無線基地局群５１１，５１２，５１３に接続され、ここで、各無線基地局群５１１，５１２，５１３はそれぞれ互いに異なる周波数群Ｆ１，Ｆ２，Ｆ３を用いて移動端末局と無線通信を行なう。一方、無線制御局５１０は、公知の通り自動車電話交換局５３０を介して固定電話網５４０に接続される。また、無線制御局５２０は、光ファイバケーブル５６１，５６２，５６３を介してそれぞれ無線基地局群５２１，５２２，５２３に接続され、ここで、各無線基地局群５２１，５２２，５２３はそれぞれ互いに異なる周波数群Ｆ１，Ｆ２，Ｆ３を用いて移動端末局と無線通信を行なう。一方、無線制御局５２０は、公知の通り自動車電話交換局５３０を介して固定電話網５４０に接続される。固定電話網５４０にはさらに、他の地域の自動車電話交換局が接続され、広範囲な通信ネットワークを形成する。

【００３４】

【発明の効果】以上詳述したように本発明によれば、無線制御局と各無線基地局とを光伝送路を介して接続し、上記無線制御局は、各無線基地局で用いる複数の無線周波数の信号を情報信号で変調した各変調信号を多重化し

た後光信号に電光変換して、上記光伝送路を介して上記各無線基地局に伝送し、上記各基地局は上記伝送された光信号を光電変換して無線信号として各移動端末局に放射する移動体無線通信システムであって、上記各無線基地局によってそれぞれ互いに重ならない小無線ゾーンを形成し、上記各小無線ゾーンによって1 つの無線ゾーンを形成し、上記各小無線ゾーンにおいて上記各無線基地局と上記各移動端末機との間で複数の周波数からなる同一の周波数群の無線信号を用いて無線通信を行なう。

【００３５】従って、上記無線制御局と上記各無線基地局との間の信号伝送路として、光伝送路を用いているので、副搬送波周波数はマイクロ波であろうが、ミリ波であろうが、信号の伝送特性が各無線ゾーンで用いる周波数によって影響されず、より多くの移動端末機を収容することができるとともに、広帯域信号をも伝送することができる。また、当該システムにおいては、各無線基地局はそれぞれ、例えば光分岐合成器のほかに、少なくとも光電変換器と電光変換器と送信用電力増幅器と受信用増幅器とアンテナとを備えるだけでよいので、従来の自動車電話及び携帯電話システムの無線基地局に比較して、装置を小型化することができ、当該各無線基地局装置を例えば電話局の鉄塔、電柱、信号機、建物内の天井などに装備することができる。さらに、上記各小無線ゾーンは従来の無線ゾーンよりも小さく形成されているので、各小無線ゾーンの半径は小さくなり、これによって、各移動端末局の送信出力電力を小さくし、各移動端末局の装置を小型化することができるという利点がある。

【図面の簡単な説明】

【図1】　本発明に係る第1 の実施例である移動体無線通信システムのブロック図である。

【図2】　図1 に図示した移動体無線通信システムの送信系のブロック図である。

【図3】　本発明に係る第2 の実施例である移動体無線通信システムのブロック図である。

【図4】　図1 に図示した第1 の実施例における無線ゾーンの都市内の実施態様を示す平面図である。

【図5】　図3 に図示した第2 の実施例における無線ゾーンの都市内の実施態様を示す平面図である。

【図6】　本発明に係る第3 の実施例である移動体無線通信システムのブロック図である。

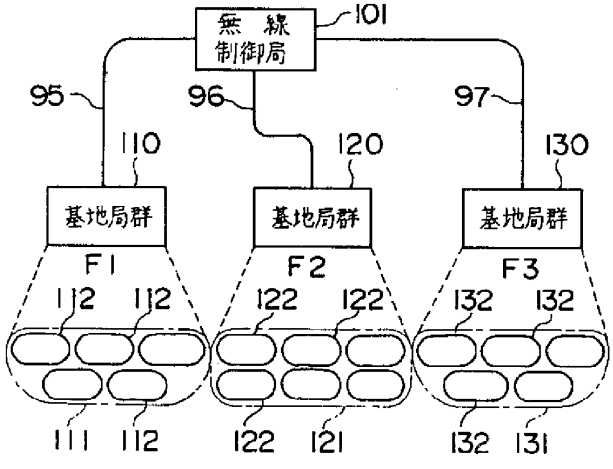
【図7】　図6 に図示した第3 の実施例の変形例を示すブロック図である。

【図8】　本発明に係る移動体無線通信システムを自動車電話システムに適用したときのブロック図である。

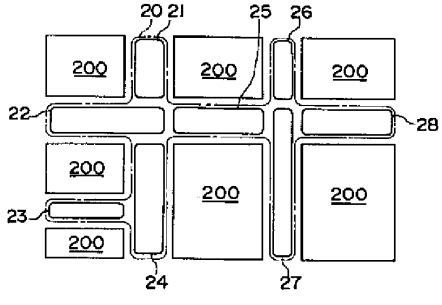
【符号の説明】

１，１０１…無線制御局、
１０…無線基地局群、
１１，１２，１３…無線基地局、
１１ａ，１２ａ，１３ａ…無線機、
１１ｂ，１２ｂ，１３ｂ…アンテナ、
１１ｃ，１２ｃ…光分岐合成器、
２０，１１１，１２１，１３１…無線ゾーン、
２１，２２，２３，１１２，１２２，１３２…小無線ゾーン、
３１，３２，３３…移動端末機、
４１ａ，４２ａ，４３ａ…光電変換器、
４１ｂ，４２ｂ，４３ｂ…電力増幅器、
４１ｃ，４２ｃ…光分岐器、
５０ａ，５０ｂ，５０ｃ…ＦＭ変調器、
５２…合成器、
５３…レーザダイオード、
９０乃至９７…光ファイバケーブル、
１１０，１２０，１３０…無線基地局群。

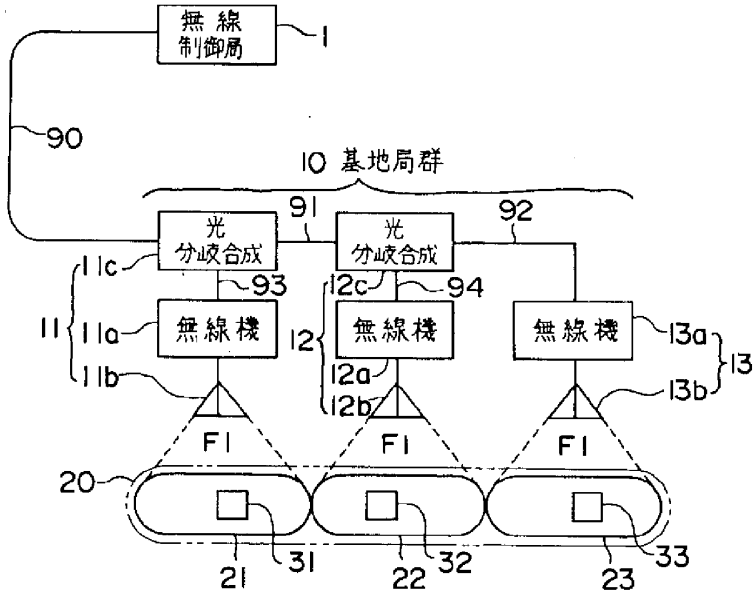
【図3】



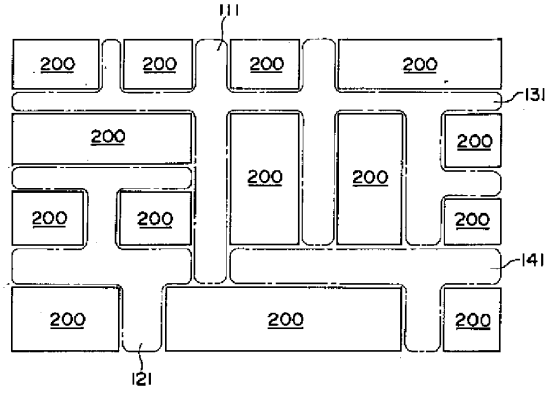
【図4】



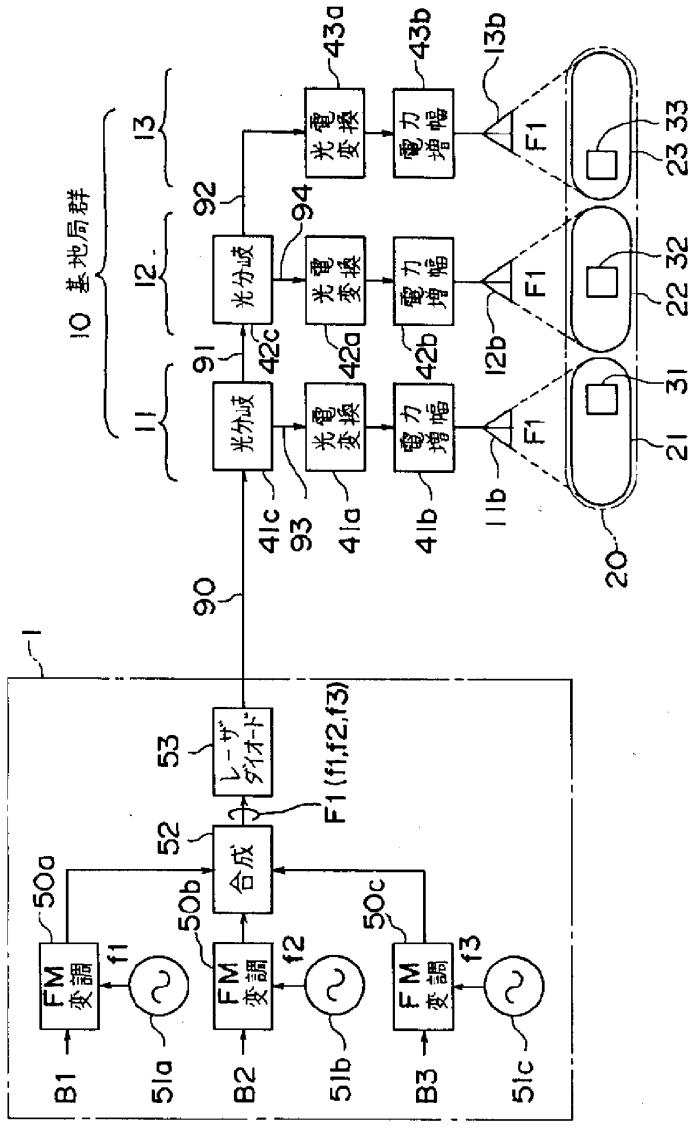
【 図1 】


無 線
制御局
1
90
10 基地局群
91
92
光
分岐合成
光
分岐合成
11c
93
12c
94
11
11a
無線機
12
無線機
無線機
13a
13
11b
12a
12b
13b
F1
F1
F1
20
21
31
22
32
23
33

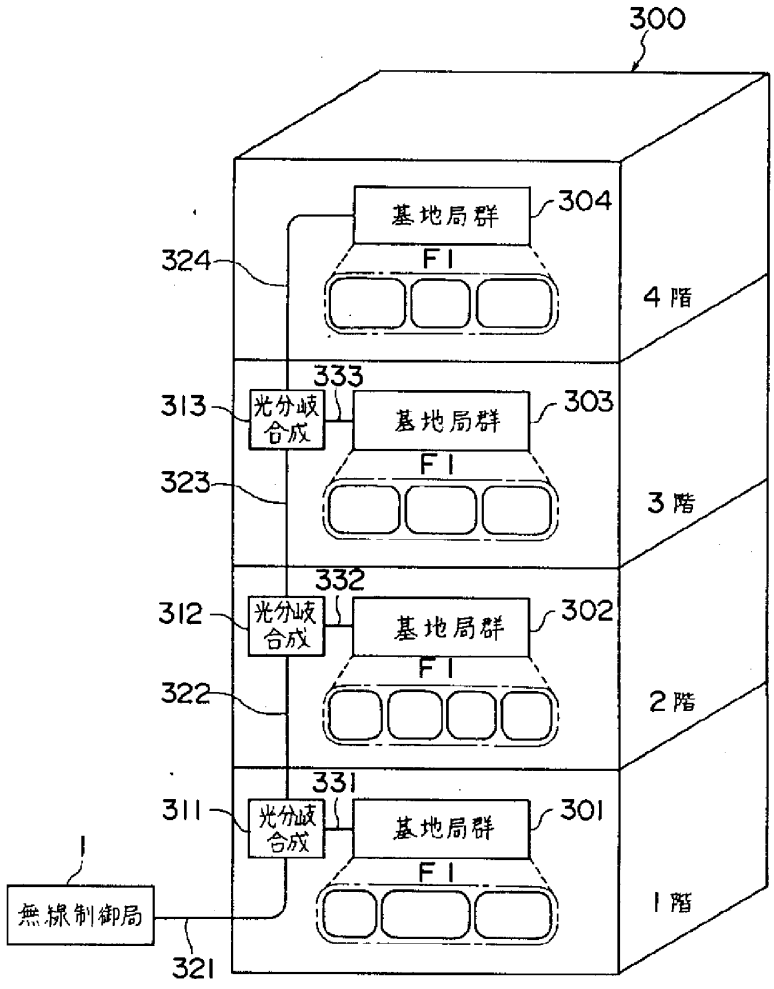
【 図5 】


111
200
200
200
200
131
200
200
200
200
200
200
200
200
141
200
200
200
121

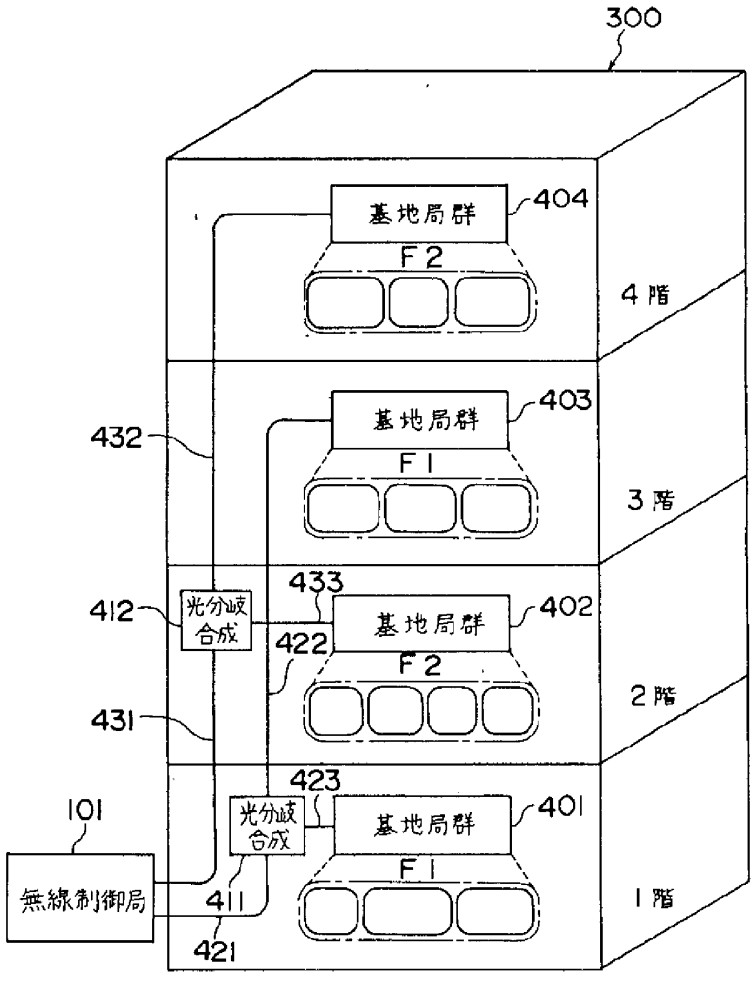
【 図2 】


10 基地局群
11
12
13
1
20
21
22
23
31
32
33
42a
42b
42c
43a
43b
50a
50b
50c
51a
51b
51c
52
53
90
91
92
93
94
41a
41b
41c
11b
12b
13b
F1
F1 (f1,f2,f3)
f1
f2
f3
B1
B2
B3
FM 変調
合成
光分岐
光電変換
電力増幅
レーザダイオード

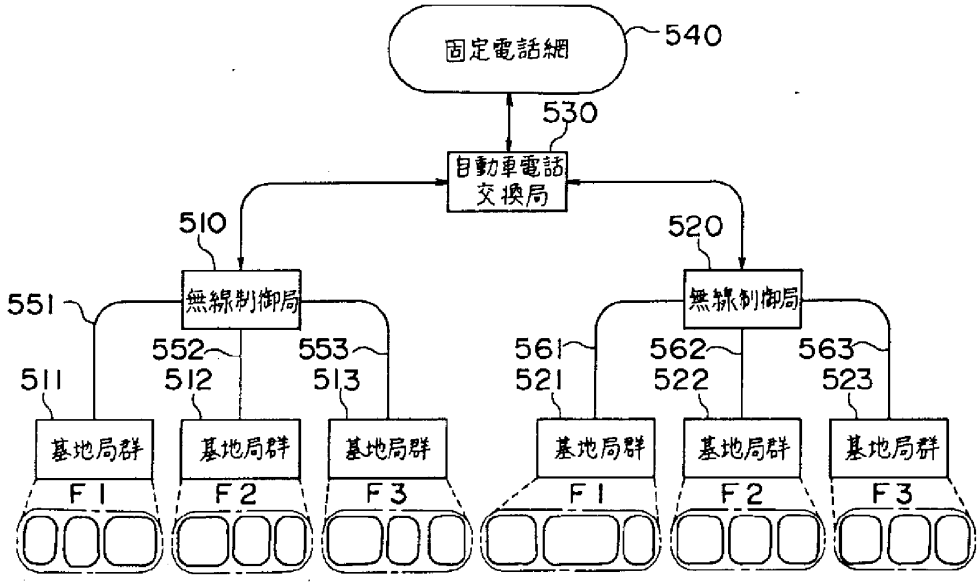
【 図6 】


300
基地局群
304
F I
324
4 階
333
光分岐合成
313
基地局群
303
F I
323
3 階
332
光分岐合成
312
基地局群
302
F I
322
2 階
331
光分岐合成
311
基地局群
301
F I
1 階
1
無線制御局
321

【 図7 】


300
基地局群
404
F 2
4 階
基地局群
403
F 1
3 階
432
412
光分岐
合成
433
422
基地局群
402
F 2
2 階
431
423
101
光分岐
合成
基地局群
401
F 1
無線制御局
411
421
1 階

【 図8 】


固定電話網
540
530
自動車電話
交換局
510
520
無線制御局
無線制御局
551
552
553
561
562
563
511
512
513
521
522
523
基地局群
基地局群
基地局群
基地局群
基地局群
基地局群
F 1
F 2
F 3
F 1
F 2
F 3

JP1993-136724,A

* NOTICES *
JPO and INPIT are not responsible for any
damages caused by the use of this translation.
1.This document has been translated by computer. So the translation may not
reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1]Connect via an optical transmission path and a radio control station and each base transceiver station the above-mentioned radio control station, Current to light transference is carried out to a crepuscular-rays signal which multiplexed each modulating signal which modulated a signal of a plurality of radio frequencies used in each base transceiver station with an information signal, It is a mobile body wireless communication system which transmits to each above-mentioned base transceiver station via the above-mentioned optical transmission path, and each above-mentioned base station carries out photoelectric conversion of the lightwave signal transmitted [above-mentioned], makes it a radio signal, and it emits to each moving terminal office, A small wireless zone with which it does not lap each other by each above-mentioned base transceiver station, respectively is formed, A mobile body wireless communication system forming one wireless zone and performing a wireless communication using a radio signal of the same frequency group which consists of a plurality of frequency in each above-mentioned small wireless zone between each above-mentioned base transceiver station and each above-mentioned moving terminal machine by each above-mentioned small wireless zone.

[Claim 2]Have multiple wireless base chain of stationses which consists of a plurality of above-mentioned base transceiver stations, and by each above-mentioned base transceiver station group, respectively, The mobile body wireless communication system according to claim 1 forming a wireless zone with which it does not lap each other, and performing a wireless communication using a radio signal of each other different frequency group in each above-mentioned wireless zone, respectively.

DETAILED DESCRIPTION

T-Mobile Ex. 1037

[Detailed Description of the Invention]

[0001]

[Industrial Application]The present invention relates to mobile body wireless communication systems, such as an automobile telephone system, a portable telephone system, and a personal communication system.

[0002]

[Description of the Prior Art]In mobile body wireless communication systems, such as the conventional car telephone and a portable telephone system, a wireless zone about 5 km in radius was formed in one base transceiver station, and the wireless communication was performed using the frequency band of UHF.

[0003]

[Problem to be solved by the invention]In the composition of such a base transceiver station, while comparatively high transmission output power was required, therefore becoming enlargement of the radio base station apparatus, there was a problem that a manufacturing cost became high. Since it was communicating using the frequency band of UHF, there was a limit also in the zone of the frequency which can be used. Therefore, in the mobile body wireless communication system which stores a huge number of mobile phones etc., it is necessary to expand the frequency band to be used as compared with the former. Since deterioration of transmission output power is expected with the miniaturization of a cellular phone, it is necessary to make small substantially distance between a base transceiver station and moving terminal machines, such as a cellular phone.

[0004]It is in the object of this invention solving the above problem, forming a smaller wireless zone as compared with the former, and providing the mobile body wireless communication system which can store more moving terminal machines.

[0005]

[Means for solving problem]The mobile body wireless communication system according to claim 1 concerning the present invention, Connect via an optical transmission path and a radio control station and each base transceiver station the above-mentioned radio control station, Current to light transference is carried out to the crepuscular-rays signal which multiplexed each modulating signal which modulated the signal of a plurality of radio frequencies used in each base transceiver station with the information signal, It is a mobile body wireless communication system which transmits to each above-mentioned base transceiver station via the above-mentioned optical transmission path, and each above-mentioned base station carries out photoelectric conversion of the lightwave signal transmitted [above-mentioned], makes it a radio signal, and it emits to each moving

terminal office, The small wireless zone with which it does not lap each other by each above-mentioned base transceiver station, respectively is formed, One wireless zone is formed and a wireless communication is performed using the radio signal of the same frequency group which consists of a plurality of frequency in each above-mentioned small wireless zone between each above-mentioned base transceiver station and each above-mentioned moving terminal machine by each above-mentioned small wireless zone.

[0006]The mobile body wireless communication system according to claim 2, The mobile body wireless communication system according to claim 1 is provided with multiple wireless base chain of stationses which consists of a plurality of above-mentioned base transceiver stations, By each above-mentioned base transceiver station group, the wireless zone with which it does not lap each other is formed, respectively, and a wireless communication is performed using the radio signal of each other different frequency group in each above-mentioned wireless zone, respectively.

[0007]

[Function]In a conventional car telephone and portable telephone system, The frequency band of 800 thru/or 900 MHz bands was used, the same frequency group was repeated and used in each each other distant wireless zone using each other different frequency group for prevention of interference, and the publicly known passage was improving the utilization efficiency of frequency in the adjoining wireless zone. On the other hand in the present invention, the building or road which consist of concretes etc., for example do not reflect the electric wave of a millimeter wave, The same frequency group F1 is repeated and used in the small wireless zone (for example, 21, 22, 23 in Fig.1) formed so that it may be placed in one wireless zone (for example, 20 in Fig.1), it may be divided paying attention to having the characteristic of absorbing rather and it may adjoin each other. In "reflection property experiment of building interior material in millimeter wave belt" Institute of Electronics, Information and Communication Engineers technical report [besides Jun Awaka], and AP April, 1-1990 [90-], the absorption feature of this millimeter wave has been reported, for example.

[0008]In the mobile body wireless communication system according to claim 1, probably subcarrier frequency is microwave, since the optical transmission path is used as a signal transmission line between the above-mentioned radio control station and each above-mentioned base transceiver station, but. Although it is a millimeter wave, while not being influenced with the frequency which the transmission characteristic of a signal uses in each wireless zone but being able to store more moving terminal machines, broadband signals, such as a TV signal, can also be transmitted. In the system concerned, since each base transceiver station should just be provided with a photoelectric converter,

a current-to-light-transference machine, the power amplifier for transmission, the low noise amplifier for reception, and antenna for example, other than a light branching composing device at least, respectively, As compared with the conventional car telephone and the base transceiver station of a portable telephone system, equipment can be miniaturized and the steel tower of a telephone office, etc. can be equipped with each radio base station apparatus concerned.

[0009]In the mobile body wireless communication system according to claim 2, Preferably the mobile body wireless communication system according to claim 1, It has multiple wireless base chain of stationses which consists of a plurality of above-mentioned base transceiver stations, and by each above-mentioned base transceiver station group, the wireless zone with which it does not lap each other is formed, respectively, and a wireless communication is performed using the radio signal of each other different frequency group in each above-mentioned wireless zone, respectively. The service area of the system concerned can be increased by this.

[0010]

[Working example]Hereinafter, it describes about the working example which starts the present invention with reference to Drawings.

[0011]<First working-example>Fig.1 is a block diagram of the mobile body wireless communication system which is a first working example concerning the present invention.

[0012]The mobile body wireless communication system of this first working example, The small wireless zones 21, 22, and 23 which adjoin each other by each base transceiver station 11, 12, and 13, respectively are formed, By one certain wireless base chain of stations 10 which corresponds to one base transceiver station in the conventional automobile telephone system, and comprises the three base transceiver stations 11, 12, and 13, Form the one wireless zone 20 and it uses the same frequency group F1 which consists of a plurality of frequency of a millimeter wave belt in each small wireless zone 21, 22, and 23, The radio control station 1 connected to the exchange station of the mobile body wireless communication system concerned is characterized by being connected to each base transceiver station 11, 12, and 13 via the fiber optic cables 90 thru/or 92. In the Drawings of this application, a wireless zone is shown using a dash-dotted line, and the solid line shows the small wireless zone which divided the wireless zone concerned. In this example, the radii of each small wireless zone 21, 22, and 23 are 100 m thru/or about 200m, and the radii of the wireless zone 20 of this example corresponding to the conventional car telephone and the wireless zone of a portable telephone system are 1.5 km thru/or about 5 km.

[0013]As shown in Fig. 1, the base transceiver station 11 is provided with the walkie-talkie 11a, the antenna 11b, and the light branching composing device 11c, and the base transceiver station 12, It has the walkie-talkie 12a, the antenna 12b, and the light branching composing device 12c, and the base transceiver station 13 is further provided with the walkie-talkie 13a, the antenna 13b, and the light branching composing device 13c. Here, the walkie-talkies 11a, 12a, and 13a are provided with a photoelectric converter, a current-to-light-transference machine, the power amplifier for transmission, and the amplifier for reception at least.

[0014]In the radio control station 1, it is transmitted from each walkie-talkie 11a, 12a, and 13a of each base transceiver station 11, 12, and 13, Each high frequency signal by which has a radio frequency and FM modulation was carried out with call signals frequency-multiplexing-izes, it synthesizes, current to light transference of the synthesized multiplexed signal is carried out to make a lightwave signal, and the lightwave signal concerned is transmitted to the light branching composing device 11c of the base transceiver station 11 via the fiber optic cable 90. While the light branching composing device 11c branches and outputs a part of transmitted lightwave signal to the walkie-talkie 11a via the fiber optic cable 93, it transmits the lightwave signal transmitted [above-mentioned] via the fiber optic cable 91 to the light branching composing device 12c of the base transceiver station 12. While the light branching composing device 12c branches and outputs a part of transmitted lightwave signal to the walkie-talkie 12a via the fiber optic cable 94, it transmits the lightwave signal transmitted [above-mentioned] to the walkie-talkie 13a of the base transceiver station 13 via the fiber optic cable 92. After carrying out photoelectric conversion of the lightwave signal transmitted, respectively to each original high frequency signal of frequency group F1, carry out power amplification of each walkie-talkie 11a, 12a, and 13a, and from the antennas 11b, 12b, and 13b, Although it adjoins each other, it emanates towards each moving terminal machine 31, 32, and 33 in the predetermined small wireless zones 21, 22, and 23 which are not overlapped. On the other hand, each high frequency signal emitted from each moving terminal machine 31, 32, and 33, It is received by the walkie-talkies 11a, 12a, and 13a via the antennas 11b, 12b, and 13b of each base transceiver station 11, 12, and 13, Contrary to the signal path of a previous transmission system, it is transmitted to the radio control station 1 via the light branching composing devices 11c and 12c and the fiber optic cables 90 thru/or 92 from each base transceiver station 11, 12, and 13. In this case, while performing current-to-light-transference processing in the walkie-talkies 11a, 12a, and 13a, signal processing contrary to a transmission system, such as performing photoelectric converting in the

radio control station 1, is performed.

[0015]Fig.2 is a specific block diagram of the transmission system of the mobile body wireless communication system illustrated to Fig.1. Here, in the small wireless zones 21, 22, and 23 which each base transceiver station 11, 12, and 13 of the wireless base chain of stations 10 concerned forms, frequency group F1 which consists of the three frequency f1, f2, and f3 of a millimeter wave belt is used, for example. For example, the frequency in a receiving system shifted only predetermined frequency from the frequency f1, f2, and f3, respectively, for example, the frequency of a millimeter wave belt is used for it.

[0016]As shown in Fig.2, in the radio control station 1, each baseband signal B1 which is call signals, B-2, and B3 are input into each FM modulator 50a, 50b, and 50c, respectively. According to the baseband signal into which the carrier signal of the frequency f1 which occurred with the carrier wave signal generator 51a was input, FM modulation of FM modulator 50a is carried out, and it outputs the FM modulation signal concerned to the composing device 52. According to the baseband signal into which the carrier signal of the frequency f2 which occurred with the carrier wave signal generator 51b was input, FM modulation of FM modulator 50b is carried out, and it outputs the FM modulation signal concerned to the composing device 52. According to the baseband signal into which the carrier signal of the frequency f3 which occurred with the carrier wave signal generator 51c was input, FM modulation of FM modulator 50c is carried out, and it outputs the FM modulation signal concerned to the composing device 52. After the composing device 52 frequency-multiplexing-izes three input FM modulation signals each and synthesizes them, it outputs the multiplexed signal of frequency group F1 to the laser diode 53 which is a current-to-light-transference element. The laser diode 53 transmits the lightwave signal concerned to the light branching machine 41c of the base transceiver station 11 via the fiber optic cable 90, after carrying out current to light transference of the input multiplexed signal to a lightwave signal.

[0017]The light branching machine 41c transmits the lightwave signal transmitted [above-mentioned] to the light branching machine 42c of the base transceiver station 12 via the fiber optic cable 91 while it branches, for example, outputs a part of transmitted lightwave signal to the photoelectric converter 41a which consists of a photo-diode. Subsequently, the light branching machine 42c transmits the lightwave signal transmitted [above-mentioned] to the photoelectric converter 43a of the base transceiver station 13 via the fiber optic cable 92 while it branches and outputs a part of transmitted lightwave signal to the photoelectric converter 42a.

[0018]In the base transceiver station 11, the photoelectric converter 41a converts the input lightwave signal to the original multiplexed signal, It emanates in the small

wireless zone 21 via the power amplifier 41b and the antenna 11b, the emitted multiplexed signal is received by the moving terminal machine 31, for example, the moving terminal machine 31 was specified in the predetermined procedure among the multiplexed signals concerned, the high frequency signal of the frequency f1 is taken out selectively, and it receives it. Like the base transceiver station 11, the base transceiver station 12 is provided with the light branching machine 42c, the photoelectric converter 42a, the power amplifier 42b, and the antenna 12b, and operates in a similar manner. Like the base transceiver station 11, the base transceiver station 13 is provided with the photoelectric converter 43a, the power amplifier 43b, and the antenna 13b, and operates in a similar manner. Here, in the small wireless zones 21, 22, and 23 formed by each base transceiver station 11, 12, and 13, a wireless communication is performed using the same frequency group F1 between each base transceiver station 11, 12, and 13 and each moving terminal machine 31, 32, and 33.

[0019]As mentioned above, although described about the transmission system of the mobile body wireless communication system with reference to Fig.2, the receiving system concerned can be similarly constituted using the equipment which performs signal processing contrary to a transmission system.

[0020]By the way, in order to store the moving terminal machine of more numbers in one wireless zone, it is necessary to make the number of channels which performs a wireless communication increase. And in order to make the number of channels increase, the subcarrier frequency in optical transmission cannot but be [a wireless broadband zone] highly necessary [it] therefore inevitably. For example, when the video signal which needs a 4-MHz zone with 1.5 GHz bands is transmitted analogically and a required zone is 36 MHz, in the frequency multiplexing of 100 waves, a 3600-MHz zone is needed and it cannot set subcarrier frequency, for example to 1.5 GHz bands. To increase the number of subcarrier frequency, it is necessary to use the frequency band from microwave to a millimeter wave. For example, 140 waves can be transmitted, if the zone which can be used sets to about 5 GHz when 60 GHz of a millimeter wave is used as subcarrier frequency. Of course, when the narrow-band-ized technology of a signal, etc. are applied, the conditions concerned differ, but it cannot be overemphasized that the number of channels which can further be transmitted by narrow-band-ization is increased.

[0021]As mentioned above, since each small wireless zone 21, 22, and 23 divides the conventional wireless zone and is formed, the radius of each small wireless zone 21, 22, and 23 becomes small, by this, can make small transmission output power of each moving terminal office, and can miniaturize the equipment of each moving terminal office.

[0022]In this example, probably subcarrier frequency is microwave, since the fiber optic cables 90 thru/or 92 are used as a signal transmission line between the radio control station 1 and each base transceiver station 11, 12, and 13, but. Although it is a millimeter wave, while not being influenced with the frequency which the transmission characteristic of a signal uses in each wireless zone but being able to store above more many moving terminal machines, there is an advantage that a broadband signal can also be transmitted. In the transmission system of the system concerned, each base transceiver station 11, 12, and 13, respectively, Since what is necessary is just to have the photoelectric converters 41a, 42a, and 43a, the power amplifiers 41b, 42b, and 43b, and the antennas 11b, 12b, and 13b other than the light branching machines 41c and 42c at least, As compared with the conventional car telephone and the base transceiver station of a portable telephone system, equipment can be miniaturized and there is an advantage that the steel tower of a telephone office, etc. can be equipped with each radio base station apparatus concerned.

[0023]In the above first working example, although each high frequency signal is frequency-multiplexing-ized, Time Division Multiplexing not only of this but each high frequency signal may be carried out. In each small wireless zone 21, 22, and 23, a plurality of moving terminal machines may be assigned to frequency 1 wave using a time-division multiplex system.

[0024]Fig.4 is a plan view showing the embodiment in the city of the wireless zone in the first working example illustrated to Fig.1. As shown in Fig.4, the wireless zone 20 which consists of each small wireless zone 21 thru/or 28 is formed on the road between the buildings 200 in a city. The fiber optic cable is laid under each road concerned, and the lightwave signal is branched and synthesized on a plurality of points. The form of the wireless zone 20 can be set up arbitrarily and Fig.4 is the example.

[0025]<Second working-example>Fig.3 is a block diagram of the mobile body wireless communication system which is a second working example concerning the present invention. As shown in Fig.3, the three wireless base chain of stationses 110,120,130 are connected to the radio control station 101 via the fiber optic cables 95, 96, and 97. The first wireless base chain of stations 110 uses frequency group F1, and forms the wireless zone 111 which consists of the five small wireless zones 112. Using the different frequency group F2 from frequency group F1, the second wireless base chain of stations 120 forms the wireless zone 121 which consists of the six small wireless zones 122. Using frequency group F1 and the different frequency group F3 from F2, the 3rd wireless base chain of stations 130 forms the wireless zone 131 which consists of the five small wireless zones 132. Here, the wireless zone 111,121,131 formed by each base transceiver station

group 110,120,130 is formed so that it may not overlap each other.

[0026]Although the respectively same frequency group is used in each wireless zone 111,121,131, as long as there is no interference top problem, the same frequency group may be used in the wireless zone 111 and the wireless zone 131. By this, effective use of frequency can be aimed at and a flexible network can be built.

[0027]Fig.5 is a plan view showing the embodiment in the city of the wireless zone in the second working example illustrated to Fig.3. As shown in Fig.5, the wireless zone 111,121,131,141 which consists of each small wireless zone (not shown in Fig.5) is formed on the road between the buildings 200 in a city. The fiber optic cable is laid under each road concerned, and the lightwave signal is branched and synthesized on a plurality of points. Here, although each wireless zone 111,121,131,141 uses each other different frequency groups, as long as the wireless zone 121 and the wireless zone 131 do not have a radio-wave-interference top problem, they may use the same frequency group.

[0028]The <3rd working-example>Fig.6 is a block diagram of the mobile body wireless communication system which is the 3rd working example concerning the present invention. This 3rd working example is a case where the mobile body wireless communication system concerning the present invention is applied to the floor of each story of the building 300 of 4 stories.

[0029]As shown in Fig.6, the wireless base chain of stations 301 and the light branching composing device 311 are provided on the first floor of the building 300 concerned, the wireless base chain of stations 302 and the light branching composing device 312 are provided on the second floor of the, the wireless base chain of stations 303 and the light branching composing device 313 are provided on the third floor of the, and the wireless base chain of stations 304 is provided on the fourth floor of the. For example, in a transmission system, the lightwave signal outputted from the radio control station 1 is transmitted to the light branching composing device 311 of the first floor via the fiber optic cable 321, and the light branching composing device 311 branches in a part of transmitted lightwave signal, While transmitting to the wireless base chain of stations 301 via the fiber optic cable 331, the lightwave signal transmitted [above-mentioned] is transmitted to the light branching composing device 312 of the second floor via the fiber optic cable 322. Here, while the light branching composing device 312 branches and transmits a part of transmitted lightwave signal to the wireless base chain of stations 302 via the fiber optic cable 332, it transmits the lightwave signal transmitted [above-mentioned] to the light branching composing device 313 of the third floor via the fiber optic cable 323. While the light branching composing device 313 branches and transmits a part of transmitted lightwave signal to the wireless base chain of stations 303 via the

fiber optic cable 333, it transmits the lightwave signal transmitted [above-mentioned] to the wireless base chain of stations 304 of the fourth floor via the fiber optic cable 324.

[0030]On the other hand, in a receiving system, the lightwave signal outputted from each base station group 301 thru/or 304 is transmitted to the radio control station 1 via the fiber optic cable 331 thru/or 333,321 thru/or 324, and the light branching composing devices 311 thru/or 313. In this case, signal processing contrary to a previous transmission system is performed.

[0031]As long as there is a radio-wave-interference top problem, it may be made to change the frequency group which the wireless base chain of stations of the story which adjoins each other uses, as shown in Fig.7 although each base transceiver station group 301 thru/or 304 uses the same frequency group F1. On the other hand in the modification of Fig.7, the wireless base chain of stations 401 of the first floor and the wireless base chain of stations 403 of the third floor use the frequency group F2 with the wireless base chain of stations 402 of the second floor, and the respectively the same wireless base chain of stations 404 of the fourth floor using respectively same frequency group F1. For example, in a transmission system, the lightwave signal outputted from the radio control station 101 is transmitted to the light branching composing device 411 of the first floor via the fiber optic cable 421, and the light branching composing device 411 branches in a part of transmitted lightwave signal, While transmitting to the wireless base chain of stations 401 via the fiber optic cable 423, the lightwave signal transmitted [above-mentioned] is transmitted to the wireless base chain of stations 403 of the third floor via the fiber optic cable 422. Another lightwave signal outputted from the radio control station 101 is transmitted to the light branching composing device 412 of the second floor via the fiber optic cable 431, and the light branching composing device 412 branches in a part of transmitted lightwave signal, While transmitting to the wireless base chain of stations 402 via the fiber optic cable 433, the lightwave signal transmitted [above-mentioned] is transmitted to the wireless base chain of stations 404 of the fourth floor via the fiber optic cable 432.

[0032]As described above, since the equipment of each base transceiver station group can be miniaturized, there is an advantage that the network in a building can be easily built using the mobile body wireless communication system concerning the present invention.

[0033]Fig.8 is a block diagram when the mobile body wireless communication system concerning the present invention is applied to an automobile telephone system. As shown in Fig.8, the radio control station 510 is connected to the wireless base chain of stations 511,512,513 via the fiber optic cable 551,552,553, and, respectively here, Each base

transceiver station group 511,512,513 performs a moving terminal office and a wireless communication using frequency group F1 each other different, respectively, and F2 and F3. On the other hand, as for a publicly known passage, the radio control station 510 is connected to the fixed-line telephone network 540 via the automobile exchange office 530. The radio control station 520 is connected to the wireless base chain of stations 521,522,523 via the fiber optic cable 561,562,563, and, respectively here, Each base transceiver station group 521,522,523 performs a moving terminal office and a wireless communication using frequency group F1 each other different, respectively, and F2 and F3. On the other hand, as for a publicly known passage, the radio control station 520 is connected to the fixed-line telephone network 540 via the automobile exchange office 530. The automobile exchange office of the area of further others is connected to the fixed-line telephone network 540, and a wide range communication network is formed.

[0034]

[Effect of the Invention]According to the present invention, as explained in full detail above, connect via an optical transmission path, and a radio control station and each base transceiver station the above-mentioned radio control station, Current to light transference is carried out to the crepuscular-rays signal which multiplexed each modulating signal which modulated the signal of a plurality of radio frequencies used in each base transceiver station with the information signal, It is a mobile body wireless communication system which transmits to each above-mentioned base transceiver station via the above-mentioned optical transmission path, and each above-mentioned base station carries out photoelectric conversion of the lightwave signal transmitted [above-mentioned], makes it a radio signal, and it emits to each moving terminal office, The small wireless zone with which it does not lap each other by each above-mentioned base transceiver station, respectively is formed, One wireless zone is formed and a wireless communication is performed using the radio signal of the same frequency group which consists of a plurality of frequency in each above-mentioned small wireless zone between each above-mentioned base transceiver station and each above-mentioned moving terminal machine by each above-mentioned small wireless zone.

[0035]Therefore, probably subcarrier frequency is microwave since the optical transmission path is used as a signal transmission line between the above-mentioned radio control station and each above-mentioned base transceiver station, but. Although it is a millimeter wave, a broadband signal can also be transmitted, while not being influenced with the frequency which the transmission characteristic of a signal uses in each wireless zone but being able to store more moving terminal machines. In the system concerned, since each base transceiver station should just be provided with a

photoelectric converter, a current-to-light-transference machine, the power amplifier for transmission, the amplifier for reception, and antenna for example, other than a light branching composing device at least, respectively, As compared with the conventional car telephone and the base transceiver station of a portable telephone system, equipment can be miniaturized and the ceiling in the steel tower of a telephone office, a telegraph pole, a signal, and a building, etc. can be equipped with each radio base station apparatus concerned. Since each above-mentioned small wireless zone is formed smaller than the conventional wireless zone, the radius of each small wireless zone becomes small, transmission output power of each moving terminal office is made small by this, and there is an advantage that the equipment of each moving terminal office can be miniaturized.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a block diagram of the mobile body wireless communication system which is a first working example concerning the present invention.

[Drawing 2]It is a block diagram of the transmission system of the mobile body wireless communication system illustrated to Fig.1.

[Drawing 3]It is a block diagram of the mobile body wireless communication system which is a second working example concerning the present invention.

[Drawing 4]It is a plan view showing the embodiment in the city of the wireless zone in the first working example illustrated to Fig.1.

[Drawing 5]It is a plan view showing the embodiment in the city of the wireless zone in the second working example illustrated to Fig.3.

[Drawing 6]It is a block diagram of the mobile body wireless communication system which is the 3rd working example concerning the present invention.

[Drawing 7]It is a block diagram showing the modification of the 3rd working example illustrated to Fig.6.

[Drawing 8]It is a block diagram when the mobile body wireless communication system concerning the present invention is applied to an automobile telephone system.

[Explanations of letters or numerals]

1,101 -- Radio control station,

10 -- Wireless base chain of stations,

11, 12, 13 -- Base transceiver station,

11a, 12a, 13a -- Walkie-talkie,

11b, 12b, 13b -- Antenna,

11c, 12c -- Light branching composing device,

20,111,121,131 -- Wireless zone

21, 22, 23,112,122,132 -- Smallness wireless zone,

31, 32, 33 -- Moving terminal machine,

41a, 42a, 43a -- Photoelectric converter,

41b, 42b, 43b -- Power amplifier,

41c, 42c -- Light branching machine,

50a, 50b, 50c -- FM modulator

52 -- Composing device,

53 -- Laser diode,

90 thru/or 97 -- Fiber optic cable

110,120,130 -- Wireless base chain of stations.

Electronic Acknowledgement Receipt	
EFS ID:	30215923
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	29-AUG-2017
Filing Date:	29-JUL-2016
Time Stamp:	16:47:36
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		102440US_IDS.pdf	146085 2cc294a7f6f64d8d5b1650ad4f6e85b251d09601	yes	5

	Multipart Description/PDF files in .zip description		
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2	Foreign Reference	JP04207532A_07291992_NTT.pdf	430395 7f023a02d4edd366390c9bafb61d123af21d1ef3	no	11
Warnings:					
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3	Foreign Reference	JP05136724A_01061993_ATR_Koundenpa.pdf	1678875 1aedfabcedf0cd14275031381d6f9d965d9d31e9	no	25
Warnings:					
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4	Non Patent Literature	NPL_EESR_11818697-2_08172017_7pp.pdf	234656 b1f802d9f0ed0b9dd4c97bffba2d3c0308b22069	no	7
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5	Non Patent Literature	JPOA_08022017_2016-174930.pdf	164145 9dc6e82de7616701f103c7c1fe4eab2a12bb21a3	no	5
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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on August 29, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

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

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

This IDS is being filed after the mailing of the first Office Action on the merits, but before the mailing date of the final Office Action, Notice of Allowance, or any other action that closes prosecution.

I hereby certify under 37 CFR §1.97(e)(1) that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

/Kelvin B. Catmull/

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Registration No. 57,535

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Attachment

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on September 5, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	AMENDMENT
Customer No.: 20350	

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

Commissioner:

In response to the Office Action mailed June 5, 2017 on the above-referenced application, please enter the following amendments and remarks:

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

Amendments to the Claims are reflected in the listing of claims that begins on page 3 of this paper.

Applicant Summary of Interview with the Examiner begins on page 7 of this paper.

Remarks/Arguments begin on page 8 of this paper.

Amendments to the Specification:

Please replace paragraph [0056] with the following amended paragraph:

[0056] The Digital Down Converters present in each of DRU's 125A-k are dynamically software-configured as described previously so that uplink signals of the appropriate desired signal format(s) present at the receive antenna ports of the respective DRU's 125A-125k are selected based on the desired uplink band(s) to be processed and filtered, converted and transported to the appropriate uplink output port of DAU 105. The DAU and DRUs frame the individual data packets corresponding to their respective radio signature using the Common Public Radio Interface ~~Standard~~ (CPRI) standard. Other Interface standards are applicable provided they uniquely identify data packets with respective DRUs. Header information is transmitted along with the data packet which identifies the DRU and DAU that corresponds to the individual data packet.

Amendments to the Claims:

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

Listing of Claims:

1. (Canceled)

2. (Currently Amended) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time; and

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

3. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

4. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in network conditions, to dynamically change from (a) sending

the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

5. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on load balancing, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

6. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in subscriber needs, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

7. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

8. (Previously Presented) The host unit of claim 2, wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface.

9. (Previously Presented) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

10. (Currently Amended) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal in compliance with the Common Public Radio Interface ~~Standard~~ (CPRI) standard.

11. (Currently Amended) A system for transporting wireless communications, comprising:

a host unit;

a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals; and

wherein the host unit is capable of receiving digital signals from each of the plurality of remote units.

12. (Previously Presented) The system of claim 11, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

13. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through a direct connection.

14. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through an indirect connection.

15. (Previously Presented) The system of claim 11, wherein each remote unit comprises at least one interface to communicatively couple the remote unit to another one of the plurality of remote units in a daisy-chain configuration.

16. (Currently Amended) A method for providing digital signals in a Distributed Antenna System (DAS), comprising:

transmitting from a host unit, at a first point in time, a first set of downlink channel signals to a first remote unit;

transmitting from the host unit, at a second point in time, a second set of downlink channel signals to the first remote unit;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

17. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a change in network conditions from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

18. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on load balancing from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

19. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a schedule from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

20. (Previously Presented) The method of claim 16, wherein the downlink channel signals are packetized.

21. (Currently Amended) The method of claim 20, wherein the downlink channel signals are packetized in compliance with the Common Public Radio Interface ~~Standard~~ (CPRI) standard.

APPLICANT SUMMARY OF INTERVIEW WITH THE EXAMINER

The undersigned thanks Examiner Zhao for the helpful telephone interview conducted on August 30, 2017. During the interview, proposed amendments to the claims were discussed. While no specific agreement regarding patentability was reached, the claims in this response have been amended consistent with the proposed amendments discussed during the interview.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 2-21 will be pending in this application. Claims 2, 10-11, 16, and 21 have been amended. No new matter is added.

Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Office Action Summary

The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter.

Claims 2-15 and 21 are objected to for informalities.

Claims 2, 5-6, 8-9, 11-16, 18, and 20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 and 6 of U.S. Patent No. 8,737,300.

Claims 2-4, 8-17, 20, and 21 are rejected under 35 USC 102(b) as being anticipated by Sulzberger (U.S. Publication No. 2005/0152695).

Claims 5, 6, and 18 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger in view of Casanova (U.S. Patent No. 6,657,993).

Claims 7 and 19 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger in view of Zhang (U.S. Publication No. 2010/0238904).

Objections to Specification

MPEP 2163.07(II) explains that "[an] amendment to correct an obvious error does not constitute new matter where one skilled in the art would not only recognize the existence of error in the specification, but also the appropriate correction." Accordingly, paragraph [0056] of the present application has been amended to correctly identify the acronym CPRI. As stated at pages 2-3 of the Office Action, CPRI is the common acronym for Common Public Radio Interface. No new matter is added.

Objections to Claims

With regard to claims 2 and 9-12, the phrase "capable of" is intended to be equivalent to the phrase "configured to".

With regard to claims 10 and 21, the acronym CPRI has been correctly identified as the Common Public Radio Interface.

Double Patenting Rejections

Applicant acknowledges the double patenting rejections and will determine whether to file a Terminal Disclaimer after overcoming the other rejections in the Office Action.

Rejections Under 35 U.S.C. § 102

Claims 2-10

Claim 2 has been amended to recite:

> "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals."

The above features of amended claim 2 can be illustrated with reference to the exemplary embodiment shown in FIG. 1 of the present application reproduced below. Note that FIG. 1 is used herein for illustrative purposes only and is not intended to be limiting.

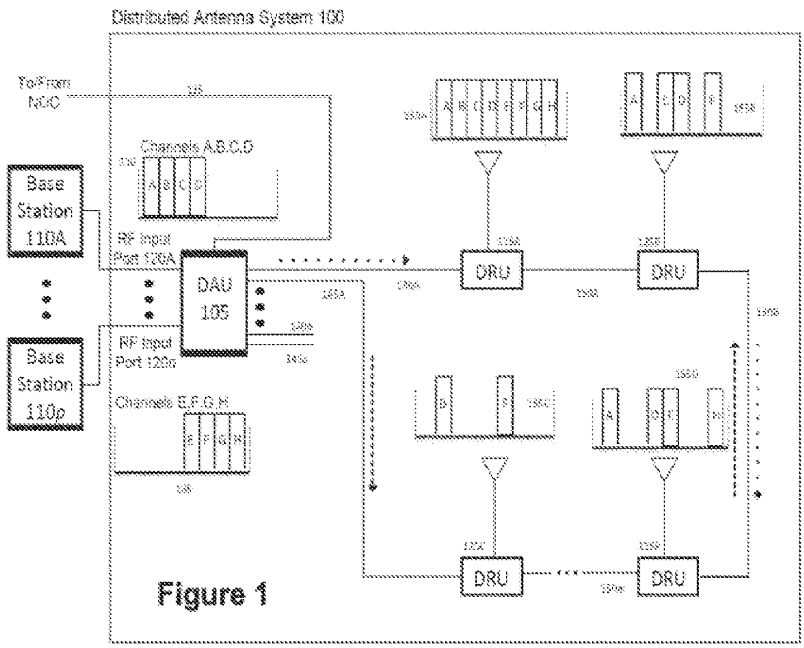


Figure 1

FIG. 1 of the present application shows an example where a number of downlink channel signals sent to DRU 125A (Channels A, B, C, D, E, F, G, H) is different from a number of downlink channel signals sent to DRU 125B (Channels A, C, D, F). Paragraph [0030] explains that "the number of channels received at each DRU is assigned by the DAU and need not be equal, adjacent or sequential, but instead will typically be any configuration that optimizes network utilization." An example of adjusting radio resources over time to optimize network utilization is provided in paragraph [0066] of the present application.

In contrast to amended claim 2, FIG. 2 of Sulzberger reproduced below shows a baseband unit (BB) and two RF heads (RH1, RH2) connected to a two-fiber optical ring (paragraph [0016] of Sulzberger). Sulzberger explains that signals from different antennas can be transmitted over the different fibers or that different carriers can be transmitted over the different fibers (paragraph [0018] of Sulzberber). Sulzberger does not, however, teach that a number of downlink channel signals to RH1 or RH2 can be changed over time. Because the number of downlink channel signals does not change, Sulzberger fails to teach "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals," as recited by amended claim 2.

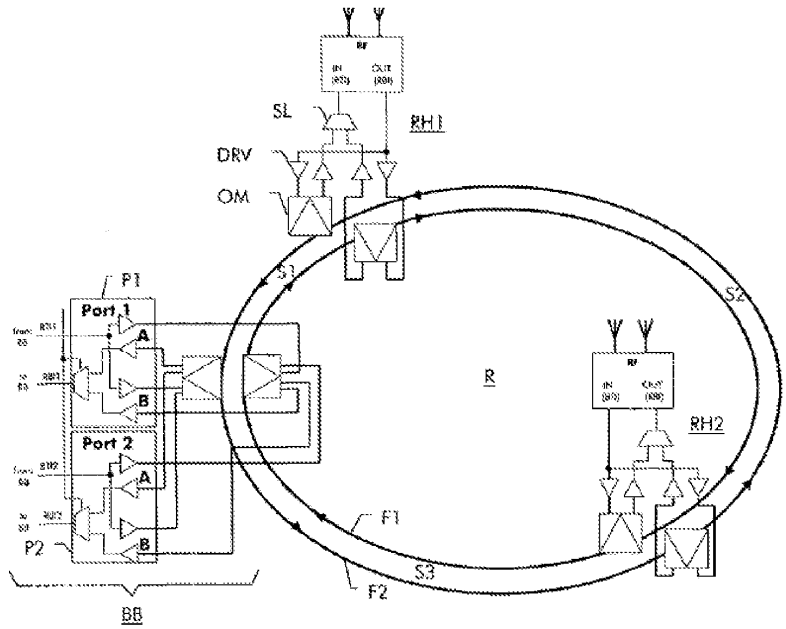


Fig. 2

Applicants respectfully submit that amended claim 2 and its dependent claims are distinguishable over Sulzberger for at least these reasons.

Claims 11-21

Independent claims 11 and 16 have each been amended to include features similar to those of amended claim 2 discussed above. Thus, Applicant respectfully submits that amended claims 11 and 16, as well as their dependent claims, are patentable over the cited references for at least the same reasons as amended claim 2.

Rejections Under 35 U.S.C. § 103

Each of the claims rejected under 35 U.S.C. § 103 depend from one of independent claims 2, 11, and 16 and are thus patentable over the cited references for at least the same reasons as amended claims 2 discussed in the previous section.

CONCLUSION

In view of the foregoing, Applicant believes all claims now pending in this Application are in condition for allowance and an action to that end is respectfully requested.

Except for the issue fees payable under 37 C.F.R. § 1.18, the Director is authorized to charge any additional fees during pendency of this application, including any required extension of time fees, or credit any overpayment to Deposit Account Number 20-1430. This paragraph is intended to be a constructive petition for extension of time in accordance with 37 C.F.R. § 1.136(a)(3).

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (650) 326-2400 or kcatmull@kilpatricktownsend.com.

Respectfully submitted,

/Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP
KBC:bsk

69491924V.1

Electronic Acknowledgement Receipt	
EFS ID:	30273569
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	05-SEP-2017
Filing Date:	29-JUL-2016
Time Stamp:	17:37:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		AMD_DW-1024-4.pdf	142468 44318cc716a89bc1cefacb5e0432553a8803c06b	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Specification	2	2
	Claims	3	6
	Applicant summary of interview with examiner	7	7
	Applicant Arguments/Remarks Made in an Amendment	8	12
Warnings:			
Information:			
	Total Files Size (in bytes):	142468	

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/223,819	Filing Date 07/29/2016	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT 09/05/2017	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

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

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

LIE
ZETA ADAMS

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

20350 7590 09/08/2017

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

NOTIFICATION DATE	DELIVERY MODE
09/08/2017	ELECTRONIC

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

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

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

ipefiling@kilpatricktownsend.com
KTSDocketing2@kilpatrick.foundationip.com

PTOL-90A (Rev. 04/07)

Applicant-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN B. CATMULL*. (4)_____.

Date of Interview: *30 August 2017*.

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

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

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

Claim(s) discussed: *1 and 2*.

Identification of prior art discussed: *of the record*.

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

Discussed some issues related to the rejections under double patenting in the office action June 5, 2017. Applicant's representative and the examiner also discussed different views between prior art and claimed invention, particularly with the limitations related to multiple sets of downlink channel signals.
No agreement was reached on the patentability and the examiner indicated that any claim amendment submitted would require further consideration.

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

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

☐ Attachment

/WEI ZHAO/ Primary Examiner, Art Unit 2473	

Summary of Record of Interview Requirements

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

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

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

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

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

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

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

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

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

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

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

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

Examiner to Check for Accuracy

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

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

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

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-2009/0191891	A1	07-30-2009	Ma et al.	
	2.	US-2010/0177760	A1	07-15-2010	Cannon et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	3.	1924109	EP	A1	05-21-2008	Alcatel Lucent		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	4.	Partial Supplementary European Search Report for European Application No. 11818695.6 mailed on August 31, 2017, 15 pages.	

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

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

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

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SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2017-09-15
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 924 109 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.05.2008 Bulletin 2008/21

(51) Int Cl.:
H04Q 7/30 *(2006.01)*

(21) Application number: **06301157.1**

(22) Date of filing: **20.11.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

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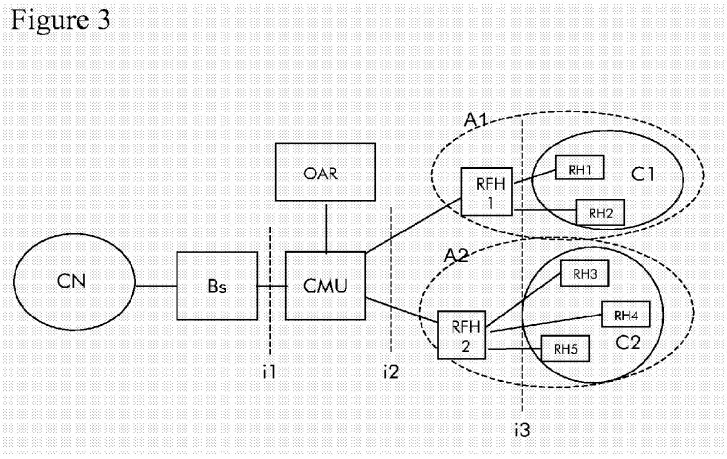
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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) Method and system for wireless cellular indoor communications

(57) The invention relates to a method for wireless cellular indoor communications, the method comprising at least one base station (Bs) connected to a cell management unit (CMU) through a first digital connection interface (i1), the cell management unit connected to at least one RF hub (RFH1,RFH2) through a second digital connection interface (i2), and the at least one RF hub connected to at least one remote radio head (RH1 to RH5) through a third digital connection interface (i3), the at least one remote radio head providing service in a certain cell area (C1, C2) inside a confined environment, and the cell management unit (CMU) comprising means for providing efficient load balancing at and between base stations through adaptive cell reconfiguration; means for mapping carriers, time, frequency or time-frequency allocations to individual radio heads; means for alignment of individual delays accumulated on the digital connections between the cell management unit and each of the radio heads; means for synchronization of the signals between the cell management unit and the individual remote radio heads; and means for failure detection of the individual digital links between the cell management unit and the remote radio heads.

Figure 3



EP 1 924 109 A1

Printed by Jouve, 75001 PARIS (FR)

T-Mobile Ex. 1037

Description

[0001] The present invention relates to indoor communications systems, and particularly to wireless cellular communications systems in buildings and tunnels.

[0002] Wireless communications systems are becoming an increasingly widespread phenomenon of modern communications. Since many users place an increasing number of cellular calls or data transmissions within buildings or other confined structures, there is a need to achieve high quality indoor coverage at appropriate capacity.

[0003] A conventional configuration to extend a wireless communications service e.g. GSM or UMTS, from an outdoor environment to an indoor area is shown in Figure 1 and is characterized by the utilization of a repeater R that is typically located within a building B to retransmit within the building a wireless signal Ws received at an external antenna A1 or retransmit outside the building the wireless signals Ws of mobile stations Ms, e.g. mobile phones, handheld computers and the like, located inside the building B. In the downlink, that is when the wireless signals Ws from the external environment are transmitted to the mobile stations Ms inside the building B, said outdoor wireless signals are passed along a first connection Co1 to the repeater R which forwards the signal along a second connection Co2 to a plurality of inter-connected amplifiers Am, the amplifiers amplify the signals which are then transmitted over the in-building antennas A2 to A4. In the uplink direction, that is, when the wireless signals Ws from the mobile stations Ms are transmitted to a wireless infrastructure outside the building B, the repeater R receives said signals along connection Co2 and transmits them along connection Co1 to the external antenna A1.

[0004] It is also possible that the repeater R of the indoor communications structure is replaced by a base station connected to a communications core network along connection Co1. Typically, the information is distributed via analogue signals inside the buildings and confined areas.

[0005] Another known indoor communications system providing wireless cellular service is shown in figure 2. A core network CN is connected to a base station Bs. The radio frequency (RF) signals from the base station or an off-air repeater OAR are digitized into base band signals in a base station interface BSI (and vice versa in uplink transmission) and distributed in the form of data packets using data cables, e.g. category 5 (CAT5) or optical fiber, to at least one Ethernet switch ES. The Ethernet switch ES then distributes the information to the corresponding remote radio heads RH1 to RH4 serving a particular cell area C1 and C2. An example of such system is disclosed in Patent Application US 2005/0157675 A1. An advantage of such systems is that they provide a cost-effective solution due to the use or re-use of low cost distribution cabling which is usually already present, totally or partly, in buildings and used for other types of digital communications e.g. local area network LAN structures using Ethernet protocol.

[0006] Using standard Ethernet switches, cell configurations can be achieved due to the sectorization of data flow. Normally, an Ethernet hub is needed in each Ethernet sector for data distribution in downlink and data packaging in uplink. The hub function is placed in at least one of the associated remote radio heads. In complex systems, series of Ethernet switches are necessary and bottlenecks of data flow are evident due to the 1 to n distribution characteristic of the Ethernet switch resulting in limiting the capacity of the network.

[0007] The object of the present invention is to provide a method and a system for wireless cellular indoor communications with improved cell and load balancing management.

[0008] The object is achieved by a and a wireless cellular indoor communications system according to claim 1 and a method for wireless cellular indoor communications according to claim 6.

[0009] The system for wireless cellular indoor communications of the invention uses a cell management unit with complex matrix function, instead of distributed standard Ethernet switches, for flexible cell management of multi-service and multi-operator functions.

[0010] The cell management unit is the interface between a number of base stations and the Ethernet connection. It provides multi-functions for a broad scope of complex scenarios of operation, with multi-carrier, multi-service and multi-operator functions, and efficient data management. In this way, the remote radio heads can be used in parallel for different services and at different functions, such as for frequency division duplex (FDD) and time division duplex (TDD). The remote radio heads are serviced by RF-Hubs similar to the original Ethernet hub functionality. Due to a compact arrangement of the cell management unit, data concentrations can be avoided and high data transfer can be achieved in complex networks.

[0011] The cell management unit provides data management in terms of packaging and addressing to the radio heads in downlink and un-packaging and addressing to the base stations in uplink. Since the cell management unit performs the frequency allocation of the remote radio heads, cell management for different services and operators can be achieved. Cell management can be performed manually, by software control or even automatically adaptive to current cell scenarios.

[0012] Due to a traffic activity control, un-used carriers in remote radio heads can be deactivated at locations of low traffic and can be shifted and activated in remote radio heads at locations of high traffic. The load-balancing in base stations can be performed independently of the cell management function. In this way, capacity can follow moving users in complex buildings, such as airports, stations, etc., with dynamic distribution of hot-spots.

[0013] Cost optimization can be achieved when cell

architectures must no longer be designed for peak traffic with moving users all over the whole building. Further cost optimization is achieved using base stations with digital interface and remote radio heads at dedicated locations, where capacity and coverage is needed. Additionally, since information is distributed in digital baseband, cost-effective transport can be used or eventually re-used, such as CAT5 cabling and optical fiber. Due to the LAN characteristic of the digital distribution infrastructure, the remote radio heads can advantageously be easily relocated.

[0014] Radio heads can be designed using low-cost technology of mobile stations avoiding high RF transmission levels.

[0015] An embodiment example of the invention is now explained with the aid of Figures 1 to 6.

Figure 1 shows a first typical indoor communications system structure, for analogue systems, according to the prior art.

Figure 2 shows a wireless cellular indoor communications system, with digital distribution of signals over Ethernet, according to the prior art.

Figure 3 shows a first example of a wireless cellular indoor communications system, with separated cell configuration, according to the invention.

Figure 4 shows a second example of a wireless cellular indoor communications system, with overlapping cell configuration, according to the invention.

Figure 5 shows an example of carrier distribution according to the wireless cellular indoor communications method of the invention.

Figure 6 shows an example block schematic of a wireless cellular indoor communications system according to the invention.

[0016] A first example of a wireless cellular indoor communications system structure according to the invention is shown in Figure 3, comprising a core network CN, a base station Bs, a cell management unit CMU, an off-air repeater (OAR), digital interfaces i1 to i3, RF hubs RFH1 and RFH2, and remote radio heads RH1 to RH5.

[0017] In the downlink direction, communications core network signals intended for the mobile station inside the indoor environment, e.g. a building or a tunnel, are received by the base station Bs. Said signals are then passed in digital form through a first connection interface i1, e.g. an electrical or optical connection using Ethernet protocol or of other standards (e.g. OBSAI or CPRI), to the cell management unit CMU. The cell management unit CMU performs data packaging in downlink and forwards said digital packets through a second digital connection interface i2, e.g. an electrical or optical connection using Ethernet protocol, to the RF Hubs RFH1 and RFH2, which in turn pass the packets through a third connection interface i3, e.g. an electrical or optical connection using Ethernet protocol, to the remote radio heads RH1 to RH5.

[0018] Similarly, in the uplink direction, radio signals Ws transmitted by the mobile stations located in the indoor environment are received by the remote radio heads RH1 to RH5 and sent to the core network CN with data packaging in the RF Hubs.

[0019] The base station is a conventional base station without radio equipment. The cell management unit CMU provides transparent operation of the radio heads RH1 to RH5 from the base station and comprises standard digital interfaces to the base station Bs and to the off-air repeater OAR, at least one Ethernet interface to connect the RF Hubs RFH1 and RFH2, an intelligent switching unit for data distribution and cell organization configurable in size and functionality according to system dimensions, a complex matrix function to combine different base stations with a number of RF hubs, multi-service and multi-operator functionality for full transparency, flexible cell management for static cell configurations, automatic cell management for adaptive cell configurations.

[0020] The CMU preferably comprises the following functionality (in a form independent of the used air interface standard):

- means for supporting efficient load balancing at and between base stations through adaptive cell reconfiguration, especially through the shifting of un-used carriers from radio heads inside areas of low traffic load to radio heads inside areas of high traffic load, e.g. means for individual load identification for each carrier on each of the radio heads by air interface activity detection and interference sensing. Air interface activity detection thereby is realized on the basis of the individually supported air interface protocols; means for de-activation of un-used carriers per radio head on an individual basis; means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers, means for activation of the shifted carriers at locations (radio heads) of high loading. The cell management unit mechanism of adaptive cell reconfiguration thereby will neither require any changes to the load balancing mechanisms at or between the access nodes (e.g. BTS, Node-B, WiMAX base station) nor any dedicated messaging between access nodes and CMU for supporting load balancing.

- mapping means from carriers or time, frequency or time-frequency allocations to individual radio heads, as identified e.g. through their MAC addresses or the connectors of the respective digital lines to which the radio heads are connected,

- delay management means for alignment of the indi-

vidual delays accumulated on the digital connections between the cell management unit and each of the radio heads,

- means for synchronization of the signals between the cell management unit and the individual radio heads,

- failure detection means for the individual digital links between the cell management unit and the radio heads.

[0021] The RF hubs provide data distribution to the remote radio heads in downlink and data packaging in uplink

[0022] The remote radio heads RH1 to RH5 are RF air interfaces to users providing a digital interface to the network. They are part of the BTS according to standards, such as OBSAI or CPRI. The remote radio heads are equipped to transmit four carriers over the full RF bandwidth of each service but channel-selective at least in uplink. In this way, a remote radio head can operate individually for dedicated operators only. Since frequency allocation of each carrier can be tuned remotely by the cell management unit CMU, the remote radio heads RH1 to RH5 can represent an individual cell and/or can be part of a greater cell. Thus, in both cases, extension of capacity and/or coverage, can be achieved. Different types of remote radio heads can be planned either for FDD or for TDD operation.

[0023] In Figure 3, the wireless cellular indoor communications system, according to the invention, is illustrated with separated cell configuration, that is, a first RF Hub RFH1 is connected to two remote radio heads RH1 and RH2 which provide service in a first cell area C1 inside a certain first indoor location area A1, and a second RF Hub RFH2 is connected to three remote radio heads RH3 to RH5 which provide service in a second cell area C2 inside a certain second indoor location area A2, and the first and second indoor location areas A1 and A2 being isolated or separated. On the other hand, Figure 4 illustrates a wireless cellular indoor communications system, according to the invention, which presents overlapping cell configuration, that is, now the first RF Hub RFH1 is connected to two remote radio heads RH1 and RH2, RH1 providing service in cell C1, and RH2 providing service in cell C2, and cells C1 and C2 overlapping in the same indoor location area A1, and the second RF Hub RFH2 is connected to three remote radio heads RH3, RH4 and RH5 which also provide service in different overlapping cells C1, C2 at the same indoor location area A2.

[0024] For the sake of generalization, other cell configurations, as the ones illustrated in the examples of Figures 3 and 4, are possible according to the invention. Each remote radio head can service a different cell area, or two, or more, remote radio heads can belong the same cell area, said cell areas overlapping inside a certain indoor location area or being in different location areas. The RF hubs can be connected to remote radio heads which serve the same cell or serve different cells.

[0025] Figure 5 shows an example of carrier distribution according to the wireless cellular indoor communications method of the invention considering four carriers per remote radio head RH-1 to RH-N. The base station Bs provides the M carriers Ca1 to CaM to the cell management unit CMU which in turn distributes it between the at least one RF Hub RFH 1 to X of the next stage. The one or more RF Hubs distribute carriers 1 to 4 to a first remote radio head RH-1 according to medium access control (MAC) addresses MA1 to MA4 in the Ethernet packets, carriers 5 to 8 to a second remote radio head RH-2 according to MAC addresses 5 to 8, and carriers M-3 to M to an N remote radio head RH-N according to MAC addresses M-3 to M, where M = N x 4.

[0026] Figure 6 shows an example block schematic of a wireless cellular indoor communications system according to the invention. In the example of the figure the cell management unit CMU operates on eight base stations BS1 to BS8 and on eight RF Hubs RFH1 to RFH8 (but, of course, more or less base stations Bs and RF Hubs could also be connected to the CMU). Each base station can provide four carriers at individual services. The eight BS can cover different services of different operators. The network between interfaces I1 and I3 is fully transparent, while the remote radio heads RH1 to RH32 are dedicated for individual services.

Claims

1. A wireless cellular indoor communications system comprising at least one base station (Bs) connected to a cell management unit (CMU) through a first digital connection interface (i1), the cell management unit connected to at least one RF hub (RFH1,RFH2) through a second digital connection interface (i2), and the at least one RF hub connected to at least one remote radio head (RH1 to RH5) through a third digital connection interface (i3), the at least one remote radio head providing service in a certain cell area (C1, C2) inside a confined environment, the cell management unit (CMU) comprising

   - means for providing efficient load balancing at and between base stations through adaptive cell reconfiguration,
   - means for mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
   - means for alignment of individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
   - means for synchronization of the signals between the cell management unit and the individual remote radio heads,

- means for failure detection of the individual digital links between the cell management unit and the remote radio heads.

2. The wireless cellular indoor communications system of claim 1 wherein the means for supporting efficient load balancing comprise means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load.

3. The wireless cellular indoor communications system of claim 2 wherein the means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load comprise

- means for individual load identification for each carrier on each of the radio heads by air interface activity detection and interference sensing,
- means for de-activation of un-used carriers per remote radio head on an individual basis;
- means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers,
- means for activation of the shifted carriers at locations where the remote radio heads are loaded over a predetermined value.

4. The wireless cellular indoor communications system of claim 1, wherein the carriers, time, frequency or time-frequency allocations are identified through their MAC addresses or the connectors of the respective digital lines to which the radio heads are connected.

5. The wireless cellular indoor communications system of claim 1, wherein the first, second and third digital interface is an electrical or optical connection using Ethernet protocol.

6. A method for wireless cellular indoor communications, the method comprising
a base station (Bs) transmitting or receiving call or data information to/from a cell management unit (CMU) through a first digital connection interface (i1),
the cell management unit transmitting or receiving call or data information to/from at least one RF hub (RFH1,RFH2) through a second digital connection interface (i2), and
the at least one RF hub transmitting or receiving call or data information to/from at least one remote radio head (RH1 to RH5) through a third digital connection interface (i3), the at least one remote radio head providing service in a certain cell area (C1, C2) inside a confined environment,
and
the cell management unit (CMU)

- providing efficient load balancing at and between base stations through adaptive cell reconfiguration,
- mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
- aligning individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- synchronizing signals between the cell management unit and the individual remote radio heads,
- detecting failure of the individual digital links between the cell management unit and the remote radio heads.

Amended claims in accordance with Rule 137(2) EPC.

1. A wireless cellular indoor communications system comprising at least one base station (Bs) connected to a cell management unit (CMU) through a first digital connection interface (i1), the cell management unit connected to at least one RF hub (RFH1,RFH2) through a second digital connection interface (i2), and the at least one RF hub connected to at least one remote radio head (RH1 to RH5) through a third digital connection interface (i3), the at least one remote radio head providing service in a certain cell area (C1, C2) inside a confined environment,
the cell management unit (CMU) comprising

- means for providing efficient load balancing at and between base stations through adaptive cell reconfiguration,
- means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load,
- means for mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
- means for alignment of individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- means for synchronization of the signals between the cell management unit and the individual remote radio heads,
- means for failure detection of the individual digital links between the cell management unit and the remote radio heads.

2. The wireless cellular indoor communications system of claim 1 wherein the means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load comprise

- means for individual load identification for each carrier on each of the radio heads by air interface activity detection and interference sensing,
- means for de-activation of un-used carriers per remote radio head on an individual basis;
- means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers,
- means for activation of the shifted carriers at locations where the remote radio heads are loaded over a predetermined value.

3. The wireless cellular indoor communications system of claim 1, wherein the carriers, time, frequency or time-frequency allocations are identified through their MAC addresses or the connectors of the respective digital lines to which the radio heads are connected.

4. The wireless cellular indoor communications system of claim 1, wherein the first, second and third digital interface is an electrical or optical connection using Ethernet protocol.

5. A method for wireless cellular indoor communications, the method comprising
a base station (Bs) transmitting or receiving call or data information to/from a cell management unit (CMU) through a first digital connection interface (i1), the cell management unit transmitting or receiving call or data information to/from at least one RF hub (RFH1,RFH2) through a second digital connection interface (i2), and
the at least one RF hub transmitting or receiving call or data information to/from at least one remote radio head (RH1 to RH5) through a third digital connection interface (i3), the at least one remote radio head providing service in a certain cell area (C1, C2) inside a confined environment,
and
the cell management unit (CMU)

- providing efficient load balancing at and between base stations through adaptive cell reconfiguration,
- shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load,
- mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
- aligning individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- synchronizing signals between the cell management unit and the individual remote radio heads,
- detecting failure of the individual digital links between the cell management unit and the remote radio heads.

6. A cell management unit (CMU) comprising:

- means for providing efficient load balancing at and between base stations through adaptive cell reconfiguration, the base stations connected to the cell management unit
- means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load, the remote radio heads connected to at least one RF Hub, the RF Hub connected to the cell management unit,
- means for mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
- means for alignment of individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- means for synchronization of the signals between the cell management unit and the individual remote radio heads,
- means for failure detection of the individual digital links between the cell management unit and the remote radio heads.

7. The management unit (CMU) according to claim 6, wherein the means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load comprise

- means for individual load identification for each carrier on each of the radio heads by air interface activity detection and interference sensing,
- means for de-activation of un-used carriers per remote radio head on an individual basis;
- means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers,
- means for activation of the shifted carriers at locations where the remote radio heads are loaded over a predetermined value.

Figure 1

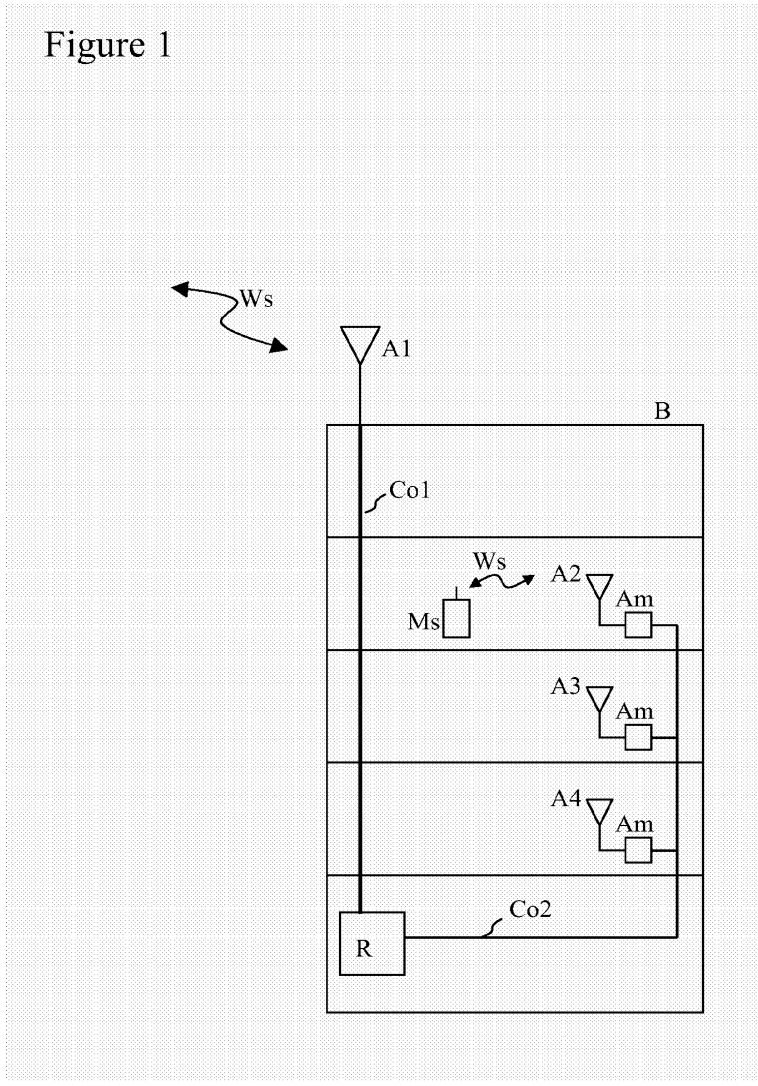


Figure 2

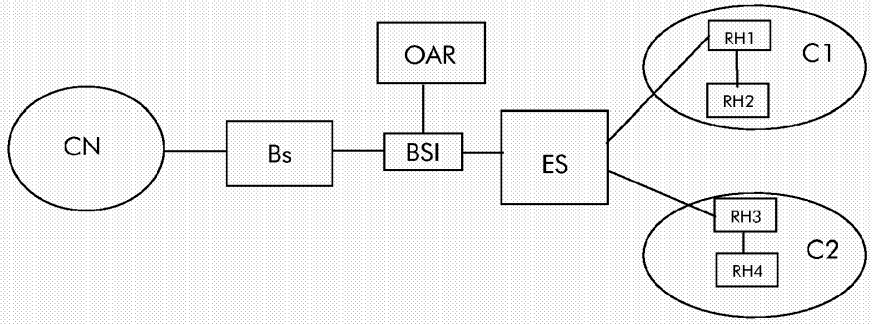


Figure 3

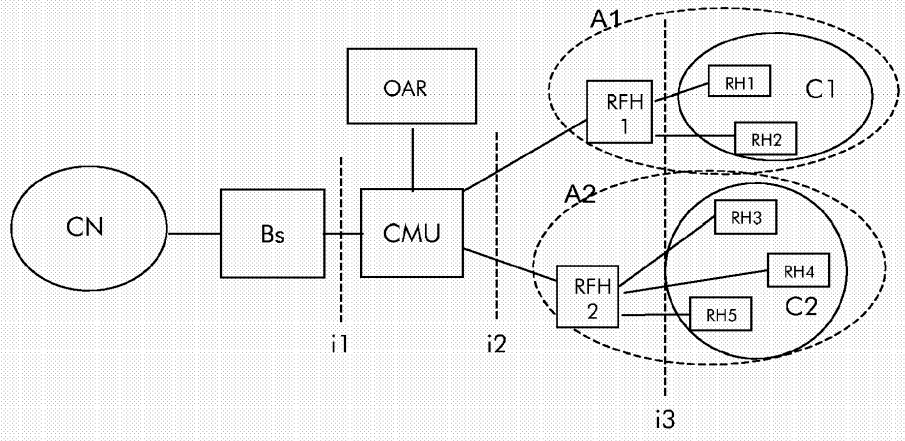


Figure 4

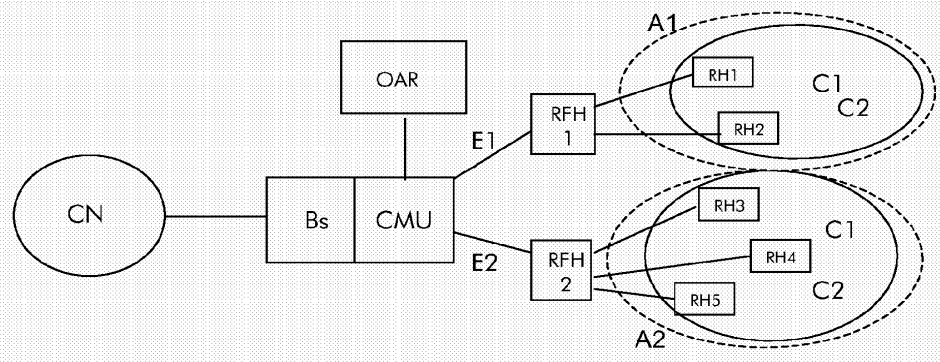


Figure 5

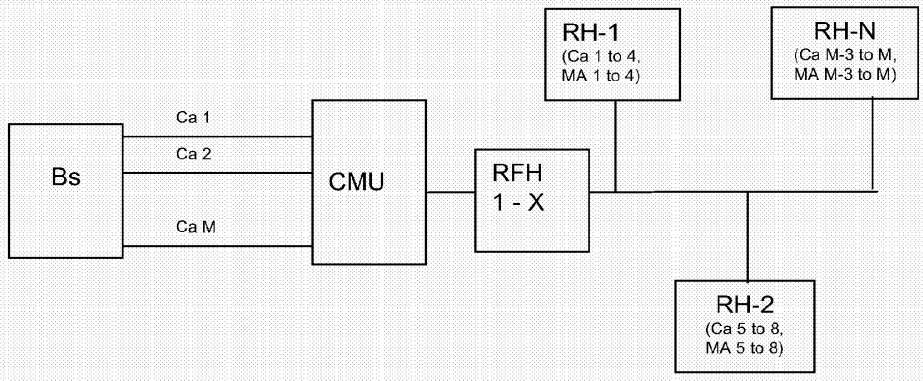
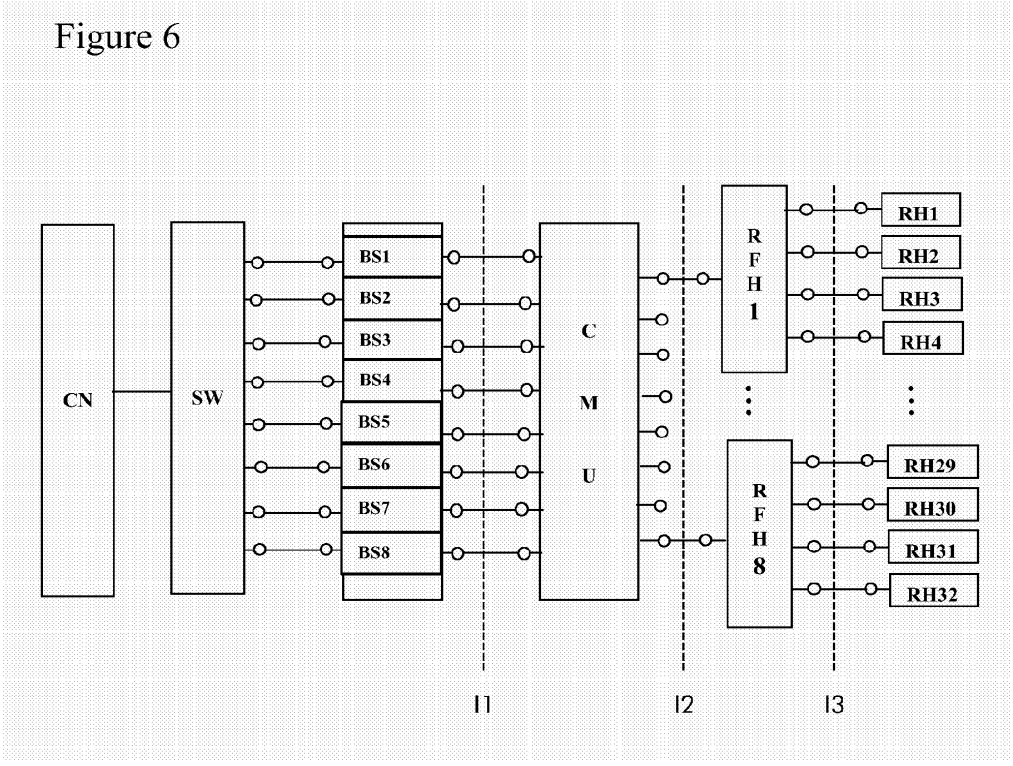


Figure 6


CN
SW
BS1
BS2
BS3
BS4
BS5
BS6
BS7
BS8
C
M
U
RFH 1
RFH 8
RH1
RH2
RH3
RH4
RH29
RH30
RH31
RH32
I1
I2
I3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 30 1157

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 03/079645 A (ADC TELECOMMUNICATIONS INC [US]) 25 September 2003 (2003-09-25) * paragraph [0002] * * paragraph [0018] - paragraph [0029] * * paragraph [0030] - paragraph [0032] * * paragraphs [0039], [0043] - paragraph [0045] * * figures 1,3,4 * -----	1-6	INV. H04Q7/30
Y	WO 2004/025887 A (STRIX SYSTEMS INC [US]; STEPHENS SPENCER [US]; BERG ALEXANDER [US]; KA) 25 March 2004 (2004-03-25) * paragraph [0015] * * paragraph [0017] - paragraph [0019] * * paragraph [0025] * * paragraph [0028] - paragraph [0029] * * paragraph [0046] - paragraph [0049] * * figures 2,8 * -----	1-6	
A	US 6 477 154 B1 (CHEONG JONG MIN [KR] ET AL) 5 November 2002 (2002-11-05) * column 1, line 57 - column 2, line 24 * * column 2, line 59 - column 3, line 23 * * column 4, line 50 - line 67 * * column 6, line 42 - line 53 * * column 11, line 49 - line 62 * * column 13, line 13 - line 31 * * figures 1,10 * -----	1-6	TECHNICAL FIELDS SEARCHED (IPC) H04Q H04B
A	EP 1 085 773 A (NORTEL MATRA CELLULAR [FR]) 21 March 2001 (2001-03-21) * paragraph [0001] * * paragraph [0043] - paragraph [0044] * * paragraphs [0046], [0057], [0072], [0074] * * figures 3,10 * -----	1-6	
	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 May 2007	Rosenauer, Hubert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
EP 06 30 1157

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 617 598 A (SAMSUNG ELECTRONICS CO LTD [KR]) 18 January 2006 (2006-01-18) * paragraph [0003] - paragraph [0005] * * paragraph [0015] * * paragraph [0030] - paragraph [0033] * * paragraph [0037] - paragraph [0044] * * figures 2,6-8 *	1,6	
A	WO 03/013065 A (SUN MICROSYSTEMS INC [US]; FENART JEAN-MARC [FR]; CARREZ STEPHANE [FR]) 13 February 2003 (2003-02-13) * page 11, line 4 - page 12, line 21 *	1,6	

TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 May 2007	Rosenauer, Hubert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

T-Mobile Ex. 1037

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 30 1157

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

04-05-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 03079645 A	25-09-2003	AU 2003220101 A1	29-09-2003
		US 2004203703 A1	14-10-2004
WO 2004025887 A	25-03-2004	AU 2003270648 A1	30-04-2004
US 6477154 B1	05-11-2002	CN 1224986 A	04-08-1999
		JP 2952249 B2	20-09-1999
		JP 11164348 A	18-06-1999
EP 1085773 A	21-03-2001	WO 0122754 A1	29-03-2001
EP 1617598 A	18-01-2006	CN 1722691 A	18-01-2006
		KR 20060005083 A	17-01-2006
		US 2006009208 A1	12-01-2006
WO 03013065 A	13-02-2003	EP 1413089 A1	28-04-2004
		US 2005022045 A1	27-01-2005

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20050157675 A1 **[0005]**

Electronic Acknowledgement Receipt	
EFS ID:	30378478
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	15-SEP-2017
Filing Date:	29-JUL-2016
Time Stamp:	17:43:09
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		IDS_102440US.pdf	143018 de2aad087ddffa743e0fd88f4ce6649b38f1a949	yes	4

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	4	
Warnings:					
Information:					
2	Foreign Reference	EP1924109A1.pdf	1473475 fca10ffa35f2ac7dddabe3190dc35010b51760d8	no	14
Warnings:					
Information:					
3	Non Patent Literature	EPpartSrchRpt08312017.pdf	574534 60c4f7a0d864bdd19b51a791f36392d86af49f13	no	15
Warnings:					
Information:					
		Total Files Size (in bytes):	2191027		

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.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on September 15, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

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

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

This Information Disclosure Statement is being filed after the mailing of the first Office Action on the merits, but before the mailing date of the final Office Action, Notice of Allowance, or any other action that closes prosecution.

I hereby certify under 37 CFR §1.97(e)(1) that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

/Kelvin B. Catmull/

Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

20350 7590 09/29/2017

KILPATRICK TOWNSEND & STOCKTON LLP
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1100 Peachtree Street
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Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

NOTIFICATION DATE	DELIVERY MODE
09/29/2017	ELECTRONIC

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

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

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

ipefiling@kilpatricktownsend.com
KTSDocketing2@kilpatrick.foundationip.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 15/223,819	Applicant(s) STAPLETON ET AL.	
	Examiner WEI ZHAO	Art Unit 2473	AIA (First Inventor to File) Status No

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

Period for Reply

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

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

Status

1)☒ Responsive to communication(s) filed on *9/5/2017*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *2-21* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *2-21* is/are rejected.

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

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

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

Application Papers

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

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

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

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

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

4) ☐ Other: _____.

DETAILED ACTION

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

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on June 26, 2017, August 29, 2017, and September 15, 2017 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Response to Amendment

3. Acknowledgment is made of Applicant's submission of amendment/remarks, dated September 9, 2017. Claims 2, 10, 11, 16, and 21 have been amended. Claims 2-21 are currently pending. This communication is considered fully responsive and sets forth below.

Double Patenting

4. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims

are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

5. Claim 2 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

Regarding claim 2, it recites, “A host unit for use in the transport of wireless communications, comprising:

at least one *interface to communicatively couple* the host unit to at least one signal source;

at least one *interface to communicatively couple* the host unit to a plurality of remote units, including at least a first remote unit;

wherein *the host unit* is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time; and

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals."

Claim 1 of U.S. Patent No. 8,737,300 recites, "1. A method for routing and switching signals, the method comprising:

providing a plurality of digital remote units, each configured to transmit one or more downlink channel signals and to receive one or more uplink channel signals;

providing at least one *digital access unit* configured to communicate with at least two of the plurality of digital remote units;

linking in a loop configuration the plurality of digital remote units and the at least one digital access unit, whereby the plurality of digital remote units and the at least one digital access unit are daisy-chained in the loop configuration such that each digital remote unit is linked to a next digital remote unit or the digital access unit by a single bi-directional optical fiber and each digital remote unit is configured to be accessed in either direction around the loop configuration; and

routing and switching packetized signals among the plurality of digital remote units and the at least one digital access unit, wherein a first digital remote unit of the plurality of digital remote units receives a first number of downlink channel signals on *a first bi-directional optical fiber* from the at least one digital access unit, and a second digital remote unit of the plurality of digital remote units receives a second number of downlink channel signals on *a second bi-directional optical fiber* from the at least one digital access unit, where the first number of downlink channel signals is different from the second number of downlink channel signals."

Based on the limitations presented above, claim 2 of the instant application claims similar limitations that are a part of the elements in claim 1 of U.S. Patent No.

8,737,300, by using different wordings, such as using “host unit” instead of “digital access unit” and using “interface to” instead of “linking” in claim 1 of the Patent.

As a matter of fact, claim 2 is merely a broader version of the claim 1 of U.S. Patent No. 8,737,300 by eliminating some terms, i.e., “whereby the plurality of digital remote units and the at least one digital access unit are daisy-chained in the loop configuration such that each digital remote unit is linked to a next digital remote unit or the digital access unit by a single bi-directional optical fiber and each digital remote unit is configured to be accessed in either direction around the loop configuration,” etc.

It has been held that the omission of an element and its function is an obvious expedient if the remaining elements perform the same function as before. In re Karlson, 136 USPQ 184 (CCPA).

The same rationale applies to claims 5, 6, 8, 9, 11-16, 18, and 20 as follows:

6. Claims 5 and 6 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 6 and 5 of U.S. Patent No. 8,737,300, individually.

7. Claims 8 and 9 are both rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

8. Claims 11-15 are all rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

9. Claim 16 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

10. Claim 18 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 6 of U.S. Patent No. 8,737,300.

11. Claim 20 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S. Patent No. 8,737,300.

Claim Rejections - 35 USC § 103

12. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

13. Claims 2-4, 8-17, 20, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sulzberger et al. (US 2005/0152695) in view of Boldi et al. (US 8,855,489).

Regarding claim 2, Sulzberger et al. teach the host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source (paragraph [0017] lines 1-17; Examiner's Notes: BB depicted in FIG. 2 of the prior art teaches the limitation of "host unit" in the instant application);

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit (paragraph [0018] lines 1-20; Examiner's Notes: RH1, RH2, … depicted in FIG. 2 of the prior art teaches the limitation of "a plurality of remote units" in the instant application);

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source (paragraph [0017] lines 1-17);

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units (paragraph [0019] lines 1-15);

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time (paragraph [0018] lines 1-20);

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time (paragraph [0017] lines 1-17).

Sulzberger et al. teach the host, without explicitly teaching a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals. However, Boldi et al. teaches a host, wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the

second set of downlink channel signals (column [3] line 47 – column [4] line 11). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. with those of Boldi et al. in order to implement the communication between a main station and procession nodes includes in an optical path defining adjacent nodes and non-adjacent nodes, operatively grouping the nodes in a plurality of distinct sub-groups..

Regarding claim 3, Sulzberger et al. further teach the host unit, wherein the host unit is configurable to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0018] lines 1-20).

Regarding claim 4, Sulzberger et al. further teach the host unit, wherein the host unit is configurable, based on a change in network conditions, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0019] lines 1-15).

Regarding claim 8, Sulzberger et al. further teach the host unit, wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface (paragraph [0017] lines 1-17).

Regarding claim 9, Sulzberger et al. further teach the host unit, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal (paragraph [0019] lines 1-15).

Regarding claim 10, Sulzberger et al. further teach the host unit, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal in compliance with the Common Public Interface Standard (CPRI) standard (paragraph [0005] lines 1-13).

Regarding claim 11, Sulzberger et al. teach the system for transporting wireless communications, comprising:

a host unit (paragraph [0017] lines 1-17; Examiner's Notes: BB depicted in FIG. 2 of the prior art teaches the limitation of "host unit" in the instant application);

a plurality of remote units, including at least a first remote unit and a second remote unit (paragraph [0018] lines 1-20; Examiner's Notes: RH1, RH2, … depicted in FIG. 2 of the prior art teaches the limitation of "a plurality of remote units" in the instant application);

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source (paragraph [0017] lines 1-17);

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source (paragraph [0018] lines 1-20);

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units (paragraph [0019] lines 1-15);

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time (paragraph [0018] lines 1-20);

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time (paragraph [0017] lines 1-17);

wherein the host unit is capable of receiving digital signals from each of the plurality of remote units (paragraph [0018] lines 1-20).

Sulzberger et al. teach the system, without explicitly teaching a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals. However, Boldi et al. teaches a host, wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals (column [3] line 47 – column [4] line 11). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. with those of Boldi et al. in order to implement the communication between a main station and procession nodes includes in an optical path defining

adjacent nodes and non-adjacent nodes, operatively grouping the nodes in a plurality of distinct sub-groups..

Regarding claim 12, Sulzberger et al. further teach the system, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal (paragraph [0019] lines 1-15).

Regarding claim 13, Sulzberger et al. teach the system, wherein the host unit is connected to each of the plurality of remote units through a direct connection (paragraph [0018] lines 1-20).

Regarding claim 14, Sulzberger et al. further teach the system, wherein the host unit is connected to each of the plurality of remote units through an indirect connection (paragraph [0018] lines 1-20).

Regarding claim 15, Sulzberger et al. further teach the system, wherein each remote unit comprises at least one interface to communicatively couple the remote unit to another one of the plurality of remote units in a daisy-chain configuration (paragraph [0018] lines 1-20).

Regarding claim 16, Sulzberger et al. teach the method for providing digital signals in a Distributed Antenna System (DAS), comprising:

transmitting from a host unit, at a first point in time, a first set of downlink channel signals to a first remote unit (paragraph [0017] lines 1-17; Examiner's Notes: BB

depicted in FIG. 2 of the prior art teaches the limitation of “host unit” and RH1 depicted in FIG. 2 of the prior art teaches the limitation of “first remote unit” in the instant application);

transmitting from the host unit, at a second point in time, a second set of downlink channel signals to the first remote unit (paragraph [0018] lines 1-20);

Sulzberger et al. teach the methodst, without explicitly teaching a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals. However, Boldi et al. teaches a host, wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals (column [3] line 47 – column [4] line 11). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. with those of Boldi et al. in order to implement the communication between a main station and procession nodes includes in an optical path defining adjacent nodes and non-adjacent nodes, operatively grouping the nodes in a plurality of distinct sub-groups..

Regarding claim 17, Sulzberger et al. further teach the method, wherein the host unit dynamically changes based on a change in network conditions from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0019] lines 1-15).

Regarding claim 20, Sulzberger et al. further teach the method, wherein the downlink channel signals are packetized (paragraph [0019] lines 1-15).

Regarding claim 21, Sulzberger et al. further teach the method, wherein the downlink channel signals are packetized in compliance with the Common Public Interface Standard (CPRI) standard (paragraph [0005] lines 1-13).

14. Claims 5, 6, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sulzberger et al. (US 2005/0152695) in view of Boldi et al. (US 8,855,489) as applied to claim 2 or 16, and further in view of Casanova et al. (US 6,657,993).

Regarding claim 5, Sulzberger et al. and Boldi et al. teach the host, without explicitly teaching load balancing. However, Casanova et al. teaches a host, wherein the host unit is configurable, based on load balancing, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (column [3] lines 45-50). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. and Boldi et al. with those of Casanova et al. in order to provide variable bandwidth transmission facilities between a local telephone switch and a remote line unit.

Regarding claim 6, Sulzberger et al. and Boldi et al. teach the host, without explicitly teaching implementing based on a change in subscriber needs. However, Casanova et al. teaches a host, wherein the host unit is configurable, based on a

change in subscriber needs, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (column [3] lines 45-50). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. and Boldi et al. with those of Casanova et al. in order to provide variable bandwidth transmission facilities between a local telephone switch and a remote line unit.

Regarding claim 18, Sulzberger et al. and Boldi et al. teach the method, without explicitly teaching implementing based on a change in subscriber needs. However, Casanova et al. teaches the method, wherein the host unit dynamically changes based on load balancing from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (column [3] lines 45-50). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. and Boldi et al. with those of Casanova et al. in order to provide variable bandwidth transmission facilities between a local telephone switch and a remote line unit.

15. Claims 7 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sulzberger et al. (US 2005/0152695) in view of Boldi et al. (US 8,855,489) as applied to claim 2 or 16, and further in view of Zhang et al. (US 2010/0238904).

Regarding claim 7, Sulzberger et al. and Boldi et al. teach the host unit, without explicitly teaching dynamically changing based on a schedule. However, Zhang et al. teaches the subject matter, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0071] lines 1-20). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. and Boldi et al. with those of Zhang et al. in order to enhance the mobility in multi-carrier high speed packet access.

Regarding claim 19, Sulzberger et al. and Boldi et al. teach the method, without explicitly teaching dynamically changing based on a schedule. However, Zhang et al. teaches the method, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit (paragraph [0071] lines 1-20). It would have been obvious to one skilled in the art to combine the teachings of Sulzberger et al. and Boldi et al. with those of Zhang et al. in order to enhance the mobility in multi-carrier high speed packet access.

Response to Remarks/Arguments

16. Objection to Specification: in the Response filed September 9, 2017, Applicants amended the specification to render the objection to the specification moot. The previous objection to the specification is withdrawn.

17. Claims Objections: in the Response, Applicants amended claims for the purpose of correcting the informalities. Therefore, the previous objections to the claims are withdrawn.

18. Claim Double Patenting Rejection: Applicants indicated to hold the rejection in abeyance until a patentability determination is made for this application. The previous claim double patenting rejection is maintained consequently.

19. Claims Art Rejections: Applicants' arguments filed September 9, 2017 have been fully considered, but they are moot in view of the new ground(s) of rejection.

Conclusion

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

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WEI ZHAO whose telephone number is (571)270-5672. The examiner can normally be reached on Monday-Friday, 7:30am-4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KWANG B. YAO can be reached on 571-272-3182. 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.

/Wei Zhao/
Primary Examiner
Art Unit 2473

Notice of References Cited	Application/Control No. 15/223,819	Applicant(s)/Patent Under Reexamination STAPLETON ET AL.	
	Examiner WEI ZHAO	Art Unit 2473	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-8,855,489 B2	10-2014	Boldi; Mauro	H04J14/0226	398/58
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

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

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-2009/0191891	A1	07-30-2009	Ma et al.	
	2.	US-2010/0177760	A1	07-15-2010	Cannon et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	3.	1924109	EP	A1	05-21-2008	Alcatel Lucent		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	4.	Partial Supplementary European Search Report for European Application No. 11818695.6 mailed on August 31, 2017, 15 pages.	

EXAMINER SIGNATURE

Examiner Signature	/WEI ZHAO/		Date Considered	09/21/2017	

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

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

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	Attorney Docket Number	091172-1017552-102440US

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

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2017-09-15
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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

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Receipt date: 06/26/2017

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

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	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

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

U.S. PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

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

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	1.	"Introduction to Receivers", downloded June 15, 2017 from http://www.ece.ucsb.edu/~long/ece145a/Introduction_to_Receivers.pdf, 28 pages.	
	2.	"Standardizing Digital IF Data Transfer with VITA 49", RTC Magazine, downloaded June 15, 2017 from http://rtcmagazine.com/articles/view/100460, 5 pages.	
	3.	LAN et al., "GSM Co-Channel and Adjacent Channel Interference Analysis and Optimization", Dec. 2011, Vol. 16, No. 6, Tsinghua Science And Technology, ISSN 1007-0214 04/12, pp 583-588.	

EXAMINER SIGNATURE			
Examiner Signature /WEI ZHAO/		Date Considered 09/21/2017	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

Receipt date: 06/26/2017

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☐ See attached certification statement.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Craig C. Largent/	Date (YYYY-MM-DD)	2017-06-23
Name/Print	Craig C. Largent	Registration Number	56,400

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

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

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

CLAIM		DATE								
Final	Original	05/26/2017	09/23/2017							
	1	-	-							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
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	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20	✓	✓							
	21	✓	✓							

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	Art Unit
	WEI ZHAO	2473

CPC- SEARCHED		
Symbol	Date	Examiner
H04W 40/02, 72/04; H04B 7/022	5/25/2017, 5/26, 9/22	wz

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

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

SEARCH NOTES		
Search Notes	Date	Examiner
searched in usocr, fprs, pgpub, uspat, ip.com, and ieee xplore	5/25/2017, 5/26, 9/22	wz
fmid search	5/25/2017, 9/22	wz
odp search in palm resource center	5/25/2017	wz
updated text search	9/22/2017	wz

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H04W	72/04	5/26/2017	wz

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S673	2469	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:52
S674	420	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and H04L12/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:52
S675	36	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and H04L12/2$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:53
S676	6	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and H04L12/26$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:53
S677	4	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and H04L12/24$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:53
S678	714	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and H04L41/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:53
S679	359	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and H04L41/06$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:53
S680	163	(failover or fail-over or fail$3) same	US-PGPUB;	ADJ	OFF	2017/09/21

		(switch$3 or rout$3) same traffic with (management or manag$3) and H04L41/066$.cpc.	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			17:53
S682	92	(failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and H04L41/0668.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:54
S683	77	(failover or fail-over or fail$3) with (switch$3 or rout$3) same traffic with (management or manag$3) and H04L41/0668.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:54
S684	65	(failover or fail-over or fail$3) with (switch$3 or rout$3) with traffic with (management or manag$3) and H04L41/0668.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:54
S685	13	(indicat$3 or identify$3) with (failover or fail-over or fail$3) with (switch$3 or rout$3) with traffic with (management or manag$3) and H04L41/0668.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:55
S686	10	(indicat$3 or identify$3) with (failover or fail-over or fail$3) with (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:55
S687	422	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:55
S688	163	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/2$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:56
S689	132	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/20$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	OFF	2017/09/21 17:56

			IBM_TDB			
S690	24	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/200$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/21 17:56
S699	1	"15223819"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/09/22 13:15
S700	28	"39563020".fmid.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/09/22 13:15
S701	24	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/200$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 13:16
S702	132	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/20$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 13:31
S704	9	(indicat$3 or identify$3) with (failover or fail-over or fail$3) same (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/2$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 15:06
S706	10	(indicat$3 or identify$3) with (failover or fail-over or fail$3) same (switch$3 or rout$3) same traffic with (management or manag$3) and G06F11/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 16:42
S707	237	(indicat$3 or identify$3) with (failover or fail-over or fail$3) same (switch$3 or rout$3) and traffic with (management or manag$3) and G06F11/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 16:46
S708	106	(indicat$3 or identify$3) with (failover or fail-over or fail$3) same (switch$3 or rout$3) and traffic with (management or manag$3) and	US-PGPUB; USPAT; USOCR; FPRS; EPO;	ADJ	OFF	2017/09/22 16:46

		G06F11/20$.cpc.	JPO; DERWENT; IBM_TDB			
S710	35	(indicat$3 or identify$3) with (failover or fail-over or fail$3) same (switch$3 or rout$3) and traffic with (management or manag$3) and G06F11/200$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 16:47
S711	277	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 17:45
S712	52	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (number or multiple or plurality) with (DL or downlink$1) with channel$1 with signals	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 17:47
S713	15	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (number or multiple or plurality) with (DL or downlink$1) with channel$1 with signals and remote with (unit$1 or device$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/22 17:48
S714	9	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/23 12:15
S715	92	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04W72/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/23 12:16
S716	91	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04W72/0$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/23 12:16
S717	83	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/23 12:16
S718	12	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or	US-PGPUB; USPAT;	ADJ	OFF	2017/09/23 12:16

		information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04W72/04.cpc.	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S719	88	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04B7/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/23 12:17
S720	17	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04B7/02$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2017/09/23 12:17

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	7	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04B7/022$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/23 17:46
L2	4	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04W40/02$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/23 17:47
L3	81	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04W72/04$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/23 17:53
L4	59	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) with (DL or downlink$1) with channel$1 with signals and H04W72/04$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/23 17:54
L5	9	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) with (DL or downlink$1) with channel$1 with signals and H04W72/04.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/23 17:54
S692	7	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and G06F11/2005$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/21 17:56
S693	71	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and H04L12/2$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/21 18:04
S694	3	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and H04L12/26$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/21 18:04
S695	1	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and H04L12/24$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/21 18:04

S696	434	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and H04L41/06$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/21 18:04
S697	101	(indicat$3 or identify$3) with (failover or fail-over or fail$3) and (switch$3 or rout$3) with traffic with (management or manag$3) and H04L41/0668$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/21 18:05
S698	17	(indicat$3 or identify$3) with (failover or fail-over or fail$3) same (switch$3 or rout$3) with traffic with (management or manag$3) and H04L41/0668$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/21 18:05
S721	16	(send$3 or transmit$4) with digital with (signal$1 or representation$1 or information or packet$1) same (DL or downlink$1) with channel$1 with signals and H04B7/02$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2017/09/23 13:06

9/23/2017 5:56:38 PM
C:\Users\wzhao\Documents\EAST\Workspaces\temp.wsp

Receipt date: 08/29/2017

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

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

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-2002/0186436	A1	12-12-2002	Mani et al.	
	2.	US-2006/121944	A1	06-08-2006	Buscaglia et al.	
	3.	US-2007/0281643	A1	12-06-2007	Kawai	
	4.	US-2007/0064506	A1	03-22-2007	Bauman et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	5.	1992-207532	JP	A	07-29-1992	Nippon Telegr & Teleph Corp		
	6.	1993-136724	JP	A	01-06-1993	A T R Koudenpa Tsushin Kenkyush		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	7.	Extended European Search Report for European Application No. 11818697.2 mailed on August 17, 2017, 7 pages.	
	8.	Office Action for Japanese Application No. 2016-174930 mailed August 2, 2017, 4 pages.	

EXAMINER SIGNATURE

Examiner Signature	/WEI ZHAO/		Date Considered	09/21/2017	

3

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

Receipt date: 08/29/2017

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

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

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

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2017-08-29
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

Receipt date: 08/29/2017

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

70092352V.1

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I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on November 28, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Shawn Patrick Stapleton et al.
Application No.: 15/223,819
Filed: July 29, 2016
For: DISTRIBUTED ANTENNA SYSTEM
Customer No.: 20350

Confirmation No.: 3273
Examiner: Wei Zhao
Technology Center/Art Unit: 2473

AMENDMENT UNDER 37 CFR § 1.116
EXPEDITED PROCEDURE

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

Commissioner:

In response to the Final Office Action mailed September 29, 2017 on the above-referenced application, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 6 of this paper.

Electronic Acknowledgement Receipt	
EFS ID:	31062142
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	28-NOV-2017
Filing Date:	29-JUL-2016
Time Stamp:	16:42:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		102440US_AMDAF.pdf	124608 2ba7888625e478c27a19e1af2cae832c0c91d6b9	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	6	8
	Claims	2	5
	Response After Final Action	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	124608	

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.

REMARKS/ARGUMENTS

Claims 2-21 are pending in this application. No amendments are made by this response.

Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Office Action Summary

Claims 2, 5-6, 8-9, 11-16, 18, and 20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 and 6 of U.S. Patent No. 8,737,300.

Claims 2-4, 8-17, and 20-21 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger (US 2005/0152695) in view of Boldi (US 8,855,489).

Claims 5-6 and 18 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger in view of Boldi and Casanova (US 6,657,993).

Claims 7 and 19 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger in view of Boldi and Zhang (US 2010/0238904).

Double Patenting Rejections

Applicant acknowledges the double patenting rejections and will determine whether to file a Terminal Disclaimer after overcoming the other rejections in the Office Action.

Rejections Under 35 U.S.C. § 103

Claims 2-10

Claim 2 recites:

> "wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time; wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time; and wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals."

The above features of claim 2 can be illustrated with reference to the exemplary embodiment shown in FIG. 1 of the present application reproduced below. Note that FIG. 1 is used herein for illustrative purposes only and is not intended to be limiting.

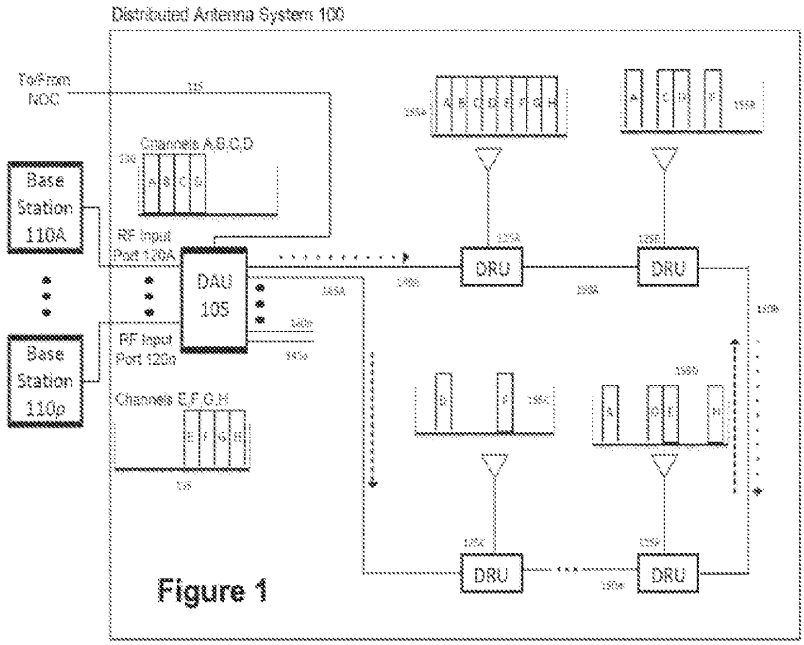


FIG. 1 of the present application shows an example where a number of downlink channel signals are sent to each of the DRUs 125A, 125B, 125C, 125k. For example, downlink channel signals A, B, C, D, E, F, G, H are sent to DRU 125A, and downlink channel signals A, C, D, F are sent to DRU 125B. Paragraph [0030] explains that "the number of channels received at each DRU is assigned by the DAU and need not be equal, adjacent or sequential, but instead will typically be any configuration that optimizes network utilization." An example of adjusting radio resources over time to optimize network utilization is provided in paragraph [0066] of the present application.

In contrast to claim 2, Sulzberger and Boldi fail to teach or suggest these features. For example, Boldi describes a system where nodes are separated into sub-groups and a single sub-data stream is sent to each node (Boldi at col. 3, line 47 to col. 4, line 11). Because a single sub-data stream is sent to each node, Boldi does not send a first number of sub-data streams to a node

at a first point in time and a different number of sub-data streams to the node at a second point in time. Instead, Boldi sends only a single sub-data stream to each node. Thus, Boldi fails to teach the above features of claim 2.

Sulzberger also fails to teach these features. Applicant respectfully submits that claim 2 and its dependent claims are patentable over Sulzberger and Boldi for at least these reasons.

Claims 11-21

Independent claims 11 and 16 each include features similar to those of claim 2 discussed above. Thus, Applicant respectfully submits that claims 11 and 16, as well as their dependent claims, are patentable over the cited references for at least the same reasons as claim 2.

CONCLUSION

In view of the foregoing, Applicant believes all claims now pending in this Application are in condition for allowance and an action to that end is respectfully requested.

Except for the issue fees payable under 37 C.F.R. § 1.18, the Director is authorized to charge any additional fees during pendency of this application, including any required extension of time fees, or credit any overpayment to Deposit Account Number 20-1430. This paragraph is intended to be a constructive petition for extension of time in accordance with 37 C.F.R. § 1.136(a)(3).

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (650) 326-2400 or kcatmull@kilpatricktownsend.com.

Respectfully submitted,

/Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

KBC:bsk

70249150V.1

Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1. (Canceled)

2. (Previously Presented) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time; and

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

3. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

4. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in network conditions, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

5. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on load balancing, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

6. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in subscriber needs, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

7. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

8. (Previously Presented) The host unit of claim 2, wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface.

9. (Previously Presented) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

10. (Previously Presented) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal in compliance with the Common Public Radio Interface (CPRI) standard.

11. (Previously Presented) A system for transporting wireless communications, comprising:

a host unit;

a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals; and

wherein the host unit is capable of receiving digital signals from each of the plurality of remote units.

12. (Previously Presented) The system of claim 11, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

13. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through a direct connection.

14. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through an indirect connection.

15. (Previously Presented) The system of claim 11, wherein each remote unit comprises at least one interface to communicatively couple the remote unit to another one of the

plurality of remote units in a daisy-chain configuration.

16. (Previously Presented) A method for providing digital signals in a Distributed Antenna System (DAS), comprising:

transmitting from a host unit, at a first point in time, a first set of downlink channel signals to a first remote unit;

transmitting from the host unit, at a second point in time, a second set of downlink channel signals to the first remote unit;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

17. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a change in network conditions from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

18. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on load balancing from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

19. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a schedule from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

20. (Previously Presented) The method of claim 16, wherein the downlink channel signals are packetized.

21. (Previously Presented) The method of claim 20, wherein the downlink channel signals are packetized in compliance with the Common Public Radio Interface (CPRI) standard.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-8,548,526	B2	10-01-2013	Schmidt et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	2.	US-2011/0241425	A1	10-06-2011	Hunter, JR. et al.	
	3.	US-2010/0291949	A1	11-18-2010	Shapira et al.	
	4.	US-2014/0126914	A1	05-08-2014	Berlin et al.	
	5.	US-2011/0135013	A1	06-09-2011	Wegener	
	6.	US-2009/0003196	A1	01-01-2009	Capece et al.	
	7.	US-2010/0178936	A1	07-15-2010	Wala et al.	
	8.	US-2012/0281565	A1	11-08-2012	Sauer	
	9.	US-2011/0249708	A1	10-13-2011	Maca	
	10.	US-2005/0143091	A1	06-30-2005	Shapira et al.	
	11.	US-2002/0191565	A1	12-19-2002	Mani et al.	
	12.	US-2017/0214420	A1	07-27-2017	Phillips et al.	
	13.	US-2008/0058018	A1	03-06-2008	Scheinert	
	14.	US-2011/0281579	A1	11-17-2011	Kummetz	
	15.	US-2011/0223958	A1	09-15-2011	Chen et al.	
	16.	US-2011/0069657	A1	03-24-2011	Gholmieh et al.	
	17.	US-2009/0274085	A1	11-05-2009	Wang et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	18.	101394647	CN	A	03-25-2009	Datang Mobile Comm Equip Co		
	19.	10-1996-0702978	KR	A	05-23-1996	ADC Telecommunications, Inc.		

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	20.	Office Action for Chinese Patent Application No. 201510531485.1 mailed on November 2, 2017, 6 pages.	
	21.	Notice of Allowance for Korean Patent Application No. 10-2015-7024302, mailed November 10, 2017, 5 pages.	

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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

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

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on Novenber 28, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

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

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

With regards to references 18 through 21, I hereby certify that these items of information contained in this Information Disclosure Statement were first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

I hereby certify that references 1 through 17 contained in the Information Disclosure Statement filed herewith were not cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the Information Disclosure Statement.

This Information Disclosure Statement is being filed after an action closing prosecution, but before the payment of the Issue Fee.

The Commissioner is authorized to charge the fee set forth in §1.17(p) to the firm's credit card for consideration of this paper. The Commissioner is authorized to charge any additional fee due to Deposit Account No. 20-1430.

Respectfully submitted,

/Kelvin B. Catmull/

Kelvin B. Catmull
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KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

Patents

Sign In

Method and system for realizing cell networking

Abstract

The invention discloses a method for cell-networking, which is used for realizing the flexible planning of a cell and the cell networking in various forms, and improving the availability of a frequency spectrum or saving network resources. The method comprises cell split and cell merge. The cell split method and the cell merge method comprise cell establishment and cell deletion. The cell split method comprises the following steps: calculating the occupation situations of physical resources on a plurality of antennae corresponding to the same cell; determining the physical resources occupied being not less than the prearranged threshold value continually within the prearranged time, and determining to carry out the cell split when reaching the prearranged time; splitting the same cell into at least two cells; and respectively allocating the antennae to the two cells. The cell merge method is similar to the cell split method. The invention further discloses a device, a distributed typebase station and an internal unit thereof for planning a cell.

Classifications

H04W16/24 Cell structures

View 1 more classifications

CN101394647A

CN Application

Find Prior Art

Other languages: Chinese

Inventor: 军 李, 王洪波, 煊 范, 邹素玲

Original Assignee: 大唐移动通信设备有限公司

Priority date: 2007-09-21

Family: CN (1) WO (1)

Date	App/Pub Number	Status
2007-09-21	CN 200710122184	
2009-03-25	CN101394647A	Applicatio
2013-10-02	CN101394647B	Grant

Info: Patent citations (14), Cited by (18), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (41)

translated from Chinese

1, a distributed base station of the cell erasing method, characterized by comprising the steps of: deleting the plurality of antennas corresponding to the same cell in which at least a common channel and a dedicated channel on one antenna; and said at least one antenna and the cell state is set to the common channel is absent; removal of the radio link on the at least one antenna.

2, a cell as claimed in claim 1 deletion method, wherein the plurality of antennas of the same or different RRU.

3, the method of deleting a cell as claimed in claim 1, wherein said at least one common antenna is an antenna or smart antenna comprising a plurality of antenna elements, or from polarized antenna.

4, a cell as claimed in claim 1 deletion method, wherein the request to delete the common channel on the multiple antennas at the same cell, and deleting the message dedicated channel according to a cell.

5. A method of splitting a cell, characterized by comprising the steps of: physical resource occupancy statistics on a plurality of antennas corresponding to the same cell; determining a physical resource within a predetermined time duration occupied not less than a predetermined "i Shu threshold value, and determines the need for cell division at the preset time; the same cell is split into at least two cells, and the plurality of antennas are arranged into at least two cells.

6, cell splitting method as claimed in claim 5, wherein, when the physical resources occupied start timing reaches the threshold value, and when the occupied time of the timer does not reach the preset time physical resources is less than the threshold value, the timed clear.

7, cell splitting method as claimed in claim 5, wherein the same cell is split into at least two cells comprising the step of: deleting the cell corresponding to a plurality of resources on the same cell antennas, respectively, and said plurality of different antenna configurations cell resources; or delete the resource on the cell corresponding to a plurality of antennas in the same cell in the portion of the antenna, and the cell configuration different from the resources of the same cell as part of the antenna.

8, cell splitting method as claimed in claim 7, wherein said resources comprise at least a cell i is also present cell identification.

9. The cell splitting method according to claim 7, characterized in that the cell resource configuration process, when the same cell need to configure resources to a plurality of antennas, according to a cell setup request message to a plurality of identical antenna configuration community resources.

10. The method as claimed in cell division in claim 5, wherein said plurality of antennas corresponding to the same cell belonging to the same radio remote unit RRU or belong to different RRU.

11. The method as claimed in cell division in claim 5, wherein said plurality of antennas corresponding to the same cell in an antenna common antenna or smart antenna comprising a plurality of antenna elements, or the polarization antenna.

12. The method as claimed in cell division in claim 5, wherein the physical resources include transmit power and / or channelization code resource.

13. The cell splitting method according to claim 5, characterized in that the further digital signals from the plurality of antennas corresponding to the same cell correspond to the same sub-carrier multiplexed digital signal is superimposed in the same time position vector.

14. A method for combined cell, characterized by comprising the steps of: physical resource occupancy

statistics within each cell; determining the presence of at least two cells, at least two cells for each cell within a preset time determining the need for merging cells occupied physical resources is not greater than a predetermined duration threshold, and the at least two cells have reached the preset time; the at least two cells into one cell, the corresponding original at least two of said plurality of antennas disposed to the cells a cell.

15, a cell as claimed in claim 14 combined method, wherein the physical resources include transmit power and / or channelization code resource.

16. An apparatus for network planning a cell, characterized by comprising: a counting unit, the physical resource consumption statistics on a plurality of antennas corresponding to the same cell; and control means for determining a preset time physical resources occupied duration not less than a preset threshold value, and determines the need for cell division at the preset time; configuration unit, the same cell for splitting at least two cells, and the plurality antennas are arranged into at least two cells.

17. The apparatus as claimed in claim 16, characterized in that said means belonging to the radio network controller the RNC, the OMC or an evolved base station.

18 A the RRU, characterized by comprising: an external interface unit for receiving and sending messages; radio unit for connecting a plurality of antennas and receiving radio frequency signals from a plurality of antennas and transmitting radio frequency signals to a plurality of antennas ; configuration unit for establishing request message according to the received cell is connected to the plurality of antennas configured to at least one cell, and the deletion request message according to the received cell to the plurality of antennas at least one antenna cell resource deletion.

19, the RRU as claimed in claim 18, characterized in that, further comprising: a combining unit, configured to correspond to the same sub-carrier digital signal in the same time position on the upstream digital signal corresponding to the same cell of a multi-antenna Gen ^ f vector superposition.

20, a distributed base station, comprising: an antenna for receiving and transmitting analog RF signals; the RRU radio remote unit, connected to the plurality of antennas, for establishing request message according to the received cell is connected a plurality of antennas arranged at least one cell, and a cell according to the received deletion request message, deletes the cell resources on a plurality of antennas at the same cell at least one antenna; the BBU base band unit, for processing the digital signal from the RRU.

21. The distributed base station according to claim 20, wherein the RNC or the forwarding to the cells transmitted by the OMC by the RRU and BBU cell setup request message deletion request message.

22, the distributed base station as claimed in claim 20, wherein the cell established by the transmission to the OMC request message and the RRU cell delete request message.

23, the distributed base station as claimed in claim 20, characterized in that, comprising: a cell planning means for planning a cell, a cell setup request message and sends a deletion request message to the cell and the RRU.

24, the distributed base station as claimed in claim 23, characterized in that the unit is located within the cell planning BBU.

25, the distributed base station as claimed in claim 20, characterized in that it comprises a plurality of the RRU, the RRU is a plurality of series, parallel or hybrid relationships; and / or the distributed

base station with the RRU other RRU comprising as series or parallel relationship.

26, the distributed base station as claimed in claim 25, wherein a plurality of said at least one antenna on the RRU one RRU and the at least one antenna on the other RRU corresponding to the same cell.

27, a distributed base station, comprising: an antenna for receiving and transmitting analog RF signals; a plurality of the RRU, respectively, for establishing a cell according to the received resource request message cell is configured to connect to a local antenna , and a cell according to the received deletion request message, deletes the resources on a cell connected to a local antenna; wherein the plurality of antennas a plurality of RRU configured with the same cell resources; the BBU, for from the RRU digital signal processing.

28, the distributed base station as claimed in claim 27, wherein said plurality of RRU in series, parallel or hybrid relationships; and said plurality of RRU and the base station includes a distributed RRU other in series or parallel relationship.

29, the distributed base station as claimed in claim 27, wherein the RNC or the forwarding to the cells transmitted by the OMC by the RRU and BBU cell setup request message deletion request message.

30, the distributed base station as claimed in claim 27, wherein transmitting a cell established by the RRU to the OMC request message and a cell delete request message.

31, the distributed base station as claimed in claim 27, characterized in that, comprising: a cell planning means for planning a cell, a cell setup request message and sends a deletion request message to the cell and the RRU.

32. A distributed base station, comprising: an antenna for receiving and transmitting analog RF signals; the RRU radio remote unit, connected with a plurality of antennas, for converting the analog RF signals from the plurality of antennas is after transmitting the digital signal, wherein the plurality of antennas corresponding to the same cell, each portion of the antenna or the antennas corresponding to a plurality of different cells; the BBU base band unit, for processing the digital signal from the RRU.

33, distributed base station as claimed in claim 32, characterized in that it comprises a plurality of the RRU, the RRU is a plurality of series, parallel or hybrid relationships; and / or the distributed base station with the RRU other RRU comprising as series or parallel relationship.

34, the distributed base station as claimed in claim 33, wherein the at least one antenna of at least two RRU corresponding to the same cell on each RRU.

35, the distributed base station as claimed in claim 34, wherein said distributed base station comprises all RRU corresponding to the same cell.

36. The distributed base station according to claim 32, characterized in that, further comprising: a baseband interface the BIU unit, for forwarding the digital signals between the BBU and the RRU.

37, the distributed base station as claimed in claim 36, wherein the RRU is a plurality, the plurality BIU; a plurality of the BBU to the RRU are connected by a plurality of said BIU.

38, distributed base station as claimed in claim 32, wherein said distributed base station comprises a plurality of BBU.

39, a distributed base station, comprising: an antenna for receiving and transmitting analog RF signals; a plurality of RRU, each RRU includes an antenna for the RF analog signals from the antenna into a digital signal transmitting; wherein a plurality of said plurality of RRU antennas corresponding to the same cell; the BBU, a digital signal from the RRU processing.

40, fans 39 as claimed in claim distributed base station, wherein said plurality of RRU in series, parallel or hybrid relationships; and said plurality of RRU and the other RRU of the distributed base station comprises a series or parallel relationship.

41, the distributed base station as claimed in claim 39, characterized in that, further comprising: one or more baseband interface the BIU unit, configured between the BBU and the RRU plurality of forwarding the digital signal.

Description

translated from Chinese

A method for implementing a cell and networking systems

FIELD

The present invention relates to communication field, particularly to a method and system for networking the cells to achieve. Background technique

Currently the prior art, a conventional antenna or smart antenna comprising a plurality of antenna elements corresponding to a cell. With the rapid development of communication users and communication services, existing community resources can not meet the demand, in order for communication system expansion, one way is to increase the number of antennas in order to increase community resources, another way is to multiplex signal into one signal.

In the conventional base station system, the transmission between the transceiver and the baseband analog signal. Can be superimposed on an analog signal through the transmission line is directly sent to the baseband processing side. However, during the transmission of analog signals, as the transmission distance increases, the analog signal will continue to decay. In the long-distance transmission of analog signals, typically using a relay device (such as a dry discharge station) for amplifying the analog signal processing to achieve coverage without blind spots, however, while the amplified analog signal is also amplified noise signal, the signal quality serious impact, and there is a greater power consumption, but the disadvantage is not easy to maintain the relay device.

Currently, the emergence of a prior art Remote Radio, the radio base station remote units, set

Near the antenna. In this manner, it implements a baseband unit (BBU) can be connected to a plurality of radio remote unit (the RRU), but due to the limitations of existing hardware level, the BBU baseband demodulation can not exceed the design capability to support a plurality of antennas, for example a BBU supports up to 6 sub-carriers (denoted by C), 8 antennas (indicated by a), the support up to 48 signals. Since some drawbacks analog signal is achieved by increasing the number of antennas considered way no blind cover, and a limited processing capacity of the BBU, so this needs to be increased to achieve BBU capacity expansion of the communication system. However, the relatively high cost of BBU, expansion work to bring pressure. And, requires additional artificial antenna communication system, and each time the expansion phase

Corresponding RRU, it may further require additional BBU, in this way take up more human

resources. in case

In the initial stage of networking will build more antennas and cell, resulting in a waste of communication system resources.

Be seen, the prior art in order to meet the communication needs of business development, one way is to support more semaphores by superimposing an analog signal of a way to achieve coverage without blind spots, but there are shorter distance this manner, the signal to noise greater interference problems. Another way is by artificial means continued expansion of communication systems, but requires more human resources. Yet another way is in the initial stage of networking will build more antennas and cell communication system but lead to a waste of resources.

SUMMARY

Embodiment of the present invention provides a method and system for implementing a cell network for flexible network planning and various forms of cells to achieve cell, spectrum efficiency or save network resources.

A method for deleting cell distributed base station, comprising the steps of:

A plurality of antennas corresponding to the same cell to remove at least a common channel and a dedicated channel on one antenna;

The state of the cell on at least one antenna and the common channel is set does not exist;

The removal of the at least one antenna on a wireless link.

A cell splitting method, comprising the steps of:

Physical resource occupancy statistics on a plurality of antennas corresponding to the same cell;

Determining occupied within a preset time duration physical resource is not less than a predetermined threshold value, and determines the need for cell division at the preset time;

The same cell is split into at least two cells, and the plurality of antennas are arranged into at least two cells.

A cell combining method, comprising the steps of:

Physical resources within each cell occupancy statistics;

Determining the presence of at least two cells, at least two cells for each cell, the physical resource within a preset time duration occupied not greater than a preset threshold value, and the at least two cells have reached a predetermined The combined time required to determine the cell time;

Said at least two cells into one cell, the at least two of said original corresponding to a plurality of cells of the one cell antenna configuration.

An apparatus for network planning a cell, comprising:

Statistics unit, the physical resource consumption statistics on a plurality of antennas corresponding to the same cell;

A control unit for determining physical resources occupied within a preset time duration not less than a predetermined threshold value, and determines the need for cell division at the preset time;

Configuration unit for the same cell is split into at least two cells, and the plurality of antennas are arranged into at least two cells.

One kind of RRU, including:

The external interface unit, for receiving and sending messages;

A radio frequency unit for connecting a plurality of antennas and receiving radio frequency signals from a plurality of antennas and transmitting radio frequency signals to a plurality of antennas;

Configuration unit for establishing request message according to the received cell is connected to the plurality of antennas configured to at least one cell, and the deletion request message according to the received cell to the plurality of antennas at least one antenna delete community resources.

A distributed base station, comprising:

An antenna for transmitting and receiving analog RF signals;

The RRU radio remote unit, connected to the plurality of antennas, for establishing request message according to the received cell is connected to a plurality of antennas arranged at least one cell, and the deletion request message according to the received cell, the plurality of cells under the same antenna cell resources on the at least one antenna deleted;

Baseband unit BBU, for processing the digital signal from the RRU.

A distributed base station, comprising:

An antenna for transmitting and receiving analog RF signals;

A plurality of the RRU, each configured for a cell setup request message to a resource connected to the local antenna, and the deletion request message according to the received cell, the cell will be deleted resources on a local connection of the antenna according to the received cell; wherein a plurality of RRU multiple antennas configured with the same cell resources;

BBU, configured to process the digital signal from the RRU.

A distributed base station, comprising:

An antenna for transmitting and receiving analog RF signals;

The RRU radio remote unit, connected to the plurality of antennas, for transmitting the converted analog radio frequency signals from a plurality of antennas into digital signals, wherein said plurality of antennas corresponding to the same cell, or a plurality of antennas each part of the antenna corresponding to a different cell;

Baseband unit BBU, for processing the digital signal from the RRU.

A distributed base station, comprising:

An antenna for transmitting and receiving analog RF signals;

A plurality of RRU, each RRU includes an antenna for transmitting the converted analog RF signals from the antenna into a digital signal; wherein said plurality of RRU multiple antennas corresponding to the same cell; the BBU, for from the RRU digital signal processing.

Example embodiments provide a method for cell planning, including deleting a cell, cell splitting and merging cells, enables flexible network cell, the cell may be dynamic based on the actual programming and networking environment, saving human resources or the present invention improves the communication transmission quality. Further, embodiments of the present invention provides an apparatus for base stations and distributed programming cell, cell enables flexible networking.

BRIEF DESCRIPTION

FIGS 1A- FIG configuration diagram of a distributed base station in embodiment 8 of the present invention;

9 flowchart showing a main method for establishing a cell in the embodiment of the embodiment of the invention;

Examples RNC 10 initiates a flowchart of a method embodiment of the cell to establish cell established when the present invention;

11 flowchart OMC embodiment a method for initiating the establishment of a cell when the cell to establish the present invention;

The method of initiating the flow cell to establish cell established when an evolved base station according to embodiment 12 of the present invention, FIG.

Figure;

FIG flowchart showing a main method of Example 13 to remove cell embodiment of the invention;

FIG 14 a flow chart of a specific method embodiment remove cell embodiment of the invention;

FIG flowchart showing a main method of embodiment 15 cell divisions embodiment of the invention;

FIG. 16A flowchart of a specific embodiment for a method according to a cell transmission power split embodiment of the present invention;

FIG. 16B flowchart of a specific embodiment a method for splitting a cell code channel resource according to embodiments of the present invention;

Example 17 The combined cell flowchart of a method embodiment of the present invention;

The basic structure of FIG. 18 in the embodiment of FIG RRU embodiment of the invention;

19 detailed structure of the embodiment according to the present invention RRU;

FIG 20 cell plan configuration diagram of the embodiment of the present invention means;

21 in a configuration diagram of an RNC embodiment of the present invention.

detailed description

Embodiments of the invention according to the actual environment in which a plurality of antennas corresponding to a cell, a cell in order to save resources, or to a plurality of antennas corresponding to a plurality of cells, or to meet the traffic needs of the user communications.

Examples of cell resources include local cell ID, and physical training sequence resource

embodiment of the present invention, the physical resources include transmit power and channel code resources.

Distributed base station in the embodiment of the present invention (referred to as a base station) includes a base station (Node B) under the Universal Mobile Telecommunications System (Universal Mobile Telecommunication System 'UMTS) and Long Term Evolution evolved NodeB under (Long Time Evolution, LTE) system (Evolved Node B). Example embodiments of the present invention the antenna comprises a common antenna, having a smart antenna and a non-smart antennas (such as polarized antenna), and other antenna elements. An antenna in the embodiment of the present embodiment is determined to be a channel, a plurality of antennas connected RRU multichannel RRU, RRU single antenna is connected to a single channel RRU.

Distributed base station according to embodiments of the present invention (referred to as a base station) includes an antenna for receiving and transmitting analog RF signals, BBU and RRU (including multi-channel and single RRU RRU) and the like. Distributed base station may comprise a plurality of RRU, RRU may be a plurality of parallel, series or hybrid relationship. The hybrid relationship means: a plurality of series relationship RRU constituting a parallel relationship with one or more other RRU, RRU all of these series relationship and parallel relationship constitute hybrid relationship. Embodiments of the present invention may be initiated to establish cell-cell and remove the device includes a radio network controller (Radio Network Controller, RNC), operation and maintenance center (Operation & Maintenance Center, OMC) and an evolved base stations.

The BBU in the distributed base station for processing a baseband digital signal. When the RNC or by OMC

When the cell network planning, BBU RNC is further configured to forward the cell or OMC setup request message and sending a cell delete request message. When planning a network cell evolved base station, comprising a distributed base station cell planning unit 101, see FIG. 1A, the cell planning unit for planning cell 101, the cell is determined to create and delete the like, generates and transmits a cell setup request message and the cell deletion request message, may be sent directly to the RRU, or forwarded to the RRU via the BBU. The cell scheduling unit 101 may also be attributable to a BU, equivalent cell network planning by the BBU. Which, BBU may be multiple, constitute BBU pool resources together to provide services for the RRU connection.

RRU for transmitting the converted plurality of antennas connected to the radio frequency of the received analog signals to digital signals, and converting the received digital signal by a plurality of antennas to transmit the analog RF signals, the plurality of antennas corresponding to at least one cell. RRU is further configured to setup request message according to the received cell is configured to connect a plurality of antennas at least one cell, and the deletion request message according to the received cell, the cell resources on the plurality of antennas at least one antenna deleted. A BBU connected to the plurality of channel RRU example shown in Figure 1B. A plurality of multi-channel RRU may correspond to a cell, or a multi-channel portion of the antenna on the antenna RRU and other multi-channel or single RRU RRU corresponds to one cell. The multi-channel RRU can, a plurality of the prior art is connected to a plurality of single-channel RRU RRU, configured in series, parallel or hybrid relationship, and the multi-channel RRU, RRU, and the prior art single channel of a cell may correspond RRU .

Alternatively, the RRU sends the converted for a connected antenna the received analog RF signal to a digital signal, and converting the digital signal received by an antenna to transmit the analog radio frequency signals. The RRU is further configured to setup request message configured according to the received cell to a cell connected to an antenna, and a delete request message

according to the received cell, the cell resources on an antenna deleted. May correspond to a plurality of single-channel RRU cell, a single-channel BBU and RRU are connected example shown in FIG. The single channel with a plurality of multi-channel RRU RRU, RRU in the plurality of the prior art connector, configured in series, parallel or hybrid relationship.

Examples of a plurality of BBU may be connected RRU, the present embodiment provides a plurality of BBU RRU are connected in series relationship as shown in FIG.

Distributed base station may further comprise one or more baseband interface units (the BIU), see FIG. 2, 4-8, the BIU for forwarding a digital signal between the RRU and the BBU, so that any BBU may RRU

Connection, the network in the form of more flexible.

By the above-described embodiments can be seen, a BBU connector beyond its design capacity of a plurality of antennas, and more BBU to process signals from the antenna must be within the scope of its design capacity, the present embodiment provides a combined digital signal from the plurality of antennas a method the BBU in line with multi-channel digital signal processing design capacity.

The combined digital signal is: time synchronization based on the principle of multi-channel digital signal corresponding to the same sub-carriers and superimposed on the same cell vector. Corresponding to the same sub-carriers and the same cell on the I component of the direction of multi-channel digital signal, in the same time position of the overlay operation, and corresponding to the same sub-carriers and the same cell multiplexed digital signal Q component direction, follow the same temporal position overlay for shoving. In this embodiment, the digital signal is regarded as' T 'and "O" continuous combined as one digital data signal at a point in time is 1100, every' T or "O" that is a data. In the same point in time, that is multi-channel digital data signals superimposed on multiplex bit digital signals are added, the operation of the binary adder. This embodiment will be further described by a mathematical model. Suppose a point in time is represented as a digital signal in the form of an + jbn, a represents the data component in the direction I, j represents the Q component, b represents the Q component of the data on the direction, n-different values to identify the brightest figures signal. Then, the process of merging the digital signal can be expressed as:

(A1 + j * b1) + (a2 + j * b2) + .. • + (an + j * bn) = (a1 + a2 + .. • + an) + j * (b1 + b2 + .. ■ + bn)

A plurality of distributed units merge operation can be carried out inside the base station a digital signal, such as the BBU, BIU

And RRU can merge operations.

Understand the structure of the distributed base station can operate the cell planning, including the establishment of a cell and the cell removed.

Referring to Figure 9, the main process of the method established in the cell of the present embodiment is as follows: Step 901: at least two antennas assigned to the same local cell identifier. Step 902: Configure at least two antennas to the maximum output power. Step 903: the at least two antennas arranged training sequence and channel resources and the like.

The method of the above-described process to achieve a cell corresponding to a plurality of antennas, diversity or MIMO multiplexing system may be employed to improve transmission quality in the cell, or improve the carrying capacity of the cell. Next, the established cell side

Method described in detail, the first case RNC initiates the cell establishment process, see FIG. 10, the specific flow of the method is as follows:

Step 1001: RNC initiates a resource audit process, sending the audit request message, to inform resource audit performed NodeB Node B. Or, NodeB periodically take the initiative to report the audit results to the RNC. Step 1002: RNC message needs to be determined according to established cell Node B returns audit response.

Step 1003: RNC to the Node B transmits a cell setup request message.

RNC may indicate that Node B configured cell resources to a specific antenna by establishing request message in the cell to increase cell mode, the cell such as (T1, T3, T5), shows an arrangement the same as identified as T1, T3 and the antenna T5 of cell resources, i.e. antennas T1, T3 and T5 corresponding to the same cell. May be further increased on the RRU cell, such as (R1 (T1, T3, T5), R3 (T1, T2, T4)), expressed as the identifier to identify the RRU RI is T1, T3 and T5 of the antenna and the identification the same configuration as the cell resources T1, T2 and T4 to the antenna on the identification of R3 RRU. Alternatively, RNC sending established by multiple cell configuration request message indicates the same cell Node B resources (esp same local cell identifier) for the plurality of antennas. Alternatively, RNC by sending a cell setup request message a plurality of times indicates a different configuration of Node B resources for cells of a plurality of antennas on the RRU (esp configuration different local cell identifier).

RNC may be further increased by establishing request message indicating cell Node B mode cells to a plurality of antennas, such as single-frequency cells arranged in a cell.

Step 1004: Node B establishment request message to a plurality of antennas assigned the same local cell identifier, and stores the allocation result according to the received cell. Local cell identifier to distinguish cell marker, as long as the two regions of the local cell identifier different, then the two regions belong to different cells.

Node B can configure a respective antenna request identifying the message carried by the antenna according to the cell established. Alternatively, when a cell setup request message does not carry the antenna identifier, Node B according to the results of the audit

Determining the need for establishment of cell antennas and cell establishment request message to configure the respective antenna.

Step 1005: Node B setup request message to set the maximum output power of multiple antennas in accordance with the received cell.

Step 1006: Node B establishment request message to a plurality of antenna configurations channel resource, establishing CPICH, PSCH, SSCH, PCCPCH, BCH accordance with the received cell.

The second situation is OMC initiate cell establishment process shown in Figure 11, the specific flow of the method is as follows:

Step 1101: OMC RNC starts to establish a trigger cell by the control message.

Step 1102: RNC sends a cell to the Node B receives the control message setup request message.

Step 1103: Node B according to a cell setup request message is received from a plurality of antennas assigned the same

Local cell identifier, and stores the allocation result. Wherein, Node B transmitted according to the received control OMC

Antenna system message needs to know the cell configuration.

Step 1104: Node B according to a cell setup request message is received from a plurality of antenna configurations maximum output

Out of power.

Step 1105: Node B cell setup request message according to the received channel resource configuration is a plurality of antennas.

OMC may also trigger the LTE system evolved base station starts to establish a cell, a cell is configured by an evolved base station according to the control message transmitted by the OMC of a respective plurality of antennas to establish cell.

The third case is a cell in the LTE system initiates the process of establishing by an evolved base station, see Figure, specific flow of the method 12 are as follows:

Step 1201: The base station initiates cell evolved according to the conditions established physical resources and logical resources.

Step 1202: a plurality of antennas assigned the same local cell ID, and evolved base station allocation result is saved.

Step 1203: Configure an evolved base station maximum output power of a plurality of antennas. Step 1204: a plurality of evolved base station antenna configuration channel resources.

Referring to Figure 13, the main process of the method of the present embodiment to remove the cell as follows: Step 1301: Delete a plurality of antennas corresponding to the same cell ^ at least one common channel and a dedicated channel on the L antenna.

Step 1302: the state of the cell on at least one antenna and the common channel is set to not exist. Step 1303: the removal of the radio link on the at least one antenna. Referring to Figure 14, the specific process of the method of the present embodiment to remove the cell as follows: Step 1401: The base station determines that a cell of the delete operation.

The base station may determine the need of physical resources and logical resources of the removal of an antenna cell resources, i.e., deleting all or part of a cell. Alternatively, the base station cell according to the deletion request message sent by the RNC determines that a cell of the delete operation, wherein the RNC may initiate cell deletion or OMC, the base station may remove cell deletion request message on a plurality of antenna resources according to a cell received, the message deletion request or a plurality of cells are received on the cell resources to delete a plurality of antennas at the same cell.

Alternatively, when a plurality of cells corresponding to the antenna, a base station may remove some or all of cell ^ i Gen the antenna.

Step 1402: Delete the base station corresponding to a plurality of antennas in the same cell common channel and a dedicated channel on the at least one antenna.

Step 1403: The status of the base station on the at least one cell antenna and the common channel is set to not exist.

Step 1404: The base station radio link removal on the at least one antenna. By the above described embodiments learned about the cell to establish a plurality of antennas and remove the square cell

France, then the change can be achieved on further residential networking multiple antennas, and re-planning area, including

Including cell division and cell combined.

Cell is a cell division split into a plurality of cells, it may be deleted corresponding to a plurality of antennas

Cell, then the establishment of at least two cells of a plurality of antennas; or delete a plurality of cells corresponding to the same day

Resource cell line antenna portion and create a new cell that is part of the antenna. Cell splitting can be adapted to pass

Telecommunication services and user communications needs of development, is also applicable to a variety of changes in the physical environment, such as inter-cell corresponding to the same two antennas of a new high-rise buildings, which leads to the two antenna coverage areas isolation, blocking transmission of wireless signals, and It may lead to a rapid increase in traffic and communications users. Cell division process can be controlled by OMC. Embodiment provides a dynamic cell splitting process of the present embodiment, a flexible adapter

Should the actual surroundings and the radio transmission requirements, as shown in Figure 15, the main flow of the method is as follows: Step 1501: the total physical resource consumption statistic corresponding to a plurality of antennas on the same cell. can

Statistical operation simultaneously for all cells, a cell in the present embodiment described in detail as an example.

Step 1502: determining physical resources occupied within a preset time duration is not less than a preset threshold

Value, and determine the need for cell division when the preset time.

Step 1503: the same cell is split into at least two cells, and the plurality of antenna

Respectively disposed to said at least two cells.

Wherein the physical resources include transmit power and channel code resources, etc., may be carried out according to any physical resource

Cell division, are described in detail below.

Referring to Figure 16A, depending on the particular method of transmission power cell splitting process is as follows:

Step 1601: the total transmit power of a plurality of antennas corresponding to the same cell count.

Step 1602: When the total transmit power reaches a threshold power split, starts counting.

Step 1603: determining whether the counted time reaches a preset time, and determining the total transmit power

Whether continued to meet or exceed the threshold power split.

Step 1604: When the timer reaches the preset time period and the total transmit power continued to meet or exceed the

When the power split threshold, initiates a cell division operations. Proceed to step 1606. For example, the maximum transmit power

W is m, the predetermined time is n days, the threshold value is 10 watts power split, when the total transmit power to 10

And sustained between day n m, is required to determine cell division.

Step 1605: When the timer preset time period is shorter than the total transmit power will be reduced to the power division

Below the threshold, clear the timing of time. May continue to step 1601.

Step 1606: the at least one cell is split into two cells. There are many specific ways, such as deleting

The cell resources on the at least two antennas, and are arranged at least two different cell antenna

Resources; or deleting said at least two antennas in an antenna on the cell resources, and one of the

Antenna configuration is different from the same cell-cell resource. May continue to step 1601.

Referring to Figure 16B, cell splitting transmission power according to the specific flow of the method is as follows: Step 1611: the total code channel resource consumption, particularly statistical manner corresponding to the plurality of antennas is the same cell traffic statistics.

Step 1612: When occupied code channel resources to achieve code channels division threshold value, starts counting. Step 1613: determining whether the counted time reaches a preset time, and determining whether the total transmission power reaches or exceeds a duration threshold code division channel.

Step 1614: When the timer reaches the preset time to time and has been occupied by the code channel resources continue to meet or exceed the track division threshold, initiates a cell division operations. Proceed to step 1616.

Step 1615: When the counted time does not reach the preset time has been occupied by the code channel resources will track down separatist below a threshold value, clear the timing of time. May continue to step 1611.

Step 1616: the at least one cell is split into two cells. DETAILED DESCRIPTION There are various cells such as deleting the resource on the at least two antennas, respectively, and the at least two different cell resources antenna configuration; or, deleting said at least two antennas in a cell on an antenna resources, and an antenna configuration is different from the resources of the cells of the same cell. May continue to step 1611.

The method of the above-described two embodiments are respectively divided cells according to the transmit power and code channel resource description, may be further embodiments in conjunction with the above-described two embodiments, when the transmit power and channel

code resources within a preset time duration not less than the average when reading the value corresponding to each identified a need for cell division.

Process and cell division process corresponding to the cell is combined, the plurality of cells is a cell merge into one cell. I.e., remove the cell resources corresponding to a plurality of antennas of a plurality of cells, and then configure the same cell resources plurality of antennas; or delete cell resources on a plurality of antennas of a cell, and then the plurality of antenna configurations and other a cell of the same cell resources. The combined plurality of cells adapted to change the actual environment, such as a high-rise building between the adjacent two cells were removed, the original transmission path becomes blocked clear radio signal, and may result in rapid decrease traffic and communication subscribers . The combined process cell can be controlled by OMC. It provides a combined cell dynamics process of the present embodiment, a flexible

Adapt to the actual surroundings, see FIG. 17, the flow of the method is as follows:

Step 1701: Statistical Physics resource consumption in each cell.

Step 1702: determining at least two cells, at least two cells for each cell, the physical resources occupied within a preset time duration is not greater than a predetermined threshold value (in this embodiment, said combined threshold), and determining a cell needs to be combined when the at least two cells have reached the preset time.

Step 1703: the at least two cells into one cell, the at least two of said original corresponding to a plurality of cells of the one cell antenna configuration. There are many specific implementations, such as the deletion of at least two cells, and then at least two of the plurality of antennas at the same cell configuration of the cell resources; or deleting said at least two cells as a cell corresponding to the antenna resources on a cell, then the configuration is the same cell to another cell resources for this cell a corresponding antenna.

Wherein the physical resources include transmit power and channel code resources, a cell may be split according to any one or more of the physical resources.

By the above described embodiments of a method to understand the structure and cell planning distributed base station, the following internal structure of a distributed base station units will be described.

Referring to Figure 18, in the embodiment according to the present embodiment RRU includes an external interface unit 1801, radio unit 1802 and a configuration unit 1803.

The external interface unit 1801 for connecting to other units in the distributed base station (e.g., BBU, BIU or

OMC and the like), receive and transmit messages in the form of digital signals.

Radio frequency unit 1802 for connecting the plurality of antennas, and receive and transmit radio frequency signals.

Configuration unit 1803 for establishing said plurality of day message to the connection request based on the received cell

Configured to at least one cell line, and the deletion request message according to the received cell, the plurality days

Remove cell line resources on the at least one antenna.

RRU further comprising an intermediate frequency unit 1804 and a merging unit 1805, see FIG. 19. Intermediate frequency unit 1804 for converting the radio frequency unit receives radio frequency signals into a digital signal. Combining unit 1805 configured to correspond to the same cell of the same sub-carriers and a plurality of digital signal

Digital signal vector superposition of the antenna.

Referring to Figure 20, apparatus for programming a cell of the present embodiment (referred to in this embodiment a single cell plan

Yuan) including statistical unit 2001 2002 control unit and a configuration unit 2003.

Counting unit 2001 for a physical resource occupancy statistics plurality of antennas corresponding to the same cell. The control unit 2002 for determining the occupied physical resources is not less than a certain preset time

Split threshold, and deciding cell division; and, determining the presence of at least two cells, for

The combined width set value, and determines a cell needs to be combined when the at least two cells have reached the preset time.

Configuration unit 2003 for, when the counted time reaches the predetermined time duration and divide reaches or exceeds the threshold value when occupied physical resources, and generating a cell delete request message and sending a cell setup request message, the cell is split into two identical a cell, said at least two antennas respectively corresponding to the two cells; and, when the physical resources counted time reaches the predetermined time and occupied combined lasts no more than a threshold value, and generating a cell delete request message to establish cell and transmitting the request message, the at least two cells into one cell, the at least two of said original corresponding to a plurality of cells of the one cell antenna configuration.

The unit cell may belong to programming RNC, OMC or an evolved base station. Cell planning unit may exist in separate units evolved base station, an evolved base station or entirely present in the inner existing units, such as belonging to the BBU or the plurality of cells present within an evolved base station, such as the statistics unit 2001 may be located the RRU, the control unit 2002 or may be located in the BBU RRU, the configuration unit 2003 may be located in the BBU.

Referring to Figure 21, the present embodiment includes an interface unit 2101 and the RNC cell planning unit 2102. The interface unit 2101 for interacting with the connected base station, receive and send messages. For cell planning unit 2102 by 2101 pairs of physical resource occupancy interface unit count gun, determining the occupied physical resources is not less than a preset threshold split within a certain time range, and determines the need for cell division; and, determining the presence of at least two cells, the cells for at least two

And determining a cell needs to be combined when the at least two cells have reached the preset time.

2101 when determining the need for cell division, sends messages for the same cell divides into two cells by the base station to the interface unit, and upon determining the need for cell combined transmission on multiple cells is combined to the base station a message cell.

OMC structure comprising a cell planning unit when the RNC similar, are not repeated here.

Example embodiments provide a method for cell planning, including deleting a cell, cell splitting and merging cells, enables flexible network cell, the cell may be dynamic based on the actual programming and networking environment, saving human resources and the present invention improves the communication transmission quality. Further, embodiments of the present invention provides an apparatus for base stations and distributed programming cell, cell enables flexible networking.

Obviously, those skilled in the art can make various modifications and variations to the invention without departing from the spirit and scope of the invention. Thus, if part of the claimed invention for such modifications and variations within the scope of the present invention and equivalents thereof, the present invention intends to include these modifications and variations.

Patent Citations (14)

Publication number	Priority date	Publication date	Assignee	Title
Family To Family Citations				
CN101938749B *	2009-06-30	2014-12-10	中兴通讯股份有限公司	Cell establishment method in time division synchronous code division multiple access system
CN101841935B *	2010-05-12	2013-05-22	新邮通信设备有限公司	Single-antenna remote radio unit
CN102215055A *	2011-06-08	2011-10-12	中兴通讯股份有限公司	Method and device for sending data
US8620223B2	2011-12-28	2013-12-31	Huawei Technologies Co., Ltd.	Method and base station for managing capacity of a wireless communication network
CN103209486B *	2012-01-16	2016-07-06	中兴通讯股份有限公司	Service processing method and system based on the baseband resource sharing
CN103297978B *	2012-02-29	2016-09-21	鼎桥通信技术有限公司	A cell configuration method and apparatus
CN102695178B *	2012-05-30	2015-04-22	福建星网锐捷网络有限公司	Cellular intensively-arranged network structure and control method thereof
CN103581928B *	2012-08-10	2016-08-10	中国移动通信集团河南有限	A cell combining method and

			公司	apparatus
CN103826229A *	2012-11-19	2014-05-28	中兴通讯股份有限公司	Method, SN, base station and system for performing cell merging on the basis of multiple Smallcell base stations
CN103945404A *	2013-01-22	2014-07-23	京信通信系统（中国）有限公司	Radio remote unit multi-cell establishing method and system
CN103209416B *	2013-03-11	2016-06-29	华为技术有限公司	Method and apparatus for networking a cell
CN104219684A *	2013-05-29	2014-12-17	中兴通讯股份有限公司	A cell networking method and device
CN104219673A *	2013-05-30	2014-12-17	中国电信股份有限公司	Network expansion method and system
CN106412933A *	2013-06-26	2017-02-15	华为技术有限公司	Communication method and equipment

* Cited by examiner, † Cited by third party

Cited By (18)

Publication number	Priority date	Publication date	Assignee	Title
CN101841935A *	2010-05-12	2010-09-22	新邮通信设备有限公司	Single-antenna remote radio unit
CN102215055A *	2011-06-08	2011-10-12	中兴通讯股份有限公司	Method and device for sending data
CN102695178A *	2012-05-30	2012-09-26	福建星网锐捷网络有限公司	Cellular intensively-arranged network structure and control method thereof
CN103209416A *	2013-03-11	2013-07-17	华为技术有限公司	Cell networking method and device
CN103209486A *	2012-01-16	2013-07-17	中兴通讯股份有限公司	Business processing method and system based on base band resource sharing

CN103297978A *	2012-02-29	2013-09-11	鼎桥通信技术有限公司	Cell configuring method and cell configuring device
US8620223B2	2011-12-28	2013-12-31	Huawei Technologies Co., Ltd.	Method and base station for managing capacity of a wireless communication network
CN103581928A *	2012-08-10	2014-02-12	中国移动通信集团河南有限公司	Method and device for cell combination
WO2014075490A1 *	2012-11-19	2014-05-22	Zte Corporation	Method, sn, base station, and system for cell combination based on multiple smallcell base stations
CN103945404A *	2013-01-22	2014-07-23	京信通信系统（中国）有限公司	Radio remote unit multi-cell establishing method and system
WO2014190746A1 *	2013-05-29	2014-12-04	Zte Corporation	Cell networking method, apparatus and computer readable storage medium
CN101938749B *	2009-06-30	2014-12-10	中兴通讯股份有限公司	Cell establishment method in time division synchronous code division multiple access system
CN104219673A *	2013-05-30	2014-12-17	中国电信股份有限公司	Network expansion method and system
WO2014206106A1 *	2013-06-26	2014-12-31	Huawei Technologies Co., Ltd.	Communication method and device
Family To Family Citations				
CN1107358C *	2000-02-24	2003-04-30	信息产业部电信科学技术研究院	Distributed intellignet antenna system
JP2007531424A *	2004-03-30	2007-11-01	ユーティー シダ カントン スンヨウ シアンゴン シ	The method of the micro-cell management in a mobile communication system using the centralized base

				station
CN100399842C *	2005-02-03	2008-07-02	芯通科技（成都）有限公司	Middle-frequency transmission method and middle-frequency interface for base-station to realize radio-frequency zoom-out
CN100375550C *	2005-03-07	2008-03-12	大唐移动通信设备有限公司	Base station system

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
US6408179B1	2002-06-18	Group radio communication system with shared bi-directional communication channel
US6370384B1	2002-04-09	Frequency re-use planning for wireless communications system using wireless translating repeaters
US6144645A	2000-11-07	Method and system for an air interface for providing voice, data, and multimedia services in a wireless local loop system
US20120093098A1	2012-04-19	Apparatus and method for dynamic communication resource allocation for device-to-device communications in a wireless communication system
US20030190937A1	2003-10-09	Overhead message update with decentralized control
US20090111476A1	2009-04-30	Allocation of user equipment identifier
US5553074A	1996-09-03	Transmission format in packet based communications
US20090252079A1	2009-10-08	Methods and systems for wireless networks with relays
US20020102985A1	2002-08-01	Queuing far/far service requests in wireless network
US20060199544A1	2006-09-07	Method for exploiting the diversity across frequency bands of a multi-carrier cellular system
US20120265818A1	2012-10-18	Device-to-Device Communication
US6230015B1	2001-05-08	Picking up of mobile stations from a direct mode channel
US20070165584A1	2007-07-19	Cellular communication system and method for broadcast communication
US20050152329A1	2005-07-14	Time-hopping systems and techniques for wireless

		communications
US20050113023A1	2005-05-26	Method of managing communications in a network and the corresponding signal, transmitting device and destination terminal
US20090303895A1	2009-12-10	System and method for wireless multi-hop network synchronization and monitoring
US20090023460A1	2009-01-22	System and method for setting up P2P communication group in cellular system, and P2P communication system and method using P2P communication group
US20060256737A1	2006-11-16	Method and system for allocating multiple channels in a mesh network
GB2485355A	2012-05-16	Compatible channel for efficient coexistence of voice and data traffic
US20050090276A1	2005-04-28	Wireless network using shared traffic channel mode of operation for broadcast services
EP1037484A1	2000-09-20	Time sharing of communications resources in cellular communications systems
US20110287791A1	2011-11-24	Wireless Communication System and Communication Control Method
WO2003017693A2	2003-02-27	Method and system for signaling in broadcast communication system
US20070265013A1	2007-11-15	Method and apparatus for providing in-band wireless backhaul
CN101388707A	2009-03-18	Method for implementing network access and initialization by relay station

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
CN 200710122184	2007-09-21	2007-09-21	Method and system for realizing cell networking

Applications Claiming Priority (2)

Application	Filing date	Title
CN 200710122184	2007-09-21	Method and system for realizing cell networking

PCT/CN2008/001622	2008-09-18	A method for implementing cells networking and a system thereof

Legal Events

Date	Code	Title	Description
2009-03-25	C06	Publication	
2009-05-20	C10	Request of examination as to substance	
2011-06-01	C41	Transfer of the right of patent application or the patent right	
2011-06-01	COR	Bibliographic change or correction in the description	**Free format text**: CORRECT: ADDRES FROM: 100083 NO XUEYUAN ROAD, HAIDIAN DISTRICT BEIJING TO: 1001 NO. 40, XUEYUAN ROAD, HAIDIAN DISTRICT, BEIJING
2011-06-01	ASS	Succession or assignment of patent right	**Effective date**: 20110425 **Free format text**: FORMER OWNER: DATANG MOBILE COMMUNICATION EQUIPMENT CO., L **Owner name**: INST TELECOMMUNICA SCIENCE AND TECHNOLGOY
2013-10-02	C14	Granted	

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04Q 7/36 (2006.01)
H04Q 7/30 (2006.01)
H04B 7/14 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200710122184.9

[43] 公开日 2009 年 3 月 25 日

[11] 公开号 CN 101394647A

[22] 申请日 2007.9.21
[21] 申请号 200710122184.9
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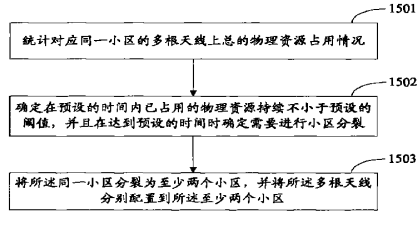
[74] 专利代理机构 北京同达信恒知识产权代理有限公司
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权利要求书 6 页 说明书 15 页 附图 13 页

[54] 发明名称

一种实现小区组网的方法及系统

[57] 摘要

本发明公开了一种实现小区组网的方法，用于实现小区的灵活规划及多种形式的小区组网，提高频谱利用率或节省网络资源。 所述方法包括小区分裂和小区合并。 小区分裂方法和小区合并方法包括小区建立和小区删除。 小区分裂方法为：统计对应同一小区的多根天线上的物理资源占用情况；确定在预设的时间内已占用的物理资源持续不小于预设的阈值，并且在达到预设的时间时确定需要进行小区分裂；将所述同一小区分裂为至少两个小区，并将所述多根天线分别配置到所述至少两个小区。 小区合并方法与小区分裂方法类似。 本发明还公开了一种用于规划小区的装置、分布式基站及其内部单元。



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1、一种分布式基站的小区删除方法，其特征在于，包括以下步骤：

删除对应同一小区的多根天线中至少一根天线上的公共信道和专用信道；

将所述至少一根天线上的小区和公共信道的状态置为不存在；

撤除所述至少一根天线上的无线链路。

2、如权利要求 1 所述的小区删除方法，其特征在于，所述多根天线属于相同或不同的 RRU。

3、如权利要求 1 所述的小区删除方法，其特征在于，所述至少一根天线为普通天线，或为包括多个天线单元的智能天线，或为极化天线。

4、如权利要求 1 所述的小区删除方法，其特征在于，根据一条小区删除请求消息删除所述同一小区下的多根天线上的公共信道和专用信道。

5、一种小区分裂方法，其特征在于，包括以下步骤：

统计对应同一小区的多根天线上的物理资源占用情况；

确定在预设的时间内已占用的物理资源持续不小于预设的阈值，并且在达到预设的时间时确定需要进行小区分裂；

将所述同一小区分裂为至少两个小区，并将所述多根天线分别配置到所述至少两个小区。

6、如权利要求 5 所述的小区分裂方法，其特征在于，当所述已占用的物理资源达到所述阈值时开始计时，并在计时的时间未达到所述预设的时间时已占用的物理资源小于所述阈值，则进行计时清零。

7、如权利要求 5 所述的小区分裂方法，其特征在于，将所述同一小区分裂为至少两个小区的步骤包括：删除所述对应同一小区的多根天线上的小区资源，并分别为所述多根天线配置不同的小区资源；或者，删除所述对应同一小区的多根天线中一部分天线上的小区资源，并为所述一部分天线配置不同于所述同一小区的小区资源。

8、如权利要求 7 所述的小区分裂方法，其特征在于，所述小区资源至少

包括本地小区标识。

9、如权利要求 7 所述的小区分裂方法，其特征在于，在配置小区资源过程中，当需要为多根天线配置相同的小区资源时，根据一条小区建立请求消息为多根天线配置相同的小区资源。

10、如权利要求 5 所述的小区分裂方法，其特征在于，所述对应同一小区的多根天线属于同一射频拉远单元 RRU 或属于不同的 RRU。

11、如权利要求 5 所述的小区分裂方法，其特征在于，所述对应同一小区的多根天线中的一根天线为普通天线、或为包括多个天线单元的智能天线、或为极化天线。

12、如权利要求 5 所述的小区分裂方法，其特征在于，所述物理资源包括发射功率和/或码道资源。

13、如权利要求 5 所述的小区分裂方法，其特征在于，进一步将来自所述对应同一小区的多根天线的数字信号中对应相同子载波的多路数字信号按照相同时间位置进行矢量叠加。

14、一种小区合并方法，其特征在于，包括以下步骤：

统计各小区内的物理资源占用情况；

确定存在至少两个小区，对于至少两个小区中的每个小区，在预设的时间内已占用的物理资源持续不大于预设的阈值，并且在所述至少两个小区均达到预设的时间时确定需要进行小区合并；

将所述至少两个小区合并为一个小区，将对应原所述至少两个小区的多根天线配置为所述一个小区。

15、如权利要求 14 所述的小区合并方法，其特征在于，所述物理资源包括发射功率和/或码道资源。

16、一种用于规划小区组网的装置，其特征在于，包括：

统计单元，用于统计对应同一小区的多根天线上的物理资源占用情况；

控制单元，用于确定在预设的时间内已占用的物理资源持续不小于预设的

阈值，并且在达到预设的时间时确定需要进行小区分裂；

配置单元，用于将所述同一小区分裂为至少两个小区，并将所述多根天线分别配置到所述至少两个小区。

17、如权利要求 16 所述的装置，其特征在于，所述装置归属于无线网络控制器 RNC、操作维护中心 OMC 或演进基站。

18、一种 RRU，其特征在于，包括：

外部接口单元，用于接收和发送消息；

射频单元，用于连接多根天线，并接收来自多根天线的射频信号及向多根天线发送射频信号；

配置单元，用于根据接收到的小区建立请求消息将连接的所述多根天线配置为至少一个小区，以及根据接收到的小区删除请求消息，将所述多根天线中至少一根天线上的小区资源删除。

19、如权利要求 18 所述的 RRU，其特征在于，还包括：

合并单元，用于将上行数字信号中对应同一小区的多根天线上对应相同子载波的数字信号按照相同时间位置进行矢量叠加。

20、一种分布式基站，其特征在于，包括：

天线，用于接收和发射模拟射频信号；

射频拉远单元 RRU，与多根天线连接，用于根据接收到的小区建立请求消息为连接的多根天线配置至少一个小区，以及根据接收到的小区删除请求消息，将同一小区下的多根天线中至少一根天线上的小区资源删除；

基带单元 BBU，用于处理来自 RRU 的数字信号。

21、如权利要求 20 所述的分布式基站，其特征在于，由所述 BBU 向所述 RRU 转发 RNC 或 OMC 发送的小区建立请求消息和小区删除请求消息。

22、如权利要求 20 所述的分布式基站，其特征在于，由 OMC 向所述 RRU 发送小区建立请求消息和小区删除请求消息。

23、如权利要求 20 所述的分布式基站，其特征在于，包括：

小区规划单元，用于进行小区规划，并向所述 RRU 发送小区建立请求消息和小区删除请求消息。

24、如权利要求 23 所述的分布式基站，其特征在于，小区规划单元位于 BBU 内。

25、如权利要求 20 所述的分布式基站，其特征在于，包括多个所述 RRU，多个所述 RRU 为串联、并联或混联关系；和/或

所述 RRU 与所述分布式基站包括的其它 RRU 为串联或并联关系。

26、如权利要求 25 所述的分布式基站，其特征在于，多个所述 RRU 中一个所述 RRU 上的至少一根天线与其它所述 RRU 上的至少一根天线对应同一小区。

27、一种分布式基站，其特征在于，包括：

天线，用于接收和发射模拟射频信号；

多个 RRU，分别用于根据接收到的小区建立请求消息为本地连接的一根天线配置小区资源，以及根据接收到的小区删除请求消息，将本地连接的一根天线上的小区资源删除；其中，所述多个 RRU 的多根天线配置有相同的小区资源；

BBU，用于对来自 RRU 的数字信号进行处理。

28、如权利要求 27 所述的分布式基站，其特征在于，所述多个 RRU 为串联、并联或混联关系；和

所述多个 RRU 与所述分布式基站包括的其它 RRU 为串联或并联关系。

29、如权利要求 27 所述的分布式基站，其特征在于，由所述 BBU 向所述 RRU 转发 RNC 或 OMC 发送的小区建立请求消息和小区删除请求消息。

30、如权利要求 27 所述的分布式基站，其特征在于，由 OMC 向所述 RRU 发送小区建立请求消息和小区删除请求消息。

31、如权利要求 27 所述的分布式基站，其特征在于，包括：

小区规划单元，用于进行小区规划，并向所述 RRU 发送小区建立请求消

息和小区删除请求消息。

32、一种分布式基站，其特征在于，包括:

天线，用于接收和发射模拟射频信号;

射频拉远单元 RRU，与多根天线连接，用于将来自多根天线的模拟射频信号转换为数字信号后发送，其中，所述多根天线对应同一个小区，或所述多根天线中的每一部分天线分别对应到不同的小区;

基带单元 BBU，用于处理来自 RRU 的数字信号。

33、如权利要求 32 所述的分布式基站，其特征在于，包括多个所述 RRU，多个所述 RRU 为串联、并联或混联关系; 和/或

所述 RRU 与所述分布式基站包括的其它 RRU 为串联或并联关系。

34、如权利要求 33 所述的分布式基站，其特征在于，至少两个 RRU 中每一个 RRU 上的至少一根天线对应同一小区。

35、如权利要求 34 所述的分布式基站，其特征在于，所述分布式基站包括的所有 RRU 对应同一小区。

36、如权利要求 32 所述的分布式基站，其特征在于，还包括:

基带接口单元 BIU，用于在所述 BBU 与所述 RRU 之间转发数字信号。

37、如权利要求 36 所述的分布式基站，其特征在于，所述 RRU 为多个，所述 BIU 为多个; 多个所述 RRU 分别通过多个所述 BIU 与所述 BBU 连接。

38、如权利要求 32 所述的分布式基站，其特征在于，分布式基站包括多个所述 BBU。

39、一种分布式基站，其特征在于，包括:

天线，用于接收和发射模拟射频信号;

多个 RRU，各 RRU 包括一根天线，用于将来自天线的模拟射频信号转换为数字信号后发送; 其中，所述多个 RRU 的多根天线对应同一小区;

BBU，用于对来自 RRU 的数字信号进行处理。

40、如权利要求 39 所述的分布式基站，其特征在于，所述多个 RRU 为

串联、并联或混联关系；和

所述多个 RRU 与所述分布式基站包括的其它 RRU 为串联或并联关系。

41、如权利要求 39 所述的分布式基站，其特征在于，还包括：

一个或多个基带接口单元 BIU，用于在所述 BBU 与所述多个 RRU 之间转发数字信号。

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一种实现小区组网的方法及系统

技术领域

本发明涉及通信领域，特别是涉及实现小区组网的方法及系统。

背景技术

目前现有技术中一根普通天线或一根包括多个天线单元的智能天线对应一个小区。随着通信用户和通信业务的迅速发展，已有的小区资源已不能满足需求，为了对通信系统进行扩容，一种方式是增加天线的数量，以增加小区资源，另一种方式是将多路信号合并为一路信号。

在传统的基站系统中，在基带与收发信机之间传输的是模拟信号。通过传输线路可以直接对模拟信号进行叠加，并发送到基带侧进行处理。但是，在模拟信号的发送过程中，随着传输距离的增加，模拟信号会不断衰减。在实现模拟信号的远距离传输过程中，通常使用中继设备（如干放站）对模拟信号进行放大处理，实现无盲区覆盖，但是，在放大模拟信号的同时也放大了噪声信号，对信号质量产生严重影响，并存在更大的功率消耗，而且中继设备存在不易维护的缺点。

目前，现有技术中出现一种射频拉远技术，将基站中的射频单元拉远，置于天线附近。通过这种方式，实现了一个基带单元（BBU）可连接多个射频拉远单元（RRU），而由于受到现有硬件水平的限制，BBU 的基带解调只能支持不超过设计能力的多根天线，例如一个 BBU 最多支持 6 个子载波（用 C 表示）、8 根天线（用 A 表示），则最多支持 48 路信号。由于模拟信号存在一些缺陷，则考虑通过增加天线数量的方式实现无盲区覆盖，而一个 BBU 的处理能力有限，所以这就需要增加 BBU 来实现通信系统的扩容。然而 BBU 的成本比较高，给扩容工作带来压力。并且，每次扩容通信系统时都需要人为的增设天线及相应的 RRU，可能进一步需要增设 BBU，这种方式占用较多的人力资源。如果

在建网初期便建设较多的天线和小区，则导致通信系统资源的浪费。

可见，现有技术为了满足通信业务发展的需求，一种方式是通过叠加模拟信号的方式来支持更多的信号量，以实现无盲区覆盖，但这种方式存在传输距离较短，受噪声信号干扰较大的问题。另一种方式是通过人工的方式不断的扩容通信系统，但需要较多的人力资源。再一种方式是在建网初期便建设较多的天线和小区，但导致通信系统资源的浪费。

发明内容

本发明实施例提供一种实现小区组网的方法及系统，用于实现小区的灵活规划及多种形式的小区组网，提高频谱利用率或节省网络资源。

一种分布式基站的小区删除方法，包括以下步骤：

删除对应同一小区的多根天线中至少一根天线上的公共信道和专用信道；

将所述至少一根天线上的小区和公共信道的状态置为不存在；

撤除所述至少一根天线上的无线链路。

一种小区分裂方法，包括以下步骤：

统计对应同一小区的多根天线上的物理资源占用情况；

确定在预设的时间内已占用的物理资源持续不小于预设的阈值，并且在达到预设的时间时确定需要进行小区分裂；

将所述同一小区分裂为至少两个小区，并将所述多根天线分别配置到所述至少两个小区。

一种小区合并方法，包括以下步骤：

统计各小区内的物理资源占用情况；

确定存在至少两个小区，对于至少两个小区中的每个小区，在预设的时间内已占用的物理资源持续不大于预设的阈值，并且在所述至少两个小区均达到预设的时间时确定需要进行小区合并；

将所述至少两个小区合并为一个小区，将对应原所述至少两个小区的多根天线配置为所述一个小区。

一种用于规划小区组网的装置，包括:

统计单元，用于统计对应同一小区的多根天线上的物理资源占用情况;

控制单元，用于确定在预设的时间内已占用的物理资源持续不小于预设的阈值，并且在达到预设的时间时确定需要进行小区分裂;

配置单元，用于将所述同一小区分裂为至少两个小区，并将所述多根天线分别配置到所述至少两个小区。

一种 RRU，包括:

外部接口单元，用于接收和发送消息;

射频单元，用于连接多根天线，并接收来自多根天线的射频信号及向多根天线发送射频信号;

配置单元，用于根据接收到的小区建立请求消息将连接的所述多根天线配置为至少一个小区，以及根据接收到的小区删除请求消息，将所述多根天线中至少一根天线上的小区资源删除。

一种分布式基站，包括:

天线，用于接收和发射模拟射频信号;

射频拉远单元 RRU，与多根天线连接，用于根据接收到的小区建立请求消息为连接的多根天线配置至少一个小区，以及根据接收到的小区删除请求消息，将同一小区下的多根天线中至少一根天线上的小区资源删除;

基带单元 BBU，用于处理来自 RRU 的数字信号。

一种分布式基站，包括:

天线，用于接收和发射模拟射频信号;

多个 RRU，分别用于根据接收到的小区建立请求消息为本地连接的一根天线配置小区资源，以及根据接收到的小区删除请求消息，将本地连接的一根天线上的小区资源删除; 其中，所述多个 RRU 的多根天线配置有相同的小区资源;

BBU，用于对来自 RRU 的数字信号进行处理。

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一种分布式基站，包括:

天线，用于接收和发射模拟射频信号;

射频拉远单元 RRU，与多根天线连接，用于将来自多根天线的模拟射频信号转换为数字信号后发送，其中，所述多根天线对应同一个小区，或所述多根天线中的每一部分天线分别对应到不同的小区;

基带单元 BBU，用于处理来自 RRU 的数字信号。

一种分布式基站，包括:

天线，用于接收和发射模拟射频信号;

多个 RRU，各 RRU 包括一根天线，用于将来自天线的模拟射频信号转换为数字信号后发送；其中，所述多个 RRU 的多根天线对应同一小区;

BBU，用于对来自 RRU 的数字信号进行处理。

本发明实施例提供了小区规划的方法，包括小区删除、小区分裂和小区合并，实现了小区的灵活组网，可根据实际环境进行动态的小区规划和组网，节省了人力资源或提高了通信传输质量。并且，本发明实施例提供了用于规划小区的装置和分布式基站等，实现了灵活的小区组网。

附图说明

图 1A－图 8 为本发明实施例中分布式基站的结构图;

图 9 为本发明实施例中小区建立的主要方法流程图;

图 10 为本发明实施例中 RNC 发起小区建立时小区建立的方法流程图;

图 11 为本发明实施例中 OMC 发起小区建立时小区建立的方法流程图;

图 12 为本发明实施例中演进基站发起小区建立时小区建立的方法流程图;

图 13 为本发明实施例中小区删除的主要方法流程图;

图 14 为本发明实施例中小区删除的具体方法流程图;

图 15 为本发明实施例中小区分裂的主要方法流程图;

图 16A 为本发明实施例中根据发射功率进行小区分裂的具体方法流程图;

图 16B 为本发明实施例中根据码道资源进行小区分裂的具体方法流程图；

图 17 为本发明实施例中小区合并的方法流程图；

图 18 为本发明实施例中 RRU 的基本结构图；

图 19 为本发明实施例中 RRU 的详细结构图；

图 20 为本发明实施例中小区规划单元的结构图；

图 21 为本发明实施例中 RNC 的结构图。

具体实施方式

本发明实施例根据实际的环境使多根天线对应一个小区，以节省小区资源，或者使多根天线对应多个小区，以满足通信业务或通信用户的需求。

本发明实施例中的小区资源包括本地小区标识、训练序列和物理资源等，物理资源包括发射功率和码道资源等。

本发明实施例中的分布式基站（简称基站）包括通用移动通信系统（Universal Mobile Telecommunication System，UMTS）下的基站（Node B）和长期演进（Long Time Evolution，LTE）系统下的演进基站（Evolved Node B）。本发明实施例中的天线包括普通天线、具有多个天线单元的智能天线和非智能天线（如极化天线）等。本实施例中将一根天线确定为一个通道，连接多根天线的 RRU 为多通道 RRU，连接单根天线的 RRU 为单通道 RRU。

本发明实施例中分布式基站（简称基站）包括用于接收和发送模拟射频信号的天线、BBU 和 RRU（包括多通道 RRU 和单通道 RRU）等。分布式基站可包括多个 RRU，多个 RRU 可以是并联、串联或混联关系。所述混联关系是指：构成串联关系的多个 RRU 与其它一个或多个 RRU 构成并联关系，这些串联关系和并联关系中的所有 RRU 共同构成混联关系。本发明实施例中可以发起小区建立和小区删除的设备包括无线网络控制器（Radio Network Controller，RNC）、操作维护中心（Operation & Maintenance Center，OMC）和演进基站等。

分布式基站中的 BBU 用于基带数字信号的处理。当由 RNC 或 OMC 进行

小区组网的规划时，BBU 还用于转发 RNC 或 OMC 发送的小区建立请求消息和小区删除请求消息。当由演进基站进行小区组网的规划时，分布式基站包括小区规划单元 101，参见图 1A 所示，该小区规划单元 101 用于规划小区，确定小区的建立和删除等，生成和发送小区建立请求消息和小区删除请求消息，可直接发送给 RRU，或者经 BBU 转发给 RRU。该小区规划单元 101 也可归属于 BBU，相当于由 BBU 进行小区组网的规划。其中，BBU 可以为多个，构成 BBU 资源池，共同为连接的 RRU 提供服务。

RRU 用于将连接的多根天线接收到的模拟射频信号转换为数字信号后发送，以及将收到的数字信号转换为模拟射频信号后通过多根天线发送，该多根天线至少对应一个小区。RRU 还用于根据接收到的小区建立请求消息为连接的多根天线配置至少一个小区，以及根据接收到的小区删除请求消息，将所述多根天线中至少一根天线上的小区资源删除。一个 BBU 与多通道 RRU 的连接实例如图 1B 所示。多个多通道 RRU 也可对应一个小区，或者一个多通道 RRU 上的部分天线与其它多通道 RRU 或单通道 RRU 上的天线对应一个小区。该多通道 RRU 可与多个单通道 RRU、多个现有技术中的 RRU 连接，构成串联、并联或混联关系，并且多通道 RRU、单通道 RRU 和现有技术中的 RRU 可以对应一个小区。

或者，RRU 用于将连接的一根天线接收到的模拟射频信号转换为数字信号后发送，以及将收到的数字信号转换为模拟射频信号后通过一根天线发送。该 RRU 还用于根据接收到的小区建立请求消息为连接的一根天线配置一个小区，以及根据接收到的小区删除请求消息，将所述一根天线上的小区资源删除。多个单通道 RRU 可对应一个小区，一个 BBU 与单通道 RRU 的连接实例如图 2 所示。该单通道 RRU 可与多个多通道 RRU、多个现有技术中的 RRU 连接，构成串联、并联或混联关系。

一个 BBU 可连接多个 RRU，本实施例提供一个 BBU 连接多个串联关系的 RRU 的实例如图 3 所示。

分布式基站还可包括一个或多个基带接口单元（BIU），参见图 2、4－8所示，BIU 用于转发 BBU 与 RRU 之间的数字信号，使 RRU 可以与任意 BBU 连接，使组网形式更灵活。

通过上述实施例可知，一个 BBU 连接了超过其设计能力的多根天线，而 BBU 必须在其设计能力范围内处理来自较多天线的信号，本实施例提供合并来自多根天线的数字信号的方法，使 BBU 处理符合设计能力的多路数字信号。

合并数字信号的方法是：依据时间同步原则，将对应同一子载波及同一小区的多路数字信号进行矢量叠加。将 I 分量方向上对应相同子载波及同一小区的多路数字信号，按照相同时间位置进行叠加操作，以及将 Q 分量方向上对应相同子载波及同一小区的多路数字信号，按照相同时间位置进行叠加操作。本实施例中，将数字信号看作是“1”和“0”的连续组合，如一路数字信号在一个时间点上的数据为 1100，每个“1”或“0”即是一个数据。按照相同的时间点，多路数字信号的叠加即为多路数字信号的数据按位相加，进行二进制加法的操作。本实施例通过数学模型作进一步说明。假设某个时间点的数字信号表示为 an+jbn 的形式，a 表示 I 分量方向上的数据，j 表示 Q 分量，则 b 表示 Q 分量方向上的数据，n 取不同的值以标识各路数字信号。那么，数字信号的合并过程可表示为：

(a1+j*b1)+(a2+j*b2)+…+(an+j*bn) = (a1+a2+…+an) + j*(b1+b2+…+bn)

分布式基站内部的多个单元均可进行数字信号的合并操作，如 BBU、BIU 和 RRU 均可进行合并操作。

了解了分布式基站的结构，便可进行小区规划的操作，包括小区建立和小区删除。

参见图 9，本实施例中小区建立的主要方法流程如下：

步骤 901：为至少两根天线分配相同的本地小区标识。

步骤 902：为所述至少两根天线配置最大输出功率。

步骤 903：为所述至少两根天线配置训练序列和信道资源等。

上述方法流程实现了多根天线对应一个小区，可采用 MIMO 系统的分集或复用技术提高小区内的传输质量或提高小区的承载能力。下面对小区建立的方法进行详细描述，第一种情况是 RNC 发起小区建立过程，参见图 10 所示，具体方法流程如下：

步骤 1001：RNC 发起资源审计过程，向 Node B 发送审计请求消息，通知 Node B 进行资源审计。或者，Node B 周期性主动向 RNC 报告审计结果。

步骤 1002：RNC 根据 Node B 返回的审计响应消息确定需要进行小区建立。

步骤 1003：RNC 向 Node B 发送小区建立请求消息。

RNC 可通过在小区建立请求消息中增加信元的方式指示 Node B 为具体的天线配置小区资源，信元如（T1，T3，T5），表示为标识为 T1、T3 和 T5 的天线配置相同的小区资源，即天线 T1、T3 和 T5 对应同一小区。可进一步增加关于 RRU 的信元，如（R1（T1，T3，T5），R3（T1，T2，T4）），表示为标识为 R1 的 RRU 上的标识为 T1、T3 和 T5 的天线及标识为 R3 的 RRU 上的标识为 T1、T2 和 T4 的天线配置相同的小区资源。或者，RNC 通过多次发送小区建立请求消息指示 Node B 为多根天线配置相同的小区资源（尤指配置相同的本地小区标识）。或者，RNC 通过多次发送小区建立请求消息指示 Node B 为一个 RRU 上的多根天线配置不同的小区资源（尤指配置不同的本地小区标识）。

RNC 可进一步通过在小区建立请求消息中增加信元的方式指示 Node B 为一根天线配置多个小区，如配置单频点小区。

步骤 1004：Node B 根据收到的小区建立请求消息为多根天线分配相同的本地小区标识，并保存分配结果。本地小区标识是区分小区的标志，只要两个区域的本地小区标识不同，则这两个区域属于不同的小区。

Node B 可根据小区建立请求消息中携带的天线标识对相应的天线进行配置。或者，当小区建立请求消息中未携带天线标识时，Node B 根据审计结果

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确定需要进行小区建立的天线，并根据小区建立请求消息对相应的天线进行配置。

步骤 1005：Node B 根据收到的小区建立请求消息为多根天线配置最大输出功率。

步骤 1006：Node B 根据收到的小区建立请求消息为多根天线配置信道资源，建立 CPICH、PSCH、SSCH、PCCPCH、BCH。

第二种情况是 OMC 发起小区建立过程，参见图 11 所示，具体方法流程如下：

步骤 1101：OMC 通过控制消息触发 RNC 开始小区建立。

步骤 1102：RNC 收到控制消息后向 Node B 发送小区建立请求消息。

步骤 1103：Node B 根据收到的小区建立请求消息为多根天线分配相同的本地小区标识，并保存分配结果。其中，Node B 根据收到的 OMC 发送的控制消息获知需要进行小区配置的天线。

步骤 1104：Node B 根据收到的小区建立请求消息为多根天线配置最大输出功率。

步骤 1105：Node B 根据收到的小区建立请求消息为多根天线配置信道资源。

OMC 也可触发 LTE 系统中的演进基站开始小区建立，由演进基站根据 OMC 发送的控制消息对相应的多根天线进行小区配置，以建立小区。

第三种情况是在 LTE 系统中由演进基站发起小区建立过程，参见图 12 所示，具体方法流程如下：

步骤 1201：演进基站根据物理资源和逻辑资源的状况发起小区建立。

步骤 1202：演进基站为多根天线分配相同的本地小区标识，并保存分配结果。

步骤 1203：演进基站为多根天线配置最大输出功率。

步骤 1204：演进基站为多根天线配置信道资源。

参见图 13，本实施例中小区删除的主要方法流程如下：

步骤 1301：删除对应同一小区的多根天线中至少一根天线上的公共信道和专用信道。

步骤 1302：将所述至少一根天线上的小区和公共信道的状态置为不存在。

步骤 1303：撤除所述至少一根天线上的无线链路。

参见图 14，本实施例中小区删除的具体方法流程如下：

步骤 1401：基站确定需要进行删除小区的操作。

基站可根据物理资源和逻辑资源的情况确定需要撤除某天线的小区资源，即删除的全部或部分小区。或者，基站根据 RNC 发送的小区删除请求消息确定需要进行删除小区的操作，其中，可由 RNC 或 OMC 发起小区删除操作，基站可根据收到的一条小区删除请求消息删除多根天线上的小区资源，或者根据收到的多条小区删除请求消息分别删除同一小区下的多根天线上的小区资源。

或者，当一根天线对应多个小区时，基站可删除一根天线上的部分或全部小区。

步骤 1402：基站删除对应同一小区的多根天线中至少一根天线上的公共信道和专用信道。

步骤 1403：基站将所述至少一根天线上的小区和公共信道的状态置为不存在。

步骤 1404：基站撤除所述至少一根天线上的无线链路。

通过上述实施例的描述了解了关于多根天线的小区建立和小区删除的方法，那么便可进一步实现关于多根天线的小区组网的变更，重新规划小区，包括小区分裂和小区合并。

小区分裂是将一个小区分裂为多个小区，可以是删除多根天线对应的一个小区，然后为多根天线建立至少两个小区；或者，删除对应同一小区的多根天线中部分天线的小区资源，然后为这部分天线建立新小区。小区分裂可适应通

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信业务和通信用户的发展需求，也适用于多种实际环境的改变，如对应同一小区的两根天线间新建一高层建筑，则导致这两根天线覆盖区域隔离，阻挡无线信号的传输，并且可能导致通信业务和通信用户的迅速增加。小区分裂过程可通过 OMC 进行控制。本实施例提供一种动态进行小区分裂的方法，以灵活适应实际的周边环境和无线传输要求，参见图 15 所示，主要方法流程如下：

步骤 1501：统计对应同一小区的多根天线上总的物理资源占用情况。可同时对所有小区进行统计操作，本实施例以一个小区为例进行详细说明。

步骤 1502：确定在预设的时间内已占用的物理资源持续不小于预设的阈值，并且在达到预设的时间时确定需要进行小区分裂。

步骤 1503：将所述同一小区分裂为至少两个小区，并将所述多根天线分别配置到所述至少两个小区。

其中，物理资源包括发射功率和码道资源等，可根据任一项物理资源进行小区分裂，下面分别进行详细描述。

参见图 16A，根据发射功率进行小区分裂的具体方法流程如下：

步骤 1601：统计对应同一小区的多根天线的总发射功率。

步骤 1602：当总发射功率达到功率分裂阈值时，开始进行计时。

步骤 1603：判断计时的时间是否达到预设的时间，以及判断总发射功率是否持续达到或超过功率分裂阈值。

步骤 1604：当计时的时间达到预设的时间且总发射功率持续达到或超过功率分裂阈值时，发起小区分裂操作。继续步骤 1606。例如，最大发射功率为 m 瓦，预设的时间为 n 天，功率分裂阈值为 10 瓦，当总发射功率在 10 至 m 之间且持续 n 天时，确定需要进行小区分裂。

步骤 1605：当计时的时间未达到预设的时间总发射功率便降到功率分裂阈值以下时，对计时的时间清零。可继续步骤 1601。

步骤 1606：将一个小区分裂为至少两个小区。具体方式有多种，如删除所述至少两根天线上的小区资源，并分别为所述至少两根天线配置不同的小区

资源；或者，删除所述至少两根天线中一根天线上的小区资源，并为所述一根天线配置不同于所述同一小区的小区资源。可继续步骤 1601。

参见图 16B，根据发射功率进行小区分裂的具体方法流程如下：

步骤 1611：统计对应同一小区的多根天线上总的码道资源占用情况，具体方式是对话务量进行统计。

步骤 1612：当已占用的码道资源达到码道分裂阈值时，开始进行计时。

步骤 1613：判断计时的时间是否达到预设的时间，以及判断总发射功率是否持续达到或超过码道分裂阈值。

步骤 1614：当计时的时间达到预设的时间且已占用的码道资源持续达到或超过码道分裂阈值时，发起小区分裂操作。继续步骤 1616。

步骤 1615：当计时的时间未达到预设的时间已占用的码道资源便降到码道分裂阈值以下时，对计时的时间清零。可继续步骤 1611。

步骤 1616：将一个小区分裂为至少两个小区。具体方式有多种，如删除所述至少两根天线上的小区资源，并分别为所述至少两根天线配置不同的小区资源；或者，删除所述至少两根天线中一根天线上的小区资源，并为所述一根天线配置不同于所述同一小区的小区资源。可继续步骤 1611。

上述两个实施例是分别根据发射功率和码道资源进行小区分裂的方法描述，可进一步将上述两个实施例结合，当发射功率和码道资源在达到预设的时间内均持续不低于各自对应的阈值时，确定需要进行小区分裂。

与小区分裂过程对应的过程便是小区合并，小区合并是将多个小区合并为一个小区。即删除对应多个小区的多根天线上的小区资源，再对该多根天线配置相同的小区资源；或者，删除一个小区的多根天线上的小区资源，再对该多根天线配置与另一小区相同的小区资源。小区合并适用于多种实际环境的改变，如相邻两个小区之间的一高层建筑被拆除，则原先阻挡的无线信号的传输路径变得畅通，并且可能导致通信业务和通信用户的迅速减少。小区合并过程可通过 OMC 进行控制。本实施例提供一种动态进行小区合并的方法，以灵活

适应实际的周边环境，参见图 17 所示，方法流程如下：

步骤 1701：统计各小区内的物理资源占用情况。

步骤 1702：确定存在至少两个小区，对于至少两个小区中的每个小区，在预设的时间内已占用的物理资源持续不大于预设的阈值（本实施例中称合并阈值），并且在所述至少两个小区均达到预设的时间时确定需要进行小区合并。

步骤 1703：将所述至少两个小区合并为一个小区，将对应原所述至少两个小区的多根天线配置为所述一个小区。具体实现方式有多种，如删除所述至少两个小区，再为所述至少两个小区下的多根天线配置相同的小区资源；或者如删除所述至少两个小区中一个小区对应的天线上的小区资源，再为这一个小区对应的天线配置与另一小区相同的小区资源。

其中，物理资源包括发射功率和码道资源等，可根据任一项或几项物理资源进行小区分裂。

通过上述实施例的描述了解了分布式基站的结构和小区规划的方法，下面对分布式基站的内部单元的结构进行描述。

参见图 18，本实施例中的 RRU 包括外部接口单元 1801、射频单元 1802 和配置单元 1803。

外部接口单元 1801 用于连接分布式基站中的其它单元（如 BBU、BIU 或 OMC 等），接收和发送数字信号形式的消息。

射频单元 1802 用于连接多根天线，并接收和发送射频信号。

配置单元 1803 用于根据接收到的小区建立请求消息将连接的所述多根天线配置为至少一个小区，以及根据接收到的小区删除请求消息，将所述多根天线中至少一根天线上的小区资源删除。

RRU 还包括中频单元 1804 和合并单元 1805，参见图 19 所示。

中频单元 1804 用于将所述射频单元接收到的射频信号转换为数字信号。

合并单元 1805 用于将所述数字信号中对应相同子载波及同一小区的多根天线的数字信号矢量叠加。

参见图 20，本实施例中用于规划小区的装置（本实施例中称小区规划单元）包括统计单元 2001、控制单元 2002 和配置单元 2003。

统计单元 2001 用于统计对应同一小区的多根天线的物理资源占用情况。

控制单元 2002 用于确定已占用的物理资源在一定时间范围内不小于预设的分裂阈值，并确定需要进行小区分裂；以及，确定存在至少两个小区，对于至少两个小区中的每个小区，在预设的时间内已占用的物理资源持续不大于预设的合并阈值，并且在所述至少两个小区均达到预设的时间时确定需要进行小区合并。

配置单元 2003 用于当计时的时间达到预设的时间范围且已占用的物理资源持续达到或超过分裂阈值时，生成小区删除请求消息和小区建立请求消息并发送，将所述同一小区分裂为两个小区，所述至少两根天线分别对应所述两个小区；以及，当计时的时间达到预设的时间范围且已占用的物理资源持续不超过合并阈值时，生成小区删除请求消息和小区建立请求消息并发送，将所述至少两个小区合并为一个小区，将对应原所述至少两个小区的多根天线配置为所述一个小区。

所述小区规划单元可属于 RNC、OMC 或演进基站。小区规划单元在演进基站中可以以独立的单元存在，或者整体存在于演进基站中已有的单元内，如归属于 BBU，或者存在于演进基站中的多个单元内，如统计单元 2001 可位于 RRU 中，控制单元 2002 可位于 RRU 或 BBU 中，配置单元 2003 可位于 BBU 中。

参见图 21，本实施例中的 RNC 包括接口单元 2101 和小区规划单元 2102。

接口单元 2101 用于与连接的基站进行交互，接收和发送消息。

小区规划单元 2102 用于通过接口单元 2101 对物理资源的占用情况进行统计，确定已占用的物理资源在一定时间范围内不小于预设的分裂阈值，并确定需要进行小区分裂；以及，确定存在至少两个小区，对于至少两个小区中的每个小区，在预设的时间内已占用的物理资源持续不大于预设的合并阈值，并

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且在所述至少两个小区均达到预设的时间时确定需要进行小区合并。

由所述接口单元 2101 在确定需要进行小区分裂时，向基站发送关于将所述同一小区分裂为两个小区的消息，以及在确定需要进行小区合并时，向基站发送关于将多个小区合并为一个小区的消息。

OMC 包括小区规划单元时的结构与 RNC 类似，在此不再赘述。

本发明实施例提供了小区规划的方法，包括小区删除、小区分裂和小区合并，实现了小区的灵活组网，可根据实际环境进行动态的小区规划和组网，节省了人力资源及提高了通信传输质量。并且，本发明实施例提供了用于规划小区的装置和分布式基站等，实现了灵活的小区组网。

显然，本领域的技术人员可以对本发明进行各种改动和变型而不脱离本发明的精神和范围。这样，倘若对本发明的这些修改和变型属于本发明权利要求及其等同技术的范围之内，则本发明也意图包含这些改动和变型在内。

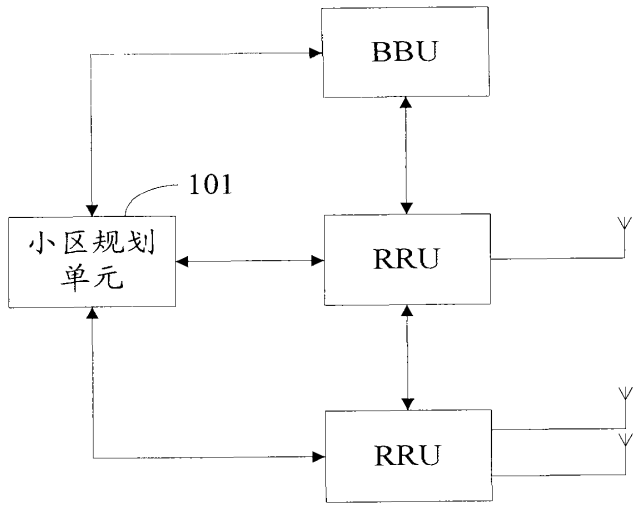


图 1A

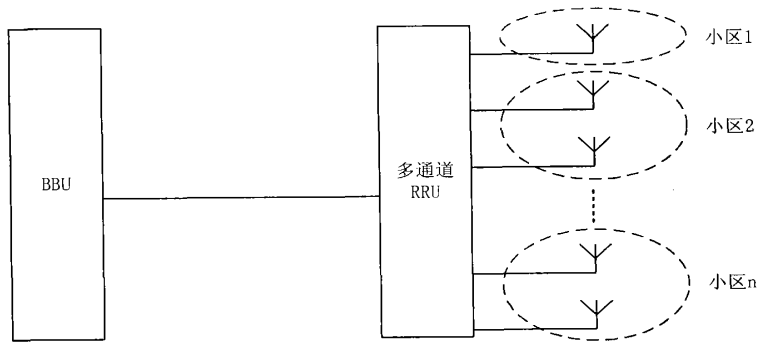


图 1B

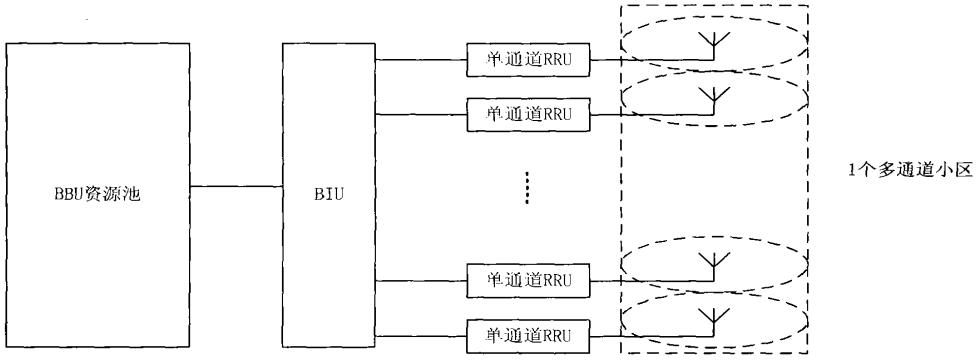

BBU资源池
BIU
单通道RRU
单通道RRU
单通道RRU
单通道RRU
1个多通道小区

图 2

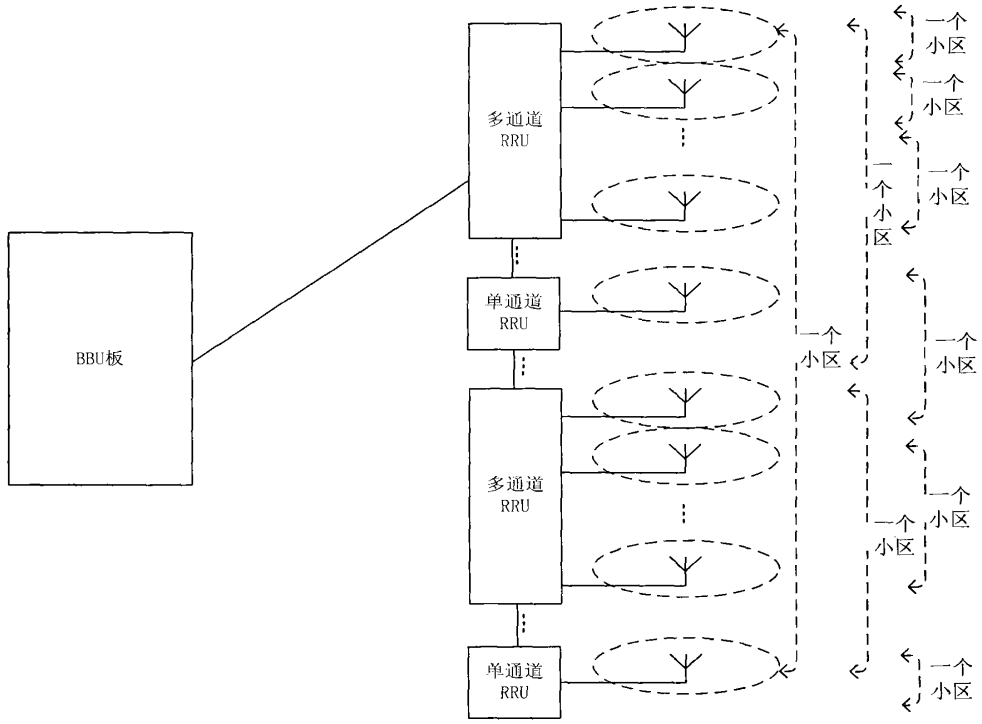

BBU板
多通道 RRU
单通道 RRU
多通道 RRU
单通道 RRU
一个小区
一个小区
一个小区
一个小区
一个小区
一个小区
一个小区
一个小区
一个小区

图 3

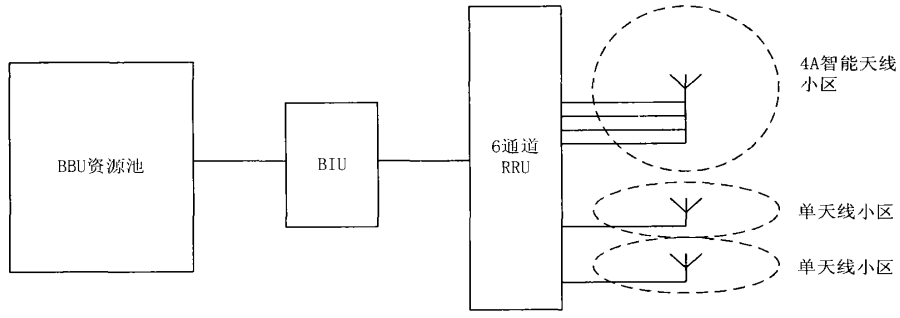

BBU资源池
BIU
6通道
RRU
4A智能天线
小区
单天线小区
单天线小区

图 4

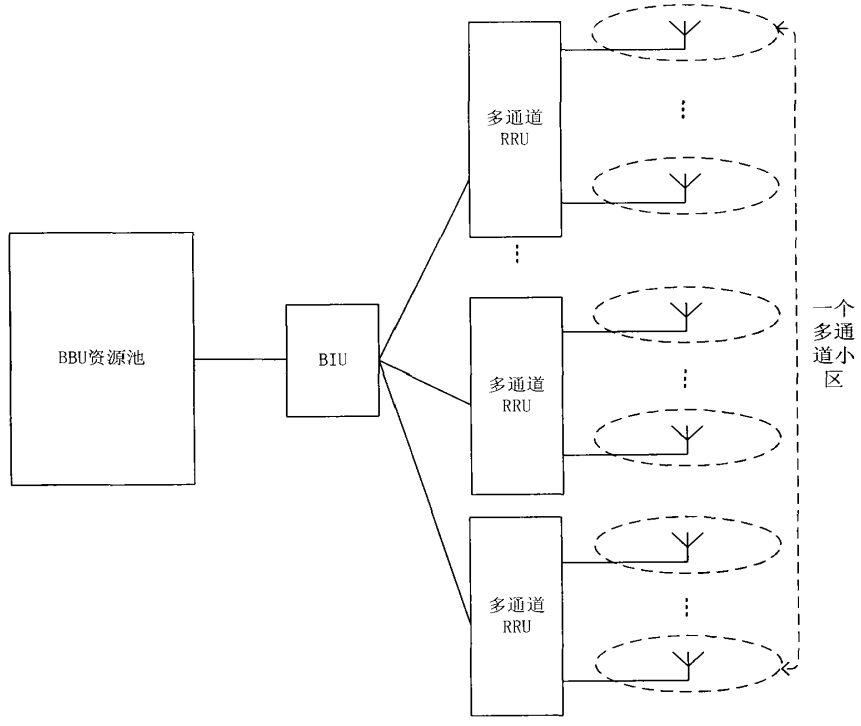

BBU资源池
BIU
多通道
RRU
多通道
RRU
多通道
RRU
一个
多通
道小
区

图 5

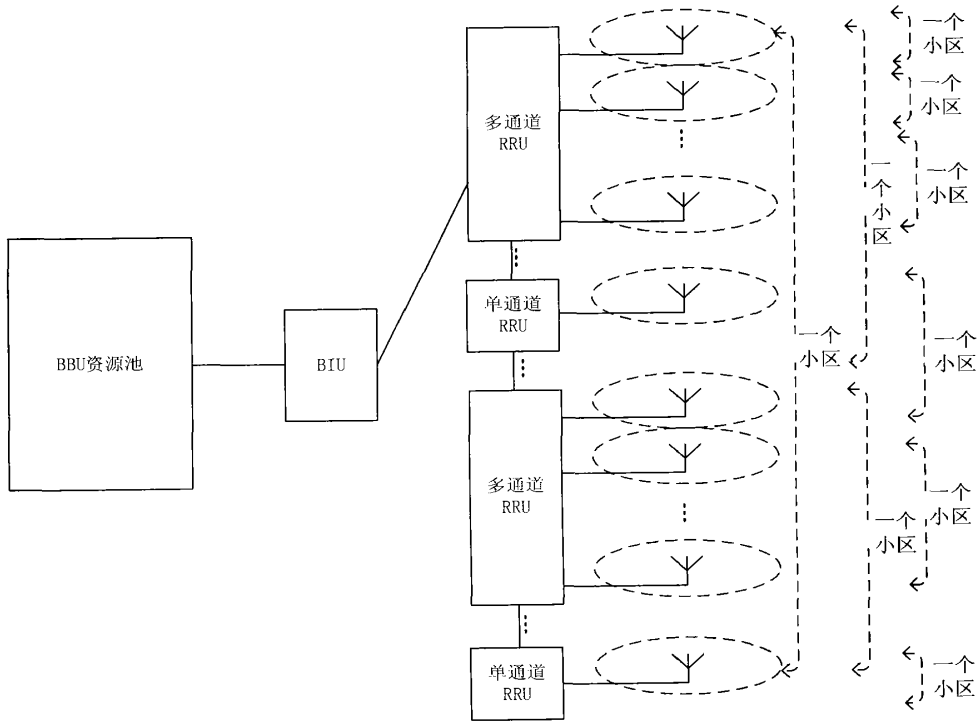

BBU资源池
BIU
多通道
RRU
单通道
RRU
多通道
RRU
单通道
RRU
一个
小区
一个
小区
一个
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一个
小区

图 6

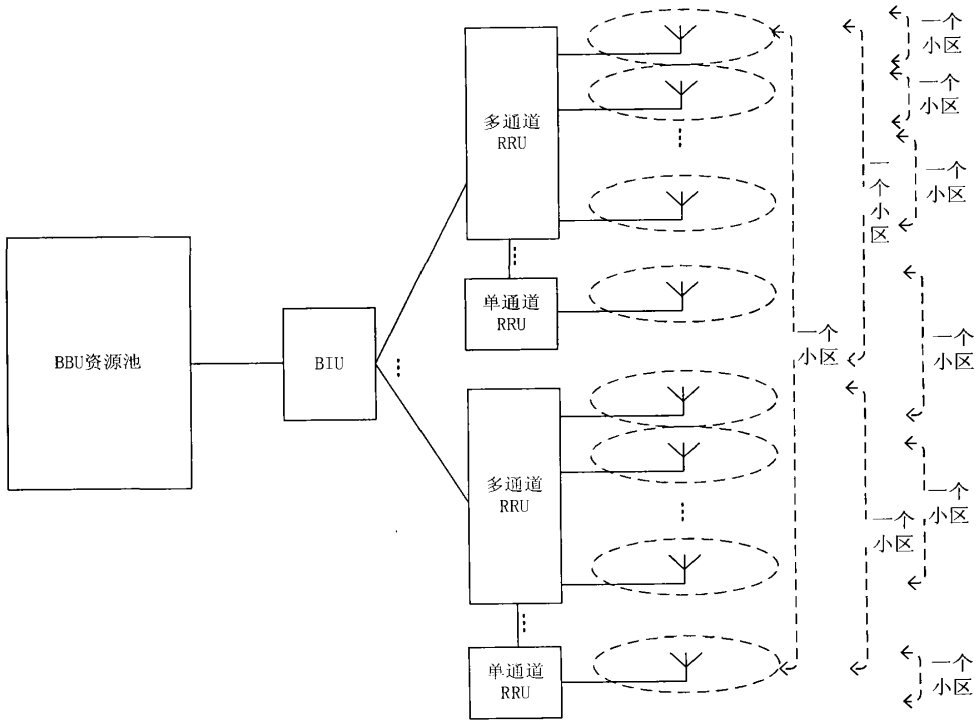

BBU资源池
BIU
多通道
RRU
单通道
RRU
多通道
RRU
单通道
RRU
一个
小区
一个
小区
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一个
小区

图 7

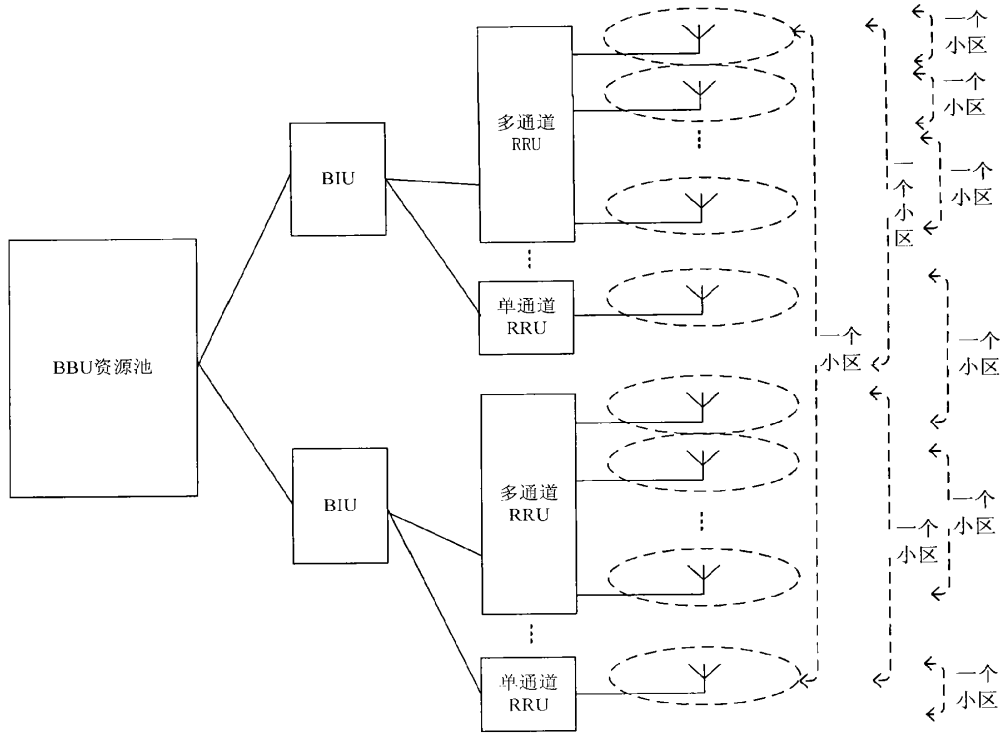

BBU资源池
BIU
BIU
多通道
RRU
单通道
RRU
多通道
RRU
单通道
RRU
一个
小区
一个
小区
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一个
小区

图 8

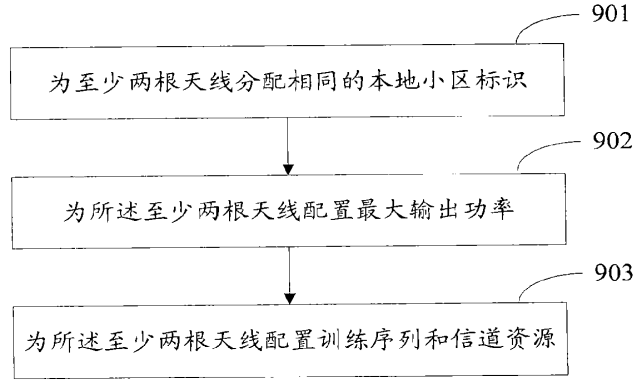

901
为至少两根天线分配相同的本地小区标识
902
为所述至少两根天线配置最大输出功率
903
为所述至少两根天线配置训练序列和信道资源

图 9

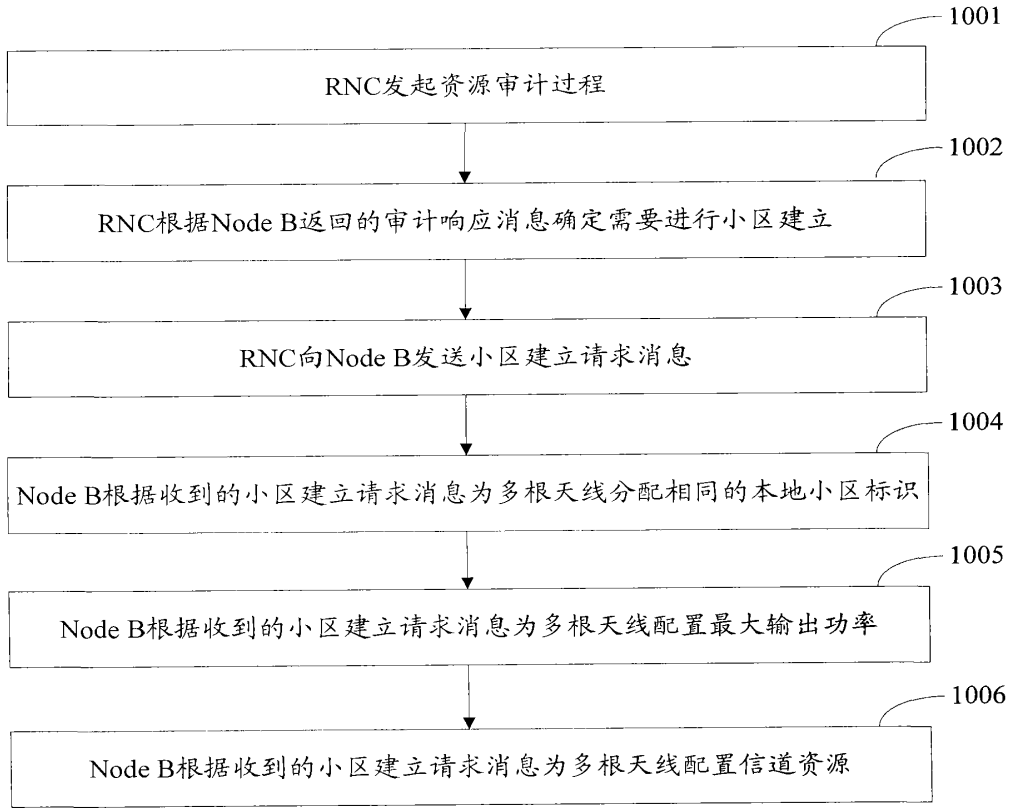

1001
RNC发起资源审计过程
1002
RNC根据Node B返回的审计响应消息确定需要进行小区建立
1003
RNC向Node B发送小区建立请求消息
1004
Node B根据收到的小区建立请求消息为多根天线分配相同的本地小区标识
1005
Node B根据收到的小区建立请求消息为多根天线配置最大输出功率
1006
Node B根据收到的小区建立请求消息为多根天线配置信道资源

图 10

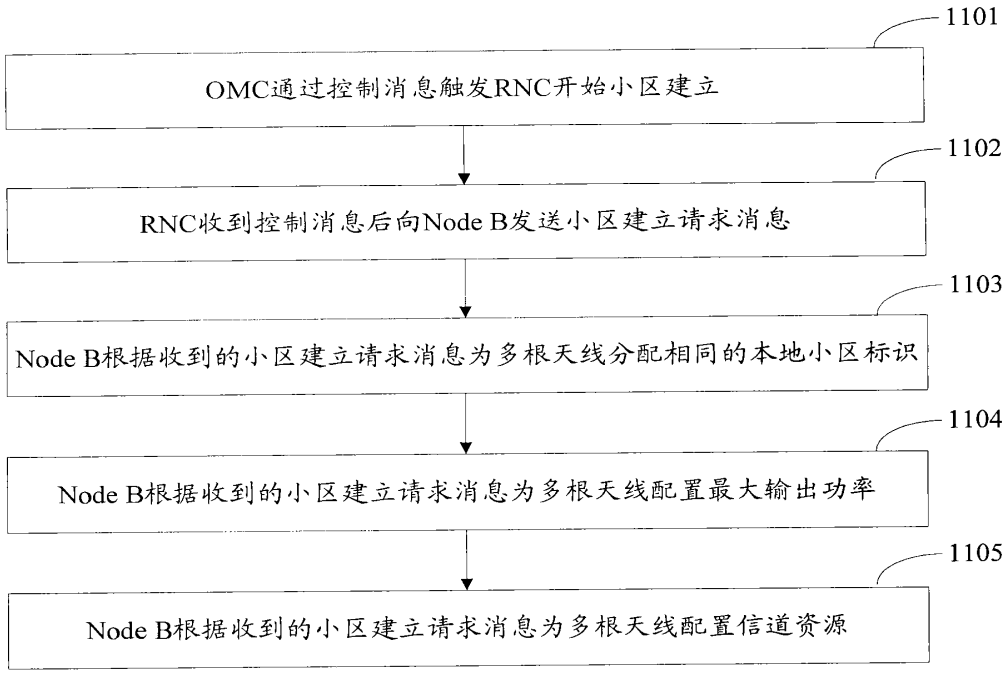

1101
OMC通过控制消息触发RNC开始小区建立
1102
RNC收到控制消息后向Node B发送小区建立请求消息
1103
Node B根据收到的小区建立请求消息为多根天线分配相同的本地小区标识
1104
Node B根据收到的小区建立请求消息为多根天线配置最大输出功率
1105
Node B根据收到的小区建立请求消息为多根天线配置信道资源

图 11

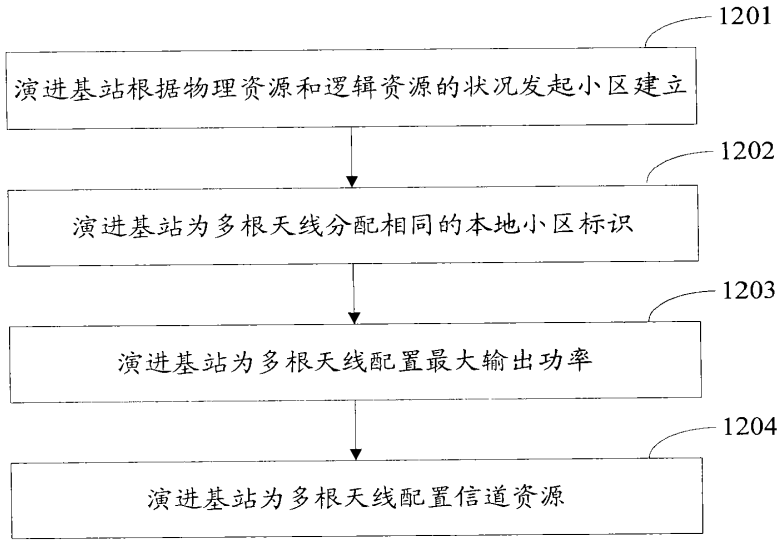

1201
演进基站根据物理资源和逻辑资源的状况发起小区建立
1202
演进基站为多根天线分配相同的本地小区标识
1203
演进基站为多根天线配置最大输出功率
1204
演进基站为多根天线配置信道资源

图 12

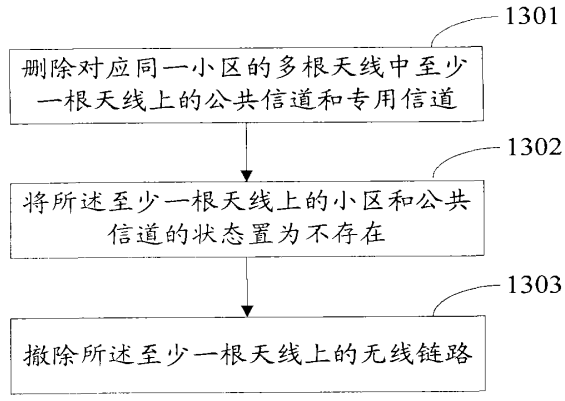

1301
删除对应同一小区的多根天线中至少一根天线上的公共信道和专用信道
1302
将所述至少一根天线上的小区和公共信道的状态置为不存在
1303
撤除所述至少一根天线上的无线链路

图 13

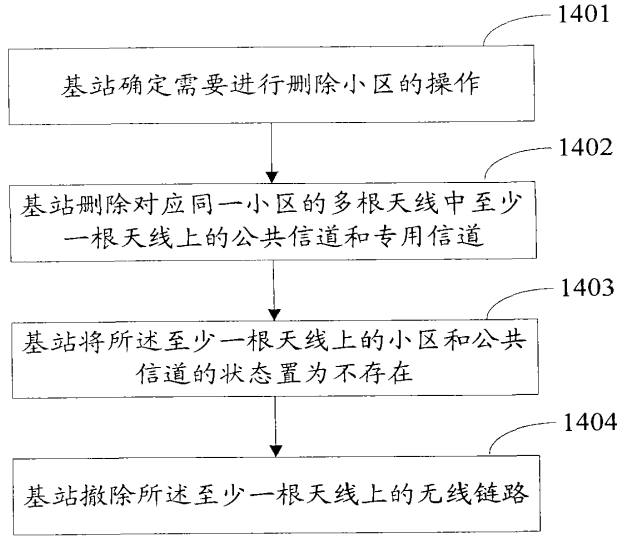

1401
基站确定需要进行删除小区的操作
1402
基站删除对应同一小区的多根天线中至少一根天线上的公共信道和专用信道
1403
基站将所述至少一根天线上的小区和公共信道的状态置为不存在
1404
基站撤除所述至少一根天线上的无线链路

图 14

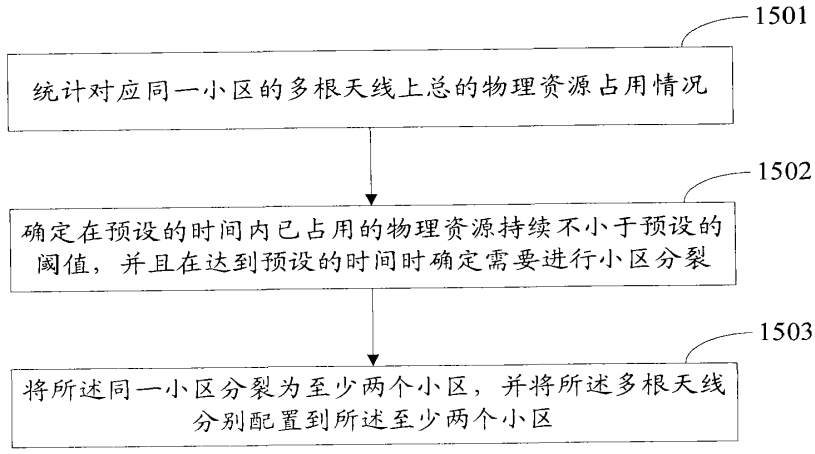

1501
统计对应同一小区的多根天线上总的物理资源占用情况
1502
确定在预设的时间内已占用的物理资源持续不小于预设的阈值，并且在达到预设的时间时确定需要进行小区分裂
1503
将所述同一小区分裂为至少两个小区，并将所述多根天线分别配置到所述至少两个小区

图 15

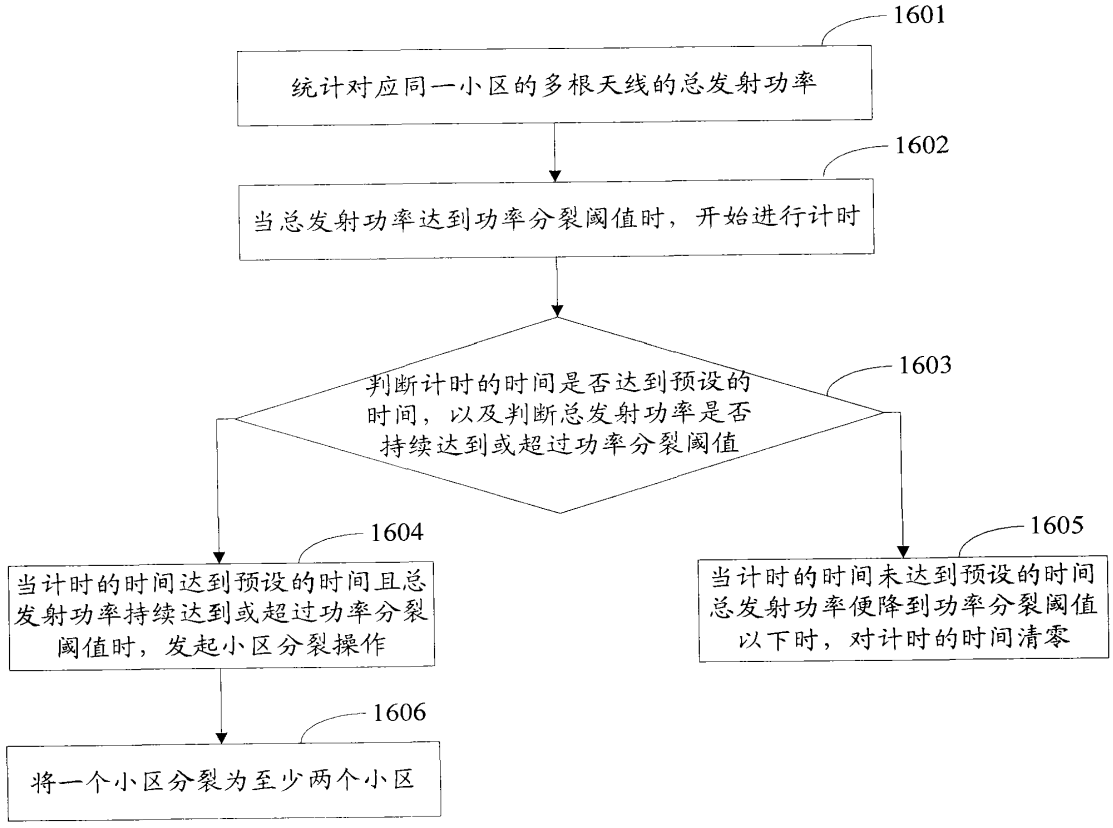

1601
统计对应同一小区的多根天线的总发射功率
1602
当总发射功率达到功率分裂阈值时，开始进行计时
1603
判断计时的时间是否达到预设的时间，以及判断总发射功率是否持续达到或超过功率分裂阈值
1604
当计时的时间达到预设的时间且总发射功率持续达到或超过功率分裂阈值时，发起小区分裂操作
1605
当计时的时间未达到预设的时间总发射功率便降到功率分裂阈值以下时，对计时的时间清零
1606
将一个小区分裂为至少两个小区

图 16A

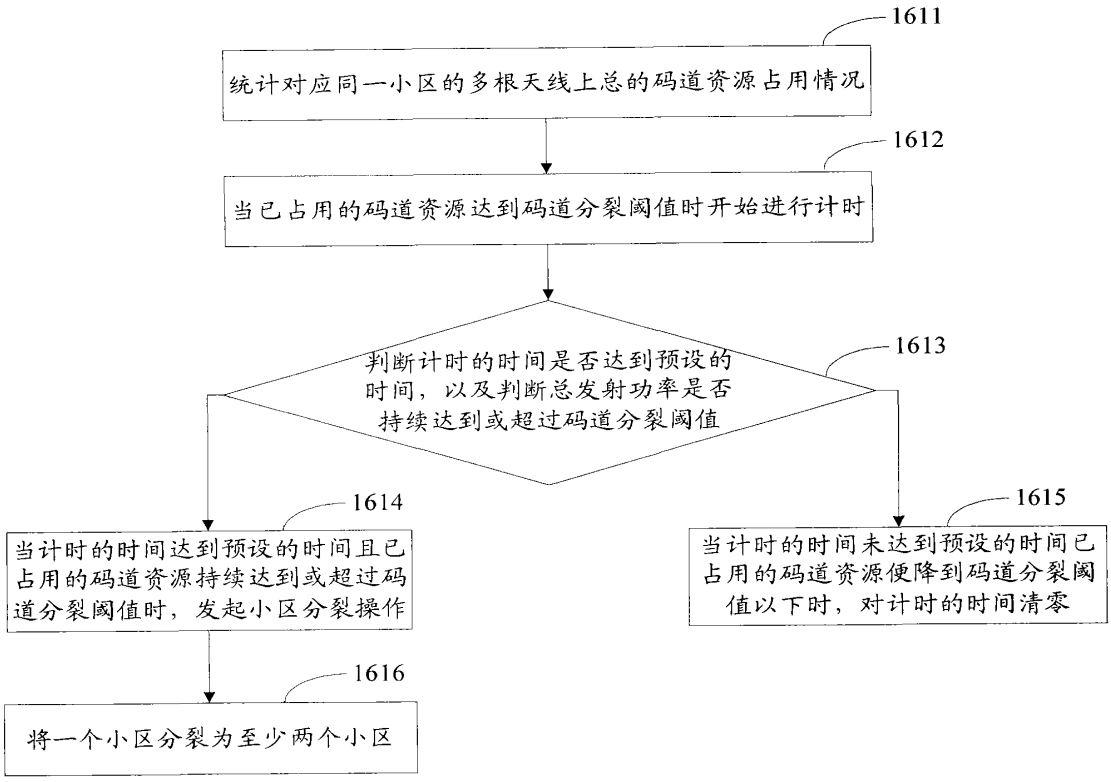

1611
统计对应同一小区的多根天线上总的码道资源占用情况
1612
当已占用的码道资源达到码道分裂阈值时开始进行计时
判断计时的时间是否达到预设的时间，以及判断总发射功率是否持续达到或超过码道分裂阈值
1613
1614
当计时的时间达到预设的时间且已占用的码道资源持续达到或超过码道分裂阈值时，发起小区分裂操作
1615
当计时的时间未达到预设的时间已占用的码道资源便降到码道分裂阈值以下时，对计时的时间清零
1616
将一个小区分裂为至少两个小区

图 16B

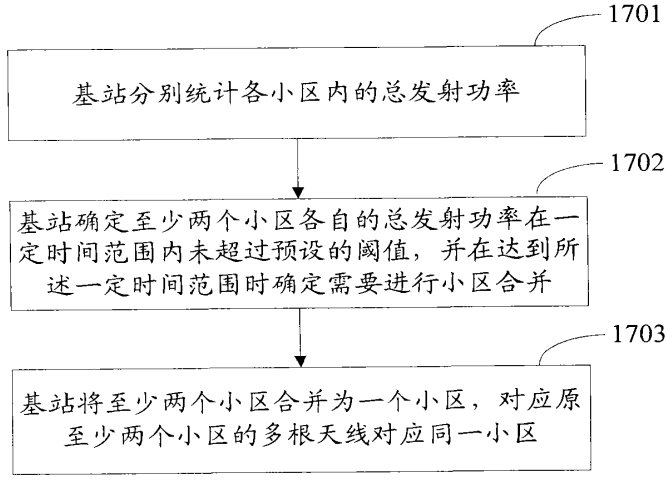

1701
基站分别统计各小区内的总发射功率
1702
基站确定至少两个小区各自的总发射功率在一定时间范围内未超过预设的阈值，并在达到所述一定时间范围时确定需要进行小区合并
1703
基站将至少两个小区合并为一个小区，对应原至少两个小区的多根天线对应同一小区

图 17

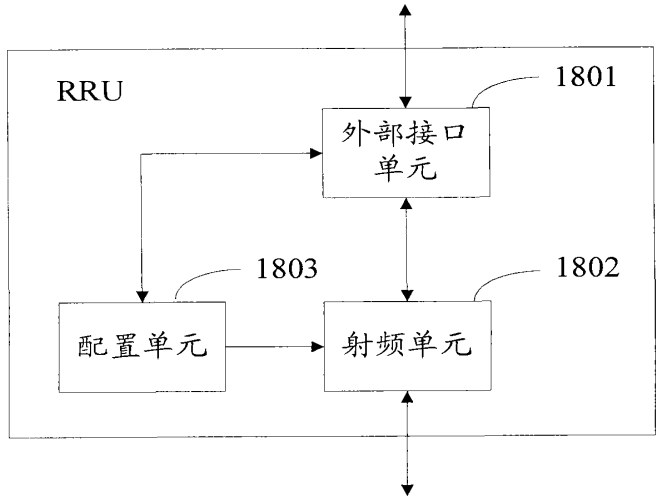

RRU
1801
外部接口单元
1803
1802
配置单元
射频单元

图 18

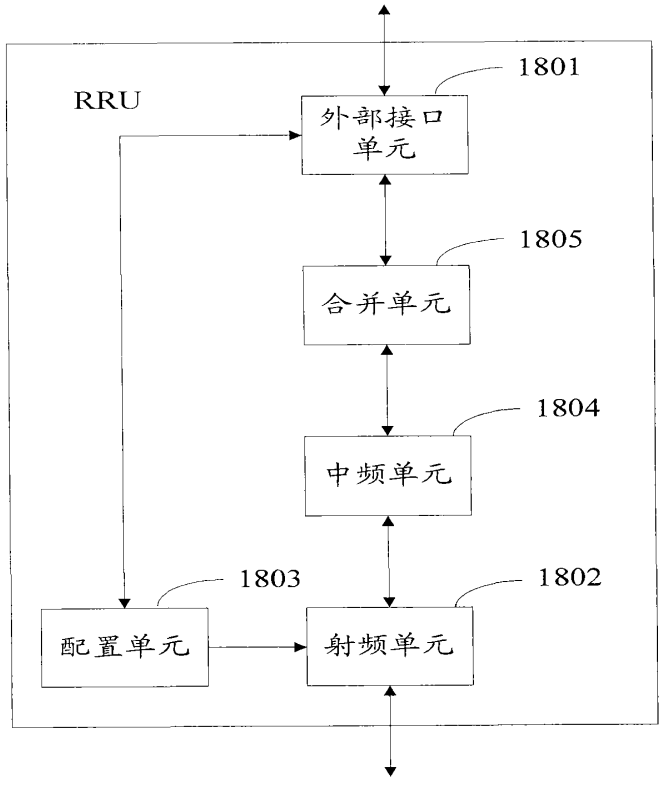

RRU
1801
外部接口单元
1805
合并单元
1804
中频单元
1803
1802
配置单元
射频单元

图 19

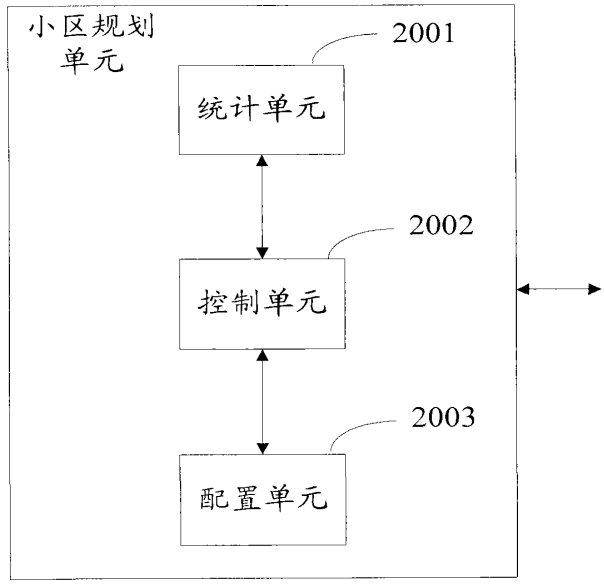

小区规划
单元
2001
统计单元
2002
控制单元
2003
配置单元

图 20

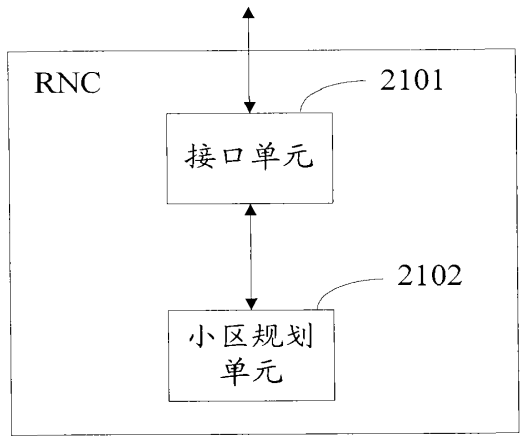

RNC
2101
接口单元
2102
小区规划
单元

图 21

(19) 대한민국특허청(KR)
(12) 국제특허출원의 출원공개공보(A)

(51) Int. Cl.[6]
H04Q 7/22

(11) 공개번호 특1996-7002978
(43) 공개일자 1996년05월23일

(21) 출원번호 특1995-7005422
(22) 출원일자 1995년11월28일
번역문제출일자 1995년11월28일
(86) 국제출원번호 PCT/US 94/05897 (87) 국제공개번호 WO 94/28690
(86) 국제출원출원일자 1994년05월25일 (87) 국제공개일자 1994년12월08일
(81) 지정국 EP 유럽특허 : 오스트리아 벨기에 스위스 및 리히텐스타인 독일 덴마크 스페인 프랑스 영국 그리이스 아일랜드 이탈리아 룩셈브르크 모나코 네덜란드 포르투갈 스웨덴

OA OAPI특허 : 베냉 브르키나파소 카메룬 중앙아프리카 차드 콩고 코트니부아르 가봉 기니 말리 마르타니아 니제르 세네갈 토고

국내특허 : 오스트리아 오스트레일리아 바베도스 불가리아 브라질 벨라루스 캐나나 스위스 리히텐스타인 중국 체코 독일 덴마크 스페인 핀란드 영국 헝가리 일본 북한 대한민국 카자흐스탄 스리랑카 룩셈브르크 라트비아 마나가스카르 몽골 말라위 네덜란드 노르웨이 뉴질랜드 폴란드 포르투갈 루마니아 러시아연방 수단 스웨덴 슬로바키아 우크라이나 우즈베키스탄 베트남 죠르지아 카르지츠스탄

(30) 우선권주장 8/068,389 1993년05월28일 미국(US)
8/183,221 1994년01월14일 미국(US)
8/204,660 1994년03월02일 미국(US)

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(54) 중심에 위치된 기지국과 분산된 안테나 유닛을 구비한 셀룰러 무선 통신 시스템(CELLULAR RADIO SYSTEM WITH CENTRALIZED LOCATED BASE STATIONS AND DISTRIBUTED ANTENNA UNITS)

요약

마이크로셀룰러 통신망은 나수의 기지국 유닛(106)과 대응하는 안테나 유닛(102)을 포함한다. 기지국 유닛은 공통 위치(114) 내에 하우징된다. 각각은 종래의 송신기와 수신기 또는 모든 니지탈 송신기 및 수신기 장비, 및 이동 통신 교환국(110)과의 인터페이스 회로(112)를 포함한다. 마이크로셀 트래픽 출력은 프레임 생성기/멀티플렉서에 인가된다. 프레임 생성기/멀티플렉서의 출력은 니지탈 변조 레이저에 인가된다. 레이저 출력은 광 파이버에 의해 원격 안테나 유닛에 전송되고, 원격 안테나 유닛은 마이크로셀 트래픽 신호를 니멀티플렉스하고 이것을 니지탈-아날로그 변환기에 인가한다. 니지탈-아날로그 변환기의 출력은 전력 증폭기에 인가하고 차례로 주 안테나에 접속된다.

이동 유닛으로부터의 RF 신호는 주 및 나이버시티 안테나 둘나에서 수신된다. 수신된 신호는 필터되고, 니지탈화되며, 함께 멀티플렉스되어 광 파이버를 통해 기지국에 역 송신된다. 가장 강한 신호가 사용을 위해 선택된다.

모든 니지탈 마이크로셀룰러 통신 시스템의 분산은 2개의 스테이지에서 일어난다. 이 방법은 업그레이드의 두번째 스테이지에서 니지탈 마이크로셀 안테나 유닛을 수정할 필요가 없이 업그레이드 초기 단계에서

달성될 디지탈 시스템의 잇점을 가능하게 해 준다.

디지탈화된 RF 신호의 디지탈 필터링이 또한 제공되어, 셀에 관련된 그들 채널 만이 안테나 유닛에 그리고 안테나 유닛으로부터 송신하기 위해 추출되고, 디지탈 수동 핸드오프 시스템은 셀 내의 모든 트래픽의 FFT 분석과 이에 응답하는 수동 스위칭을 제공한다.

QES

SZ

SMA

[발명의 명칭]

중심에 위치된 기지국과 분산된 안테나 유닛을 구비한 셀룰러 무선 통신 시스템(CELLULAR RADIO SYSTEM WITH CENTRALIZED LOCATED BASE STATIONS AND DISTRIBUTED ANTENNA UNITS)

[도면의 간단한 설명]

제1A도는 제1종래 기술의 이동 통신 시스템의 기능 블럭도,

제1B도는 종래 기술의 기지국의 기능 블럭도,

제1C도는 종래 기술의 마이크로셀 이동 통신 시스템의 기능 블럭도,

제2도는 본 발명의 마이크로셀 통신 시스템의 한 실시예의 개략 블럭도,

제3도는 제2도에 도시된 기지국 실시예의 상세 블럭도,

제4도는 제3도에 도시된 기지국의 상세 블럭도,

제5도는 제4도에 도시된 프레임 생성기/멀티플렉서(134)의 상세 블럭도.

본 내용은 요부공개 건이므로 전문 내용을 수록하지 않았음

(57) SPQ SM

청구항 1

마이크로셀룰러 통신 시스템에 있어서, 공통으로 위치된 다수의 마이크로셀 기지국 유닛으로서 파이버 경로에 의해 대응하는 다수의 안테나 유닛에 각각 접속되어 있는 공통으로 위치된 다수의 마이크로셀 기지국 유닛을 포함하며, 상기 기지국 유닛 각각은, 각 채널 마다 마이크로셀에 할당되어 있는 RF 전송기 및 수신기와, 상기 송신기로부터 출력된 RF 신호를 결합시키는 결합기 수단과, 상기 결합된 신호를 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 수단과, 상기 디지탈화된 샘플 스트림을 프레임시키는 프레이밍 수단과, 상기 프레임된 샘플 스트림을 수신하여 상기 대응하는 안테나 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 수단과, 상기 파이버 경로에서 광변조된 직렬 비트 스트림을 검출하기 위한 광 수신기 수단을 포함하며, 상기 안테나 유닛 각각은 상기 프레임된 샘플 스트림을 수신하여 디지탈화된 RF 신호를 추출하기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF 신호를 수신하여 아날로그 RF 신호를 재구성하기 위한 디지탈-아날로그 수단과, 상기 재구성된 신호를 증폭시키기 위한 증폭기 수단과, 상기 증폭된 신호를 수신하여 마이크로셀 영역에 방송하기 위한 안테나 수단과, 상기 안테나에서 수신된 RF 마이크로셀 트래픽 신호를 수신하기 위한 수단과, 상기 수신된 RF 마이크로셀 트래픽 신호를 디지탈화된 데이타 스트림으로 변환시키기 위한 아날로그-디지탈 변환기와, 상기 디지탈화된 스트림을 프레임시키기 위한 프레이머 수단과, 상기 프레임된 스트림을 수신하여 상기 대응하는 기지국 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 공급하기 위한 레이저 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 마이크로셀 트래픽 스트림을 수신하여 상기 디지탈화된 RF 신호를 추출해 내기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF 신호를 수신하여 상기 수신기에 인가되어지는 아날로그 RF 신호를 재구성하는 디지탈-아날로그 변환기를 더 포함하는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 2

제1항에 있어서, 적어도 하나의 부가 채널을 상기 파이버에 의해 전달된 상기 마이크로셀 트래픽과 함께 멀티플렉스시키는 수단을 더 포함하는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 3

제2항에 있어서, 상기 부가 채널들 중 일부는 서비스를 교대로 제공하기 위한 채널인 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 4

제3항에 있어서, 상기 부가 채널들 중 하나는 개인용 통신망(PCN) 채널인 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 5

제3항에 있어서, 상기 부가 채널들 중 하나는 페이징 서비스 채널인 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 6

제2항에 있어서, 상기 부가 채널들 중 하나는 경보 채널인 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 7

제2항에 있어서, 상기 부가 채널들 중 하나는 상기 기지국과 상기 안테나 유닛 사이에서 2방식 지정간 음성 등급 통신을 송신하기 위한 음성 채널인 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 8

케이블 시스템을 통해 이동 전화 서비스를 마이크로셀 영역에 제공하기 위한 마이크로셀룰러 통신 시스템에 있어서, 케이블 텔리비전 분배 시스템으로서, 파이버 경로에 의해 이 시스템의 선단국에 위치된 선단 유닛에 접속되어 있는 나수의 광노드를 갖는 상기 시스템의 상기 선단 유닛에 상기 파이버 경로를 통해 접속되어 있는 마이크로셀 기지국 유닛을 포함하며, 상기 기지국 유닛은 셀룰러 대역을 형성하는 나수의 각 채널마나 마이크로셀에 할당되어 있는 나수의 RF 전송기 및 수신기와, 상기 송신기로부터 출력된 RF신호를 결합시키는 결합기 수단과, 상기 결합된 신호의 셀룰러 대역 성분을 니지탈화된 샘플 스트림으로 변환시키는 아날로그-니지탈 변환기 수단과, 상기 니지탈화된 스트림을 프레이밍하는 제1프레이밍 수단과, 상기 프레임된 스트림을 수신하여 상기 선단 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 니지탈적으로 변조된 레이저 수단을 포함하며, 상기 선단 유닛은 상기 프레임된 스트림을 수신하여 니지탈화된 RF 신호를 추출해내는 니멀티플렉서 수단과, 상기 니지탈화된 RF 신호를 수신하여 셀룰러 대역을 포함한 아날로그 RF 신호를 재구성하는 니지탈-아날로그 변환기 수단과, 상기 셀룰러 대역을 상기 나수의 채널의 서브 셋트를 각각 포함하는 나수의 서브 대역으로 분할시키는 하나 이상의 필터 수단과, 상기 서브 대역 중 하나를 변조시켜 광노드에 접속된 상기 파이버 경로 중 하나에 인가시키기 위해 대응하는 광신호를 발생시키는 광 송신기에 변조된 출력을 인가시키는 변조기 수단과, 서브 대역을 포함한 변조된 광 신호를 수신하여 상기 서브 대역을 복조시키는 복조기에 인가시키기 위해 대응하는 전기 신호를 발생시켜 상기 서브 대역을 포함한 대응하는 아날로그 RF 신호를 발생시키는 광 수신기 수단과, 상기 복조기로부터 RF 신호를 수신하여 이 RF 신호를 니지탈화된 데이타 스트림으로 변환시키는 아날로그-니지탈 변환기 수단과, 상기 니지탈화된 스트림을 프레이밍시키는 제2프레이밍 수단과, 상기 프레임된 스트림을 수신하여 대응하는 기지국 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 니지탈적으로 변조된 레이저 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 마이크로셀 트래픽 스트림을 수신하여 상기 니지탈화된 RF 신호를 추출해내는 니멀티플렉서 수단과, 상기 니지탈화된 RF 신호를 수신하여 수신기에 인가되는 상기 아날로그 RF 신호를 재구성하는 니지탈-아날로그 변환기 수단과, 상기 케이블 텔리비전 시스템의 상기 광노드에 위치된 광노드 유닛을 더 포함하며, 상기 광노드 유닛은 상기 변조된 서브 대역을 상기 하나의 파이버 경로를 통해 수신하는 광 수신기 수단과, 상기 서브 대역을 포함하는 RF 신호를 발생시키기 위해 상기 변조된 서브 대역을 복조시키는 복조기 수단과, 주 안테나로부터의 송신을 위해 상기 RF 신호를 증폭시키는 증폭기 수단과, 상기 주 안테나에서 수신된 RF 신호에서 상기 서브 대역을 여파시키는 필터 수단과, 상기 수신된 서브 대역을 변조시키는 변조기 수단과, 대응하는 광 신호를 상기 한 파이버 경로에 인가시키는 광 송신기 수단을 포함하는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 9

제8항에 있어서, 상기 선단 유닛과 광 노드 유닛 내의 상기 변조기 수단 및 복조기 수단은 상기 서브 대역이 상기 한 파이버 경로를 통해 아날로그 포맷으로 송신되도록 진폭변조(AM)되는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 10

케이블 시스템을 통하며 니지탈 변조를 이용하여 이동 전화 서비스를 마이크로셀 영역에 제공하기 위한 마이크로셀룰러 통신 시스템에 있어서, 케이블 텔리비전 분배 시스템으로서, 파이버 경로에 의해 이 시스템의 선단국에 위치된 선단 유닛에 접속되어 있는 나수의 광노드를 갖는 상기 시스템의 상기 선단 유닛에 상기 파이버 경로를 통해 접속되어 있는 마이크로셀 기지국 유닛을 포함하며, 상기 기지국 유닛은 셀룰러 대역을 형성하는 나수의 각 채널마나 마이크로셀에 할당되어 있는 나수의 RF 전송기 및 수신기와, 상기 송신기의 서브 대역을 포함한 서브 셋트로부터 출력된 RF 신호를 결합시키는 결합기 수단과, 상기 결합된 신호의 셀룰러 대역 성분을 니지탈화된 샘플 스트림으로 변환시키는 아날로그-니지탈 변환기 수단과, 상기 니지탈화된 스트림을 프레이밍하는 프레이머 수단과, 상기 프레임된 스트림을 수신하여 상기 선단 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 레이저 수단을 포함하며, 상기 선단 유닛은 상기 프레임된 스트림을 수신하여 상기 송신기의 상기 서브 셋트에 대응하는 니지탈화된 RF 신호를 추출해내는 니멀티플렉서 수단과, 상기 니지탈화된 RF 서브 대역 신호를 수신하여 광노드에 접속된 상기 파이버 경로 중 하나에 인가시키기 위해 대응하는 광신호를 발생시키는 광 송신기에 변조된 출력을 인가시키는 니지탈 변조기 수단과, 상기 서브 대역에 대응하는 니지탈화된 RF 신호를 포함한 변조된 광 신호를 수신하여 상기 서브 대역에 대응하는 니지탈 데이타 스트림을 발생시키는 니지탈 복조기에 인가시키기 위해 대응하는 전기 신호를 발생시키는 광 수신기 수단과, 상기 니지탈화된 스트림을 프레이밍시키는 프레이밍 수단과, 상기 프레임된 스트림을 수신하여 상기 기지국 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 레이저 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 마이크로셀 트래픽 스트림을 수신하여 상기 니지탈화된 RF 신호를 추출해내는 니멀티플렉서 수단과, 상기 니지탈화된 RF 신호를 수신하여 수신기에 인가되는 상기 아날로그 RF 신호를 재구성하는 니지탈-아날로그 변환기 수단과, 상기 케이블 텔리비전 시스템의 상기 광노드에 위

치된 광노드 유닛을 더 포함하며, 상기 광노드 유닛은 상기 한 파이버 경로 상에서 상기 변조된 서브 대역을 수신하는 광 수신기 수단과, 상기 디지탈화된 서브 대역을 포함하는 디지탈 신호를 발생시키기 위해 상기 변조된 서브 대역을 복조시키는 디지탈 복조기 수단과, 상기 디지탈 신호를 대응하는 RF신호로 변환시키는 디지탈-아날로그 변환기 수단과, 주 안테나로부터의 송신을 위해 상기 RF 신호를 증폭시키는 증폭기 수단과, 상기 주 안테나에서 수신된 RF 신호에서 상기 서브 대역을 여파시키는 필터 수단과, 상기 아날로그 RF 신호를 대응하는 디지탈 신호로 변환시키는 아날로그-디지탈 변환기 수단과, 상기 디지탈 신호를 변조시키는 디지탈 변조기 수단과, 대응하는 레이저 신호를 상기 한 파이버 경로에 인가시키는 광 송신기 수단을 포함하는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 11

RF 신호의 송신을 위해 교환 전화망을 이용하는 마이크로셀룰러 통신 시스템에 있어서, 공통으로 위치된 다수의 마이크로셀 기지국 유닛 및 관련된 다수의 안테나 유닛을 포함하며, 상기 기지국 유닛 각각은, 각 채널 마다 마이크로셀에 할당되어 있는 RF 전송기 및 수신기와, 상기 송신기의 서브 셋트로부터 출력된 RF 신호를 결합시키는 결합기 수단과, 상기 결합된 신호를 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 변환기 수단과, 상기 디지탈화된 샘플 스트림을 상기 교환 전화망에 적합한 신호 포맷으로 프레임시키는 프레이머 수단과, 상기 프레임된 신호를 상기 교환 전화망과 인터페이스시켜 이 신호를 원격 안테나 유닛으로 어드레싱시키는 인터페이스 수단을 포함하며, 상기 안테나 유닛 각각은 상기 디지탈화된 스트림을 수신하기 위해 상기 교환 전화망과 인터페이싱하는 인터페이스 수단과, 상기 프레임된 샘플 스트림을 수신하여 디지탈화된 RF 신호를 추출하기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF 신호를 수신하여 아날로그 RF 신호를 재구성하기 위한 디지탈-아날로그 변환기 수단과, 상기 재구성된 신호를 증폭시키기 위한 전력 증폭기 수단과, 상기 증폭된 신호를 수신하여 마이크로셀 영역에 방송하기 위한 안테나 수단과, 상기 안테나에서 수신된 RF 마이크로셀 트래픽 신호를 수신하기 위한 아날로그-디지탈 변환기 수단과, 상기 수신된 RF 마이크로셀 트래픽 신호를 디지탈화된 데이타 스트림으로 변환시키기 위한 아날로그-디지탈 변환기 수단과, 상기 디지탈화된 스트림을 상기 교환 전화망에 적합한 신호 포맷으로 프레임시키기 위한 프레이머 수단을 포함하며, 상기 인터페이스 수단은 또한 상기 디지탈화된 스트림을 수신하여 상기 교환 전화망을 통해 대응하는 상기 기지국 유닛에 송신하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 마이크로셀 트래픽 스트림을 수신하여 상기 디지탈화된 RF 신호를 추출해 내기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF 신호를 수신하여 상기 수신기에 인가되어지는 아날로그 RF 신호를 재구성하는 디지탈-아날로그 변환기 수단을 더 포함하는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 12

마이크로셀룰러 통신 시스템에 있어서, 파이버 경로에 의해 대응하는 안테나 유닛에 각각 접속되어 있는 공통으로 위치된 다수의 마이크로셀 기지국 유닛을 포함하며, 상기 지기국 유닛 각각은, 이동 전화 교환국으로 부터 전화 신호를 수신하여 안테나 유닛 내의 디지탈-아날로그 변환기에 인가될 때 디지탈화된 샘플 스트림으로 변환시키며 대응하는 RF 신호를 공급하는 합성기 수단과, 상기 디지탈화된 샘플 스트림을 프레임시키는 프레이머 수단과, 상기 프레임된 샘플 스트림을 수신하여 대응하는 상기 안테나 유닛에 송신하기 위해 상기 파이버 경로에 대응하는 레이저 신호를 인가시키는 디지탈적으로 변조된 레이저 수단을 포함하며, 상기 안테나 유닛 각각은 상기 프레임된 샘플 스트림을 수신하여 디지탈화된 샘플 스트림을 추출하기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF 신호를 수신하여 아날로그 RF 신호를 재구성하기 위한 디지탈-아날로그 변환기 수단과, 상기 재구성된 신호를 증폭시키기 위한 전력 증폭기 수단과, 상기 증폭기 신호를 수신하여 마이크로셀 영역에 방송하기 위한 안테나 수단과, 상기 안테나에서 수신된 RF 마이크로셀 트래픽 신호를 수신하기 위한 아날로그-디지탈 변환기 수단과, 상기 수신된 RF 마이크로셀 트래픽 신호를 디지탈화된 데이타 스트림으로 변환시키기 위한 아날로그-디지탈 변환기 수단과, 상기 디지탈화된 스트림을 프레임시키기 위한 프레이머 수단과, 상기 프레임된 스트림을 수신하여 대응하는 상기 기지국 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 공급하기 위한 디지탈적으로 변조된 레이저 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 마이크로셀 트래픽 스트림을 수신하여- 상기 디지탈화된 RF 신호를 추출해 내기 위한 디멀티플렉서 수단을 더 포함하며, 상기 합성기 수단은 또한 상기 추출된 디지탈화된 RF 신호를 MTSO로 송신될 수 있는 형으로 변환시키는 수단을 포함하는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 13

디지탈 마이크로셀룰러 통신 시스템의 스테이지 분산 방법에 있어서, (a) 파이버 경로에 의해 대응하는 원격 안테나 유닛에 각각 접속되어 있는 공통으로 위치된 다수의 아날로그 마이크로셀 기지국 유닛을 분산시키는 단계와, (b) 다수의 원격 안테나 유닛을 분산시키는 단계와, (c) 상기 다수의 아날로그 마이크로셀 기지국을 다수의 모든 디지탈 기지국으로 교체하는 단계를 포함하며, 상기 아날로그 기지국 유닛 각각은, 각 채널마다 마이크로셀에 할당되어 있는 RF 전송기 및 수신기와, 상기 송신기로부터 출력된 RF 신호를 결합시키는 결합기와, 상기 결합된 신호를 디지탈화된 샘플 스트림으로 변환시키는 광대역 아날로그-디지탈 변환기와, 상기 디지탈화된 샘플 스트림을 프레임시키는 프레이밍 수단과, 상기 프레임된 샘플 스트림을 수신하여 대응하는 상기 안테나 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 디지탈적으로 변조된 레이저를 포함하며, 상기 안테나 유닛 각각은 상기 프레임된 샘플 스트림을 수신하여 디지탈화된 RF 신호를 추출하기 위한 디멀티플렉서와, 상기 디지탈화된 RF 신호를 수신하여 아날로그 RF 신호를 재구성하기 위한 디지탈-아날로그 변환기와, 상기 재구성된 신호를 증폭시키기 위한 전력 증폭기와, 상기 증폭된 신호를 수신하여 마이크로셀 영역에 방송하기 위한 안테나와, 상기 안테나에서 수신된 RF 마이크로셀 트래픽 신호를 수신하기 위한 아날로그-디지탈 변환기와, 상기 수신된 RF 마이크로셀 트래픽 신호를 디지탈화된 데이타 스트림으로 변환시키기 위한 아날로그-디지탈 변환기와, 상기 디지탈화된 스트림을 프레임시키기 위한 프레이밍 회로와, 상기 프레임된 스트림을 수신하여 대응하는 상기 기지국 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 공급하기 위한 디지탈적으로 변조된 레이저를 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 마이크로셀 트래픽 스트림을 수신하여 상기 디지탈화된 RF 신호를 추출해 내기 위한 디멀티플렉서와, 상기

디지탈화된 RF 신호를 수신하여 상기 수신기에 인가되어지는 아날로그 RF신호를 재구성하는 디지탈-아날로그 변환기를 더 포함하며, 상기 모든 디지탈 기지국은 이동 전화 교환국으로부터 전화 신호를 수신하여 안테나 유닛 내의 디지탈-아날로그 변환기에 인가될 때 디지탈화된 샘플 스트림으로 변환시키며 대응하는 RF 신호를 공급하는 합성기 수단과, 상기 디지탈화된 샘플 스트림을 프레이밍시키는 프레이밍 회로와, 상기 프레임된 샘플 스트림을 수신하여 상기 대응하는 안테나 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 디지탈적으로 변조된 레이저를 포함하는 것을 특징으로 하는 마이크로셀룰러 통신 시스템의 스테이지 분산 방법.

청구항 14

마이크로셀룰러 통신 시스템에 있어서, 공통으로 위치된 다수의 마이크로셀 기지국 유닛으로서, 파이버 경로에 의해 대응하는 다수의 안테나 유닛에 각각 접속되어 있는 공통으로 위치된 다수의 마이크로셀 기지국 유닛을 포함하며, 상기 기지국 유닛 각각은, 각 채널 마다 마이크로셀에 할당되어 있는 RF 전송기 및 수신기와, 상기 송신기로부터 출력된 RF 신호를 결합시키는 결합기 수단과, 상기 결합된 신호를 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 변환기 수단과, 상기 디지탈화된 샘플 스트림을 프레임시키는 프레이머 수단과, 상기 프레임된 샘플 스트림을 수신하여 상기 대응하는 안테나 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 인가시키는 디지탈적으로 변조된 레이저 수단을 포함하며, 상기 안테나 유닛 각각은 상기 프레임된 샘플 스트림을 수신하여 디지탈화된 RF 신호를 추출하기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF신호를 수신하여 아날로그 RF신호를 재구성하기 위한 디지탈-아날로그 변환기 수단과, 상기 재구성된 신호를 증폭시키기 위한 전력 증폭기 수단과, 상기 증폭된 신호를 수신하여 마이크로셀 영역에 방송하기 위한 주 안테나 수단과, 상기 주 안테나에서 수신된 주 RF 마이크로셀 트래픽 신호를 수신하기 위한 아날로그-디지탈 변환기 수단과, 상기 수신된 RF 마이크로셀 트래픽 신호를 디지탈화된 제1데이타 스트림으로 변환시키기 위한 아날로그-디지탈 변환기 수단과, 다이버시티 RF 트래픽 신호를 수신하는 다이버시티 안테나 수단과, 상기 수신된 다이버시티 RF 트래픽 신호를 디지탈화된 제2데이타 스트림으로 변환시키는 아날로그-디자탈 변환기 수단과, 상기 디지탈화된 주 및 다이버시티 데이타 스트림을 프레임시키기 위한 프레이머 수단과, 상기 프레임된 스트림을 수신하여 상기 대응하는 기지국 유닛에 송신하기 위해 대응하는 레이저 신호를 상기 파이버 경로에 공급하기 위한 디지탈적으로 변조된 레이저 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 마이크로셀 트래픽 스트림을 수신하여 상기 디지탈화된 RF 신호를 추출해 내기 위한 디멀티플렉서 수단과, 상기 디지탈화된 주 RF신호를 수신하여 주 아날로그 RF 신호를 재구성하는 디지탈-아날로그 변환기 수단과, 상기 디지탈화된 다이버시티 RF 신호를 수신하여 상기 다이버시티 아날로그 RF 신호를 재구성하는 디지탈-아날로그 변환기 수단을 더 포함하며, 상기 주 RF 신호와 디어비시티 RF신호 중 강한 신호가 수신기에 인가되어지는 것을 특징으로 하는 마이크로셀룰러 통신 시스템.

청구항 15

다수의 채널이 할당되어 있는 셀을 갖고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서 상기 셀에 관련된 영역 내에서 신호들을 방송 및 수신하도록 위치된 안테나를 갖고 있는 대응하는 각각의 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 각 채널 마다 셀에 할당되어 있는 다수의 RF 전송기 및 수신기와, 상기 송신기로부터 출력된 RF 신호를 결합시키는 결합기 수단과, 상기 결합된 신호를 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 변환 수단과, 상기 디자탈화된 샘플 스트림을 프레임시키는 프레이밍 수단과, 상기 프레임된 샘플 스트림을 수신하여 상기 대응하는 안테나 유닛에 송신하기 위해 상기 전송 수단에 대응하는 디지탈 신호를 인가시키는 수단과, 상기 전송 수단을 통해 상기 대응하는 안테나 유닛으로부터 디지탈 비트 스트림을 수신하는 수신기 수단을 포함하며, 상기 안테나 유닛 각각은 상기 프레임된 샘플 스트림을 수신하여 디지탈화된 RF 신호를 추출하기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF 신호를 수신하여 아날로그 RF 신호를 재구성하는 디지탈-아날로그 수단과, 상기 재구성된 신호를 증폭시키기 위한 증폭기 수단과, 상기 증폭된 신호를 셀에 관련된 영역으로 방송하기 위해 상기 안테나에 인가시키는 수단과, 상기 안테나에서 수신된 RF 신호를 수신하기 위한 수단과, 상기 수신된 RF 신호를 디지탈화된 데이타 스트림으로 변환시키기 위한 아날로그-디지탈 변환기와, 상기 디지탈화된 스트림을 프레임시키기 위한 프레이머 수단과, 상기 프레임된 스트림을 수신하여 상기 기지국 유닛에 송신하기 위해 상기 송신 수단에 인가시키는 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 프레임된 신호를 수신하여 상기 디지탈화된 RF 신호를 추출해 내기 위한 디멀티플렉서 수단과, 상기 디지탈화된 RF 신호를 수신하여 아날로그 RF 신호를 재구성하는 디지탈-아날로그 변환기 및 상기 RF 신호를 상기 수신기에 인가시키는 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 16

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 상기 셀에 관련된 영역에서 신호들을 방송 및 수신하도록 위치된 안테나를 갖고 있는 각각의 대응하는 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 상기 셀 영역의 이동 유닛으로 전화 신호들을 송신하는 상이한 채널들 상에 다수의 RF 신호를 발생시키고 이들 RF 신호를 결합시켜 합성 아날로그 신호를 형성하는 아날로그 RF신호 발생 수단과, 상기 합성 신호를 디지탈화된 샘플 스트림으로 변환시켜 상기 대응하는 안테나 유닛에 송신하기 위해 상기 전송 수단에 상기 샘플들을 인가시키는 아날로그-디지탈 변환 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 대응하는 합성 아날로그 RF 신호를 재구성하고, 상기 셀에 관련된 영역에 증폭된 신호를 방송하기 위해 이 신호를 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF 신호를 디지탈화된 샘플 스트림으로 변환시키고 이들 샘플들을 상기 기지국 유닛에 송신하기 위해 상기 전송 수단에 인가시키는 아날로그-디지탈 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하여 상기 아날로그 RF 신호를 재구성하는 디지탈-아날로그 변환기 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 17

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 마이크로셀에 관련된 영역에서 신호들을 방송 및 수신하도록 위치된 안테나를 갖고 있는 대응하는 각각의 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 지지국 유닛은, 무선 제어기로부터 아날로그 전화 신호를 수신하여 상기 마이크로셀 영역의 이동 유닛으로 전화 신호들을 송신하는 상이한 채널들 상에 다수의 RF 신호 발생을 디지탈적으로 합성시키고, 상기 합성된 다수의 RF 신호의 디지탈형에 대응하는 디지탈화된 샘플 스트림을 발생시켜 상기 대응하는 안테나 유닛에 송신하기 위해 상기 전송 수단에 상기 샘플들을 인가시키는 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 대응하는 합성 아날로그 RF 신호를 재구성하고, 증폭된 신호를 상기 셀에 관련된 영역으로 방송하기 위해 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF 신호를 디지탈화된 샘플 스트림으로 변환시켜 상기 기지국 유닛에 송신하기 위해 상기 샘플들을 상기 전송 수단에 인가시키는 아날로그-디지탈 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 샘플 스트림으로 표현된 아날로그 전화 신호의 디지탈형을 디지탈적으로 합성시켜, 대응하는 전화 신호를 발생시키고, 이들 전화 신호들을 상기 전화 무선 제어기에 공급하는 변환기 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 18

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 상기 셀에 관련된 영역에서 신호들을 방송 및 수신하도록 위치된 안테나를 갖고 있는 각각의 대응하는 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 이동 전화 교환국과의 인터페이스로부터 다수의 전화 신호를 디지탈형으로 수신하여 상기 셀 영역의 이동 유닛으로 전화 신호들을 송신하는 상이한 채널들 상에 다수의 RF신호 발생을 디지탈적으로 합성시키고, 상기 합성된 다수의 RF신호의 디지탈형에 대응하는 디지탈화된 샘플 스트림을 발생시켜 상기 대응하는 안테나 유닛에 송신하기 위해 상기 샘플들을 상기 전송 수단에 인가시키는 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 대응하는 합성 아날로그 RF 신호를 재구성하고, 증폭된 신호를 상기 셀에 관련된 영역으로 방송하기 위해 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF 신호를 디지탈화된 샘플 스트림으로 변환시켜 상기 기지국 유닛에 송신하기 위해 상기 샘플들을 상기 전송 수단에 인가시키는 아날로그-디지탈 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 샘플 스트림으로 표현된 아날로그 전화 신호의 디지탈형을 디지탈적으로 합성시켜, 상기 디지탈 전화 신호들을 상기 이동 전화 교환국과의 인터페이스에 공급하는 디지탈-아날로그 변환기 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 19

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서 모든 존이 상기 셀에 위치되며 그 중에서 안테나 유닛과 관련된 존에서 신호들을 방송 및 수신하도록 위치된 안테나를 각각 갖고 있는 다수의 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 이동 전환 교환국으로부터 다수의 전화 신호를 수신하여 상기 셀 내의 이동 유닛으로 전화 신호들을 전송하는 상이한 채널들 상에 다수의 RF 신호 발생을 디지탈적으로 합성시키고, 상기 합성된 RF 신호에 대응하는 디지탈화된 다수의 샘플 스트림을 각 안테나 유닛용으로 발생시켜 상기 대응하는 안테나 유닛에 전송하기 위해 상기 각 샘플 스트림을 상기 전송 수단에 인가시키며, 각 스트림으로 표현된 채널들이 제어될 수 있도록 각 샘플 스트림의 각 채널을 제어하는 제1제어 신호에 응답하는 수단을 구비하는 디지탈화 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 대응하는 아날로그 RF 신호를 재구성하고, 신호를 상기 셀에 관련된 영역으로 방송하기 위해 상기 안테나에 인가시키는 디지탈-아날로그 수단과 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF 신호를 디지탈화된 샘플 스트림으로 변환시켜 상기 기지국 유닛에 전송하기 위해 상기 샘플들을 상기 전송 수단에 인가시키는 아날로그-디지탈 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 샘플 스트림으로 표현된 아날로그 전화 신호를 디지탈적으로 합성시켜, 대응하는 전화 신호들을 상기 이동 전화 교환국으로 전송하기 위해 발생시키며, 채널을 획득한 존이 선택될 수 있도록 상기 샘플 스트림 중 하나를 통해 상기 안테나 유닛으로부터 상기 채널들 중 적어도 한 채널을 선택하고 상기 적어도 한 채널을 사용하여 해당 채널을 통해 전송된 아날로그 전화 신호의 디지탈형을 합성시키기 위한 제2제어 신호에 응답하는 수단을 구비하는 변환기 수단과, 상기 채널들이 각 존에서 방송되고 채널들이 수신된 전화 신호를 발생시키기 위해 획득된 각 존에서 상기 안테나 유닛에서 수신된 신호의 에너지 레벨에 따라 제어될 수 있도록, 각 안테나 유닛으로부터 수신된 상기 디지탈화된 샘플들을 모니터링하고, 각 스트림에서의 각 채널의 에너지 레벨을 디지탈적으로 분석하고, 상기 제1 및 제2제어 신호를 상기 디지탈화 수단과 상기 변환기 수단에 발생시키는 제어기 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 20

제19항에 있어서, 상기 제어기 수단은 다이버시티 기능을 얻기 위해 존에서 수신된 RF 신호의 페이딩(fading)을 모니터링하고 상기 제2제어 신호를 발생시켜 상기 RF 신호가 획득되는 존으로 스위칭하기 위한 페이드 제어 수단을 구비하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 21

제20항에 있어서, 상기 페이드 제어 수단은 상기 모니터링 및 스위칭 동작이 1초 내에 수행되는 것을 특

징으로 하는 셀룰러 통신 시스템.

청구항 22

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 다수의 존으로 분할된 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 상기 셀에 관련된 영역에서 신호들을 방송 및 수신하도록 위치된 안테나를 각각 가지며 각 존에 적어도 하나씩 위치된 다수의 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 상기 셀 영역의 이동 유닛으로 전화 신호들을 전송하는 상이한 채널들 상에 다수의 RF 신호를 발생시키는 아날로그 RF 신호 발생 수단과, 선택된 채널을 포함하는 각 존에 대한 합성 RF 신호를 형성하기 위해 상기 RF 신호를 스위칭 및 합성하는 제1제어 신호에 응답하는 제1스위치 수단과, 각 존에 대한 상기 합성 신호를 대응하는 디지탈화된 샘플 스트림으로 변환시켜 대응하는 각 안테나 유닛에 전송하기 위해 상기 전송 수단에 상기 샘플들을 인가시키는 아날로그-디지탈 변환 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 대응하는 합성 아날로그 RF 신호를 재구성하고, 상기 셀에 관련된 영역에 증폭된 신호를 방송하기 위해 이 신호를 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF 신호를 디지탈화된 샘플 스트림으로 변환시키고, 이들 샘플들을 상기 기지국 유닛에 전송하기 위해 상기 전송 수단에 인가시키는 아날로그-디지탈 수단을 포함하며, 상기 기지국 유닛 각각은, 각 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하여 각 안테나 유닛 용의 아날로그 RF 신호를 재구성하는 디지탈-아날로그 변환기 수단과, 수신기에 인가할 목적으로 상기 안테나 유닛으로부터의 하나 이상의 RF 신호를 각각 포함하는 다수의 합성 신호를 형성하기 위해 상기 안테나 유닛으로부터의 상기 RF 신호를 선택적으로 결합시키는 제2제어 신호에 응답하는 제2스위칭 및 결합 수단과, 상기 모든 안테나 유닛으로부터의 상기 디지탈화된 샘플 스트림을 모니터링하고, 각 존에서 각 채널의 에너지 레벨을 디지탈적으로 분석하고, 이에 따라 각 채널이 방송되는 존과 각 채널이 수신되는 존을 선택적으로 제어하기 위해 제1 및 제2제어 신호를 발생시키는 제어 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 23

제22항에 있어서, 상기 제어기 수단은 다이버시티 기능을 얻기 위해 존에서 수신된 RF 신호의 페이딩을 모니터링하고 상기 제2제어 신호를 발생시켜 상기 RF 신호가 획득되는 존으로 스위칭하기 위한 페이드 제어 수단을 구비하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 24

제23항에 있어서, 상기 페이드 제어 수단은 상기 모니터링 및 스위칭 동작이 1초 내에 수행되는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 25

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 상기 셀에 관련된 영역에서 신호들을 방송 및 수신하도록 위치된 안테나를 갖고 있는 각각의 대응하는 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 상기 셀 영역의 이동 유닛으로 전화 신호들을 송신하는 상이한 채널들 상에 다수의 RF 신호를 발생시키고, 이들 RF 신호를 결합시켜 합성 아날로그 신호를 형성하는 아날로그 RF 신호 발생 수단과, 상기 합성 신호를 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 변환 수단과, 상기 합성 신호를 여과해서 적어도 하나의 채널에 각각 대응하는 디지탈화된 다수의 개별 스트림을 발생시키고, 이들 개별 데이타 샘플 스트림을 대응하는 안테나 유닛으로 전송하기 위해 전송 수단에 인가하는 디지탈 필터 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 대응하는 아날로그 RF 신호를 재구성하고, 상기 셀에 관련된 영역에 증폭된 신호를 방송하기 위해 이 신호를 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF 신호를 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 수단과, 상기 수신된 RF신호로부터 유도된 샘플 스트림을 여과해서 채널들 중의 적어도 하나의 채널에 각각 대응하는 디지탈화된 다수의 개별 샘플 스트림을 발생시키고, 이들 개별 데이타 스트림을 상기 기지국 유닛으로 전송하기 위해 상기 전송 수단에 인가하는 디지탈 필터 수단을 포함하며, 상기 기지국 유닛 각각은, 상기 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하여 각 스트림에 대응하는 아날로그 RF신호를 재구성하고, 이들 RF 신호를 상기 수신기에 인가하는 디지탈-아날로그 변환기 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 26

제25항에 있어서, 상기 전송 수단은 교환 전화망을 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 27

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 마이크로셀에 관련된 영역에서 신호들을 방송 및 수신하도록 위치된 안테나를 갖고 있는 대응하는 각각의 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 무선 제어기로부터 아날로그 전화 신호를 수신하여 상기 마이크로셀 영역의 이동 유닛으로 전화 신호들을 전송하는 상이한 채널들 상에 다수의 RF 신호 발생을 디지탈적으로 합성시키고, 상기 합성된 RF 신호 중 적어도 하나의 디지탈형에 각각 대응하는 디지탈화된 다수의 샘플 스트림을 발생시켜 상기 대응하는 안테나 유닛에 전송하기 위해 상기 전송 수단에 상기 샘플 스트림을 인가시키는 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 대응하는 아날로그 RF 신호를 재구성하고, 증폭된 신호를 상기 셀에 관련된 영역으로 방송하기 위해 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF신호를 적어도 하나의 채널에 각각 대응하는 디지

탈환된 다수의 개별 샘플 스트림으로 변환시켜 상기 기지국 유닛에 전송하기 위해 상기 샘플 스트림을 상기 전송 수단에 인가시키는 아날로그-디지탈 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 샘플 스트림으로 표현된 전화 신호를 디지탈적으로 합성시켜, 상기 아날로그 전화 신호를 재구성하고, 상기 전화 신호를 상기 무선 제어기로 공급하는 디지탈-아날로그 변환기 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 28

제27항에 있어서, 상기 전송 수단은 교환 전화망인 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 29

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 모든 존이 상기 셀에 위치되며 그 중에서 안테나 유닛과 관련된 존에서 신호들을 방송 및 수신하도록 위치된 안테나를 각각 갖고 있는 다수의 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 이동 전화 교환국으로부터 다수의 전화 신호를 수신하여 상기 셀 영역의 이동 유닛으로 전화 신호들을 전송하는 상이한 채널들 상에 다수의 RF 신호 발생을 디지탈적으로 합성시키고, 상기 합성된 RF 신호에 대응하는 디지탈화된 다수의 개별 샘플 스트림을 상기 존 내의 전송될 채널들만이 디지탈화된 샘플 스트림으로 표현되도록 안테나 유닛으로 전송될 각 채널 용으로 발생시켜 상기 대응하는 안테나 유닛에 전송하기 위해 각 개별 샘플 스트림을 상기 전송 수단에 인가시키며, 각 안테나 유닛으로 전송된 각 채널의 성분이 제어될 수 있도록 각 채널을 제어하기 위한 제1제어 신호에 응답하는 수단을 구비하는 디지탈화 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 대응하는 아날로그 RF 신호를 재구성하고, RF 신호를 상기 셀에 관련된 영역으로 방송하기 위해 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 존에서 수신된 채널들만이 디지탈화된 샘플 스트림으로 표현되도록 상기 수신된 RF 신호에서 적어도 하나의 디지탈형의 채널에 각자 대응하는 디지탈화된 다수의 개별 샘플 스트림을 발생시켜 상기 기지국 유닛에 전송하기 위해 상기 샘플들을 상기 전송 수단에 인가시키는 아날로그-디지탈 수단을 포함하며, 상기 기지국 유닛 각각은 상기 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 상기 샘플 스트림으로 표현된 아날로그 전화 신호의 디지탈형을 디지탈적으로 합성시켜, 대응하는 전화 신호들을 상기 이동 전화 교환국으로 전송하기 위해 발생시키며, 채널을 사용한 존이 선택될 수 있도록 상기 샘플 스트림 중 하나를 통해 상기 안테나 유닛으로부터의 상기 채널들 중 적어도 한 채널을 선택하고 상기 적어도 한 채널을 사용하여 해당 채널을 통해 전송된 아날로그 전화 신호의 디지탈형을 합성시키기 위한 제2제어 신호에 응답하는 수단을 구비하는 변환기 수단과, 상기 채널들이 각 존에서 방송되고 채널들이 수신된 전화 신호를 발생시키기 위해 사용된 각 존에서 상기 안테나 유닛에서 수신된 신호의 에너지 레벨에 따라 제어될 수 있도록, 각 안테나 유닛으로부터 수신된 상기 디지탈화된 샘플들을 모니터링하고, 각 스트림에서 각 채널의 에너지 레벨을 디지탈적으로 분석하고, 상기 제1 및 제2제어 신호를 상기 디지탈화 수단과 상기 변환기 수단에 발생시키는 제어기 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 30

제29항에 있어서, 상기 전송 수단은 교환 전화망인 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 31

제30항에 있어서, 상기 제어기 수단은 다이버시티 기능을 얻기 위해 존에서 수신된 RF 신호의 페이딩을 모니터링하고 상기 제2제어 신호를 발생시켜 상기 RF 신호가 획득되는 존으로 스위칭하기 위한 페이드 제어 수단을 구비하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 32

제31항에 있어서, 상기 페이드 제어 수단은 상기 모니터링 및 스위칭 동작이 1초 내에 수행되는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 33

기지국과 대응하는 다수의 이동 유닛 사이에서 다수의 전화 신호들이 RF 전송을 이용하여 송수신하는 다수의 존으로 분할된 셀을 포함하고 있는 셀룰러 통신 시스템에 있어서, 셀 기지국 유닛으로서, 상기 셀에 관련된 영역에서 신호들을 방송 및 수신하도록 위치된 안테나를 각각 가지며 각 존에 적어도 하나씩 위치된 다수의 안테나 유닛에 전송 수단에 의해 접속되어 있는 셀 기지국 유닛을 포함하며, 상기 기지국 유닛은, 상기 셀 영역의 이동 유닛으로 전화 신호들을 송신하는 상이한 채널들 상에 다수의 RF 신호를 발생시키는 아날로그 RF 신호 발생 수단과, 선택된 채널을 포함하는 각 존에 대한 합성 RF 신호를 형성하기 위해 상기 RF 신호를 스위칭 및 합성하는 제1제어 신호에 응답하는 제1스위치 수단과, 각 존에 대한 상기 합성 신호를 대응하는 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 변환 수단과, 상기 합성 신호를 여파해서 적어도 하나의 채널에 각각 대응하는 디지탈화된 다수의 개별 스트림을 발생시키고, 이들 개별 데이타 샘플 스트림을 대응하는 안테나 유닛으로 전송하기 위해 전송 수단에 인가하는 디지탈 필터 수단을 포함하며, 상기 안테나 유닛 각각은, 상기 기지국 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하고, 대응하는 합성 아날로그 RF신호를 재구성하고, 상기 마이크로셀에 관련된 영역에 증폭된 신호를 방송하기 위해 이 신호를 상기 안테나에 인가시키는 디지탈-아날로그 수단과, 상기 안테나에서 수신된 RF 신호를 수신하고, 상기 수신된 RF 신호를 디지탈화된 샘플 스트림으로 변환시키는 아날로그-디지탈 수단과, 상기 수신된 RF 신호로부터 유도된 샘플 스트림을 여파해서 채널들 중의 적어도 하나의 채널에 각각 대응하는 디지탈화된 다수의 개별 샘플 스트림을 발생시키고, 이들 개별 데이타 스트림을 상기 기지국 유닛으로 전송하기 위해 상기 전송 수단에 인가하는 디지탈 필터 수단을 포함하며, 상기 기지국 유닛 각각은, 각 안테나 유닛으로부터 상기 디지탈화된 샘플 스트림을 수신하여 각 안테나 유닛 용의 아날로그 RF신호를 재구성하는 디지탈-아날로그 변환기 수단과, 수신기에 인가할 목적으로 상기 안테나 유닛으로부

터의 하나 이상의 RF 신호를 각각 포함하는 나수의 합성 신호를 형성하기 위해 상기 안테나 유닛으로부터의 상기 RF 신호를 선택적으로 결합시키는 제2제어 신호에 응답하는 제2스위칭 및 결합 수단과, 상기 모든 안테나 유닛으로부터의 상기 니지탈화된 샘플 스트림을 모니터링하고, 각 존에서 각 채널의 에너지 레벨을 니지탈적으로 분석하고, 이에 따라 각 채널이 방송되는 존과 각 채널이 수신되는 존을 선택적으로 제어하기 위해 제1 및 제2제어 신호를 발생시키는 제어 수단을 더 포함하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 34

제33항에 있어서, 상기 제어기 수단은 나이버시티 기능을 얻기 위해 존에서 수신된 RF 신호의 페이딩을 모니터링하고 상기 제2제어 신호를 발생시켜 상기 RF 신호가 획득되는 존으로 스위칭하기 위한 페이드 제어 수단을 구비하는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 35

제34항에 있어서, 상기 페이드 제어 수단은 상기 모니터링 및 스위칭 동작이 1초 내에 수행되는 것을 특징으로 하는 셀룰러 통신 시스템.

청구항 36

공통 셋트의 채널을 각각 공유하는 나수의 존으로 분할된 셀을 갖고 있는 셀룰러 전화 시스템에서의 수동형 스위칭 방법에 있어서, (a) 기지국에서, 각 존으로부터 채널 방송이 개별적으로 제어될 수 있도록 각 존에 대해 채널들의 셋트에 대한 RF신호의 니지탈화된 표현을 발생시키고, 상기 니지탈화된 표현을 각 존으로 전송하는 단계; (b) 각 존에서 상기 니지탈화된 표현을 수신하여 니지탈-아날로그 변환으로 대응하는 RF 신호를 발생시키고, 상기 RF 신호를 상기 존에서 방송하는 단계; (c) 상기 채널들의 셋트에 대한 존에서 RF 신호를 수신하고, 상기 기지국으로 나시 전송하기 위해 상기 RF 신호를 대응하는 니지탈화된 표현으로 변환하는 단계; (d) 상기 기지국에서, 상기 존에서 상기 니지탈화된 표현을 수신하여 각 존에 대한 대응하는 RF 신호를 획득하는 단계; 및 (e) 각 존에서의 각 채널의 에너지 레벨을 기본으로 해서 각 존으로부터 상기 RF 신호의 니지탈화된 표현을 모니터링하고, (i) 단계(a)에서 수행된 상기 니지탈화된 표현의 발생을 제어하므로써 상기 존으로의 채널 방송을 선택적으로 제어하고, (ii) 수동형 스위칭이 수행될 수 있도록 어느 존이 수신된 채널을 얻는지를 선택적으로 선택하는 단계를 포함하는 것을 특징으로 하는 수동형 스위칭 방법.

청구항 37

공통 셋트의 채널을 각각 공유하는 나수의 존으로 분할된 셀을 갖고 있는 셀룰러 전화 시스템에서의 수동형 스위칭 방법에 있어서, (a) 기지국에서, 각 존으로부터 채널 방송이 개별적으로 제어될 수 있도록 각 존에 대해 채널들의 셋트에 대한 RF신호의 니지탈화된 표현을 발생시키고, 상기 셋트에서 이들 채널에만 해당되는 니지탈화된 표현을 각 존으로 전송하는 단계; (b) 각 존에서 상기 니지탈화된 표현을 수신하여 니지탈-아날로그 변환으로 대응하는 RF 신호를 발생시키고, 상기 RF 신호를 상기 존에서 방송하는 단계; (c) 상기 채널들의 셋트에 대한 존에서 RF 신호를 수신하고, 상기 채널 셋트 내의 해당 채널만을 상기 기지국으로 나시 전송하기 위해 상기 RF 신호를 대응하는 니지탈화된 표현으로 변환하는 단계; (d) 상기 기지국에서, 상기 존에서 상기 니지탈화된 표현을 수신하여 각 존에 대한 대응하는 RF 신호를 획득하는 단계; 및 (e) 각 존에서의 각 채널의 에너지 레벨을 기본으로 해서 각 존으로부터 상기 RF 신호의 니지탈화된 표현을 모니터링하고, (i) 단계(a)에서 수행된 상기 니지탈화된 표현의 발생을 제어하므로써 상기 존으로의 채널 방송을 선택적으로 제어하고, (ii) 수동형 스위칭이 수행될 수 있도록 어느 존이 수신된 채널을 얻는지를 선택적으로 선택하는 단계를 포함하는 것을 특징으로 하는 수동형 스위칭 방법.

청구항 38

제37항에 있어서, 교환 전화망을 통해 상기 존과 상기 기지국 사이에서 상기 니지탈화된 표현을 전송하는 단계를 더 포함하는 것을 특징으로 하는 수동형 스위칭 방법.

청구항 39

채널들의 셋트를 사용하여 셀룰러 전화 전송 신호를 셀로 전송하는 전송 방법에 있어서, (a) 기지국에서, 각 채널에 대한 RF 신호의 니지탈화된 표현을 발생시키고 이 표현을 상기 기지국으로부터 원격 셀로 전송하는 단계; (b) 상기 니지탈화된 표현을 상기 셀에서 수신하여 니지탈-아날로그 변환으로 대응하는 RF 신호를 발생시키고, 이 RF 신호를 상기 셀에서 방송하는 단계; (c) 상기 채널들의 셋트에 대한 셀에서 RF 신호를 수신하고, 상기 기지국으로 나시 전송하기 위해 상기 RF 신호를 대응하는 니지탈화된 표현으로 변환하는 단계; 및 (d) 상기 기지국에서, 상기 셀로부터 상기 니지탈화된 표현을 수신하여 각 채널에 대한 대응하는 RF 신호를 획득하는 단계를 포함하는 것을 특징으로 하는 전송 방법.

청구항 40

채널들의 셋트를 사용하여 셀룰러 전화 전송 신호를 셀로 전송하는 전송 방법에 있어서, (a) 기지국에서, 채널의 전송에 필요한 대역폭이 셀룰러 대역 내의 모든 채널을 전송하는데 필요한 대역폭으로 제한되도록 각 채널에 대한 RF 신호의 니지탈화된 표현을 발생시켜 상기 셋트에서 각 채널에 대한 표현만을 상기 기지국으로부터 원격 셀로 전송하는 단계; (b) 상기 셀에서 상기 니지탈화된 표현을 수신하여 니지탈-아날로그 변환으로 대응하는 RF 신호를 발생시키고, 상기 셀에서 상기 RF 신호를 방송하는 단계; (c) 채널의 전송에 필요한 대역폭이 셀룰러 대역 내의 모든 채널을 전송하는데 필요한 대역폭으로 제한되도록, 상기 채널들의 셋트에 대한 셀에서 RF 신호를 수신하고, 상기 RF 신호를 대응하는 니지탈화된 표현으로 변환시켜 상기 셋트에서 각 채널에 대한 표현만을 상기 기지국으로 전송하는 단계; 및 (d) 상기 기지국에서, 상기 셀로부터 상기 니지탈화된 표현을 수신하여 각 채널에 대한 대응하는 RF 신호를 획득하는 단계를 포함하는 것을 특징으로 하는 전송 방법.

청구항 41

제40항에 있어서 교환 전화망을 통해 상기 셀과 상기 기지국 사이에서 상기 디지탈화된 표현을 전송하는 단계를 더 포함하는 것을 특징으로 하는 전송 방법.

청구항 42

채널들의 셋트를 사용하여 셀룰러 전화 전송 신호를 셀로 전송하는 전송 방법에 있어서, (a) 기지국에서, 이동 전화 교환국으로부터 수신된 전화 신호를 통해 각 채널에 대한 RF 신호의 디지탈 표현을 디지탈적으로 합성하고, 아날로그 송신기가 필요하지 않도록 상기 기지국으로부터 원격 셀로 상기 표현을 전송하는 단계; (b) 상기 디지탈화된 표현을 상기 셀에서 수신하여 디지탈-아날로그 변환으로 대응하는 RF 신호를 발생시키고, 이 RF 신호를 상기 셀에서 방송하는 단계; (c) 상기 채널들의 셋트에 대한 셀에서 RF 신호를 수신하고, 상기 기저국으로 다시 전송하기 위해 상기 RF 신호를 대응하는 디지탈화된 표현으로 변환시키는 단계; 및 (d) 상기 기지국에서, 상기 셀로부터 상기 디지탈화된 표현을 수신하여 아날로그 수신기가 필요하지 않도록 각 채널에 대한 대응하는 전화 신호를 디지탈적으로 획득하는 단계를 포함하는 것을 특징으로 하는 전송 방법.

청구항 43

채널들의 셋트를 사용하여 셀룰러 전화 전송 신호를 셀로 전송하는 전송 방법에 있어서, (a) 기지국에서, 아날로그 송신기가 필요없고 채널의 전송에 필요한 대역폭이 셀룰러 대역에서 모든 채널을 전송하는데 필요한 대역폭으로 제한되도록, 이동 전화 교환국으로부터 수신된 전화 신호를 통해 각 채널에 대한 RF 신호의 디지탈화된 표현을 디지탈적으로 합성하고, 상기 셋트에서 각 채널에 대한 표현만을 상기 기지국으로부터 원격 셀로 전송하는 단계; (b) 상기 셀에서 상기 디지탈화된 표현을 수신하여 디지탈-아날로그 변환으로 대응하는 RF 신호를 발생시키고, 이 RF 신호를 상기 셀에서 방송하는 단계; (c) 상기 채널들의 전송에 필요한 대역폭이 셀룰러 대역에서 모든 채널을 전송하는데 필요한 대역폭으로 제한되도록, 상기 채널들의 셋트에 대한 셀에서 RF 신호를 수신하고, 이 RF 신호를 대응하는 디지탈화된 표현으로 변환시켜 상기 셋트에서 각 채널에 대한 표현만을 상기 기지국으로 전송하는 단계; 및 (d) 상기 기지국에서 상기 셀로부터 상기 디지탈화된 표현을 수신하여 아날로그 수신기가 필요하지 않도록 각 채널에 대한 대응하는 전화 신호를 디지탈적으로 획득하는 단계를 포함하는 것을 특징으로 하는 전송 방법.

청구항 44

제43항에 있어서, 교환 전화망을 통해 상기 셀과 상기 기지국 사이에서 상기 디지탈화된 표현을 전송하는 단계를 더 포함하는 것을 특징으로 하는 전송 방법.

청구항 45

제1매크로셀을 포함하며 공통 셋트의 채널을 공유하는 다수의 매크로셀을 갖는 셀룰러 전화 시스템에서의 수동형 스위칭 방법에 있어서, (a) 다수의 제1 및 제2마이크로셀 안테나 유닛을 제공하는 단계; (b) 상기 제1매크로셀 영역을 커버하도록 상기 제1마이크로셀 안테나 유닛을 위치시키는 단계를 포함하며, 상기 제1매크로셀을 다수의 제1마이크로셀로 분할하는 단계; (c) 다수의 제2마이크로셀 안테나 유닛을 제공하는 단계, (d) 상기 제1마이크로셀을 종첩하는 매크로셀 커버 영역을 제공하도록 상기 제2마이크로셀 안테나 유닛을 위치시키는 단계; (e) 기지국에서, 이동 전화 교환국으로부터 수신된 전화 신호의 디지탈화된 표현을 생성시키고, 상기 다수의 제1 및 제2마이크로셀로부터 한 마이크로셀을 선택하며, 상기 선택된 마이크로셀의 상기 마이크로셀 안테나 유닛으로 상기 디지탈화된 표현을 전송하는 단계; (f) 상기 선택된 마이크로셀에서 상기 디지탈화된 표현을 수신하고, 디지탈-아날로그 변환으로 대응하는 RF 신호를 생성하고, 상기 선택된 마이크로셀에서 상기 RF 신호를 방송하는 단계; (g) 채널들의 셋트에 대해 상기 다수의 제1 및 제2마이크로셀의 각각에서 RF 신호를 수신하고, 상기 기지국으로 다시 전송하기 위해 수신된 상기 RF 신호를 대응하는 디지탈화된 RF 신호 표현으로 변환하는 단계; 및 (h) 상기 기지국에서, 상기 제1 및 제2마이크로셀로부터 상기 디지탈화된 RF 신호 표현을 수신하는 단계; 및 (i) 각 존에서의 각 채널의 에너지 레벨을 기본으로 해서 상기 제1 및 제2마이크로셀의 각각으로부터 상기 디지탈화된 RF 신호 표현을 모니터링하는 단계를 포함하며, 상기 모니터링 단계(i)는, 단계(e)에서 수행된 상기 디지탈화된 표현의 발생을 제어하므로써 상기 제1 및 제2마이크로셀의 각각으로의 상기 채널 방송을 선택적으로 제어하는 단계; 및 수동형 스위칭이 수행되도록 수신 채널이 수신되는 상기 다수의 제1 및 제2마이크로셀로부터 상기 마이크로셀을 선택적으로 선택하는 단계를 포함하는 것을 특징으로 하는 수동형 스위칭 방법.

청구항 46

제45항에 있어서, 이동 전화 교환국으로부터 수신된 전화 신호의 디지탈화된 표현을 발생시키는 단계는 상기 이동 전화 교환국으로부터 수신된 전화 신호로부터 각 채널용으로 전송된 RF 신호의 디지탈화된 표현을 디지탈적으로 합성하는 단계를 포함하는 것을 특징으로 하는 수동형 스위칭 방법.

청구항 47

제45항에 있어서, 이동 전화 교환국으로부터 수신된 전화 신호의 디지탈화된 표현을 발생시키는 단계는 각 채널용으로 생성된 RF 신호의 디지탈화된 표현을 발생시키는 단계를 포함하는 것을 특징으로 하는 수동형 스위칭 방법.

청구항 48

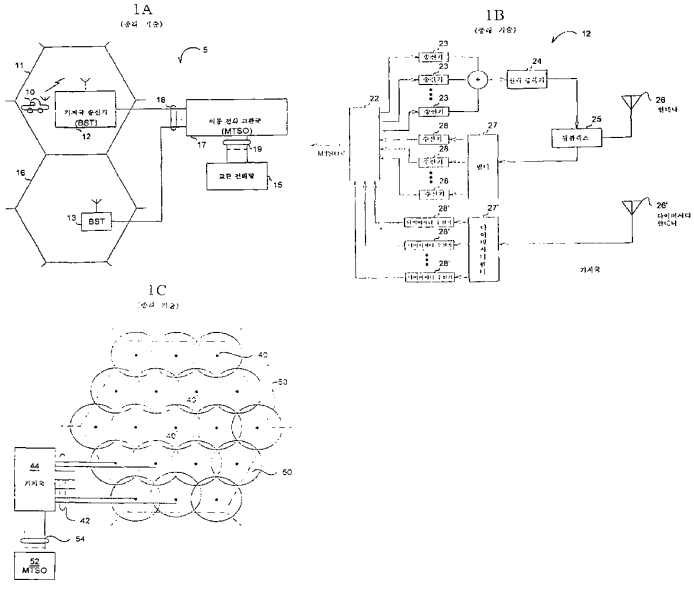
특정 셀룰러 통신의 커버 영역을 섹터 단위로 분할하는 섹터화(sectorization) 방법에 있어서, 특정 섹터를 커버하도록 구성된 안테나와 상기 특정 섹터에 할당된 채널을 여파하는데 사용하는 채널 필터 유닛을 구비하는 제1 및 제2마이크로셀 안테나 유닛을 포함하는 다수의 마이크로셀 안테나 유닛을 갖는 원격 유닛을 제공하는 단계; 각 안테나 유닛의 섹터와 관련되는 특정 섹터 주파수를 제공하는 단계를 포함하며, 상기 원격 유닛을 섹터화된 기지국 유닛과 접속시키는 단계; 상기 섹터화된 기지국 유닛을 이동 전화 교

환국에 접속시키는 단계; 상기 섹터화된 기지국 유닛에서 상기 이동 전화 교환국으로부터 수신된 전화 신호의 디지탈화된 표현을 생성하는 단계; 상기 디지탈화된 표현을 특정 섹터용의 상기 마이크로셀 안테나 유닛으로 전송하는 단계; 상기 제1마이크로셀 안테나 유닛에서 제1 RF 신호를 수신하고 상기 제1 RF 신호를 디지탈화하고, 상기 디지탈화된 제1 RF신호를 제1섹터 주파수로 변환하는 단계, 상기 제2마이크로셀 안테나 유닛에서 제2 RF신호를 수신하고, 상기 제2 RF 신호를 디지탈화하고 상기 디지탈화된 제2 RF 신호를 제2섹터 주파수로 변환하는 단계; 및 상기 디지탈화된 제1 RF 신호를 상기 제1섹터 주파수에서, 그리고 상기 디지탈화된 제2 RF 신호를 상기 제2섹터 주파수에서 멀티플렉스하고, 상기 멀티플렉스된 신호를 상기 섹터화된 기지국으로 전송하는 단계를 포함하는 것을 특징으로 하는 섹터화 방법.

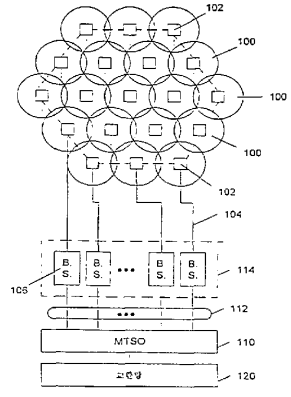
※ 참고사항 : 최초출원 내용에 의하여 공개하는 것임.

도면

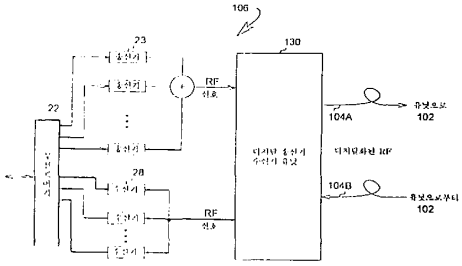
도면1



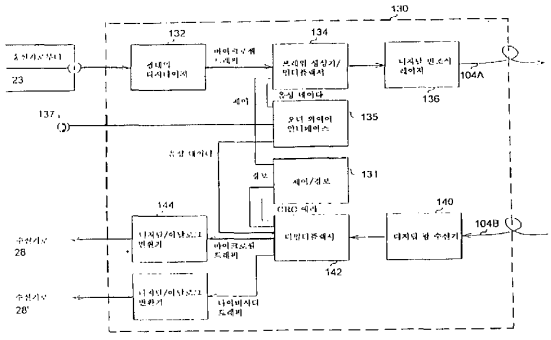
도면2



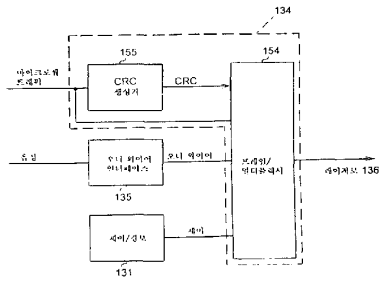
도면3


106
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도면4


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도면5


134
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Electronic Patent Application Fee Transmittal					
Application Number:	15223819				
Filing Date:	29-Jul-2016				
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM				
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton				
Filer:	Kelvin B. Catmull/Brian Kanter				
Attorney Docket Number:	091172-1017552-102440US				
Filed as Small Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
Post-Allowance-and-Post-Issuance:					
Extension-of-Time:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	90	90
		Total in USD ($)		**90**

Electronic Acknowledgement Receipt	
EFS ID:	31067232
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	28-NOV-2017
Filing Date:	29-JUL-2016
Time Stamp:	18:20:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$90
RAM confirmation Number	112917INTEFSW18220100
Deposit Account	201430
Authorized User	IPPayments KilpatrickTownsend
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS_DW-1024-4.pdf	162636 a211fcedaa68a76b87e15498e89dfbda5c1043d8	yes	4
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Information Disclosure Statement (IDS) Form (SB08)		3	4	
	Transmittal Letter		1	2	
Warnings:					
Information:					
2	Foreign Reference	CN_101394647A.pdf	4884900 bbe829ca8e823f31ccaa9726deacafe672f9f5f0	no	57
Warnings:					
Information:					
3	Foreign Reference	KR_1019960702978_A.pdf	130555 868d02333f84654ae25e98a768261dfb728af68b	no	12
Warnings:					
Information:					
4	Non Patent Literature	NPL_CN_2015105314851_OA_11022017.pdf	1186328 7a38f596ffa33459b0327fd58cf6b69ed2ba1bab	no	6
Warnings:					
Information:					
5	Non Patent Literature	NPL_KR_1020157024302_NODTG_11102017.pdf	1098747 0d1e652fc61954dc143010c4916128f8531013df	no	5
Warnings:					
Information:					

6	Fee Worksheet (SB06)	fee-info.pdf	30660 5041aa0d36c60bb8892d9db609594156c8fe5177	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	7493826	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/223,819	Filing Date 07/29/2016	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **11/28/2017**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

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

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

LIE
JACQUELYN WILLIAMS

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

20350 7590 12/06/2017

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

NOTIFICATION DATE	DELIVERY MODE
12/06/2017	ELECTRONIC

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

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

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

ipefiling@kilpatricktownsend.com
KTSDocketing2@kilpatrick.foundationip.com

PTOL-90A (Rev. 04/07)

Applicant-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN B. CATMULL*. (4)_____.

Date of Interview: *27 November 2017*.

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

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

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

Claim(s) discussed: *2-4*.

Identification of prior art discussed: *of the record*.

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

Discussed the Double Patent rejection presented in the office action September 29, 2017. Applicant's representative and the examiner also discussed different views between prior art, i.e., Boldi et al. (US 8,855,489) and Sulzberger et al. (US 2005/0152695), and the claimed invention.
No agreement was reached on the patentability. Applicant may amend the claims to overcome the rejections. Examiner will reconsider if filed.

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

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

☐ Attachment

/WEI ZHAO/ Primary Examiner, Art Unit 2473	

Summary of Record of Interview Requirements

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

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

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

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

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

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

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

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

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

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

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

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

Examiner to Check for Accuracy

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

20350 7590 12/11/2017

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

NOTIFICATION DATE	DELIVERY MODE
12/11/2017	ELECTRONIC

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

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

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

ipefiling@kilpatricktownsend.com
KTSDocketing2@kilpatrick.foundationip.com

PTOL-90A (Rev. 04/07)

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	**AIA (First Inventor to File) Status** No

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

THE REPLY FILED 28 November 2017 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

1. ☒ The reply was filed after a final rejection. No Notice of Appeal has been filed. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance;
(2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114 if this is a utility or plant application. Note that RCEs are not permitted in design applications. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires _____months from the mailing date of the final rejection.
   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action; or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   c) ☐ A prior Advisory Action was mailed more than 3 months after the mailing date of the final rejection in response to a first after-final reply filed within 2 months of the mailing date of the final rejection. The current period for reply expires months from the mailing date of *the prior Advisory Action* or SIX MONTHS from the mailing date of the final rejection, whichever is earlier.
   Examiner Note: If box 1 is checked, check either box (a), (b) or (c). ONLY CHECK BOX (b) WHEN THIS ADVISORY ACTION IS THE FIRST RESPONSE TO APPLICANT'S FIRST AFTER-FINAL REPLY WHICH WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. ONLY CHECK BOX (c) IN THE LIMITED SITUATION SET FORTH UNDER BOX (c). See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) or (c) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☒ The proposed amendments filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   a) ☒ They raise new issues that would require further consideration and/or search (see NOTE below);
   b) ☐ They raise the issue of new matter (see NOTE below);
   c) ☒ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: *See Continuation Sheet*. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____.
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☐ For purposes of appeal, the proposed amendment(s): (a) ☒ will not be entered, or (b) ☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
9. ☐ The affidavit or other evidence filed after final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
10. ☐ The affidavit or other evidence filed after the date of filing the Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing of good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
11. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

12. ☒ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: See Continuation Sheet.
13. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
14. ☐ Other: _____.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:
Claim(s) allowed: .
Claim(s) objected to: .
Claim(s) rejected: 2-21.
Claim(s) withdrawn from consideration: .

/WEI ZHAO/
Primary Examiner, Art Unit 2473

Continuation of 3. NOTE: such as 21 publications/documents submitted with IDS submitted 11/28/2017.

Continuation of 12. does NOT place the application in condition for allowance because: 1. Claim Double Patenting Rejection: Applicants indicated to hold the rejection in abeyance until a patentability determination is made for this application. The previous claim double patenting rejection is maintained consequently.

2. Claims Art Rejections: Applicants' arguments filed November 29, 2017 have been fully considered and they are not persuasive. On pages 6-8 of the Response with respects to claim 2, Applicants assert the prior art doesn't teach "wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time; wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time; wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals."

The prior art teaches that the in order to understand the concept of the delay compensation, the ring can be logically divided into three section, a first section S1 between BB and RH1, a second section S2 between RH1 and RH2 and a third section S3 between RH2 and BB. Each sector encounters a characteristic delay t1, t2, and t3, respectively. The propagation delay of signals passing from baseband unit BB to RF head RH1 over the first ring F1 is t1 and over the second ring F2 the delay is t2+t3. Conversely, the propagation delay of signals passing from RF head RH1 to baseband unit BB over the first ring F1 is t2+t3 and over the second ring F2 is t1. Thus, when different ring fibers are selected in receive and transmit direction, the delay is the same in receive and transmit direction. As a consequence, the total remote radio delay tRR is preferably chosen to equal the round trip delay of the ring, as this is the maximum delay value that may occur in either direction (paragraph [0017] lines 1-17, Sulzberger et al; Examiner's Notes: BB depicted in FIG. 2 of the prior art teaches the limitation of "host unit" in the instant application; RH1 and RH2 depicted in FIG. 2 of the prior art teaches "first remote unit" and "second remote unit" individually). The two-fiber ring can be divided into two logical loops between the baseband unit and each RF head, a shorter one and a longer one. The simple case to operate these two loops is a 1+1 protection, which means that both logical loops carry the same data signals. Then, the baseband unit as well as each RF head can decide which loop is the active one depending on their own local link status and thus on locally available information, only. In a preferred improvement of the invention, however, use is made of both ring directions at the same time and a signal degradation is allowed in the case of a failure on the ring. In one embodiment, for example, the signals from the first of the two antennas are transmitted over fiber F1 and the signals from the second antenna are transmitted over the other fiber F2. In another advantageous embodiment, the carrier frequencies are separated onto the ring directions, i.e., a first carrier is transmitted over the first fiber and a second carrier is transmitted over the other fiber. In the case of a failure somewhere in the ring, the capacity (i.e., the number of users) will decrease but the radio coverage of the full service area is still maintained (paragraph [0018] lines 1-20, Sulzberger et al; Examiner's Notes: "the signals from the first of the two antennas are transmitted over fiber F1" in the prior art teaches the limitation of "a first set of downlink channel signals" in the instant application; "the signals from the second antenna are transmitted over the other fiber F2" in the prior art teaches the limitation of "a second set of downlink channel signals;" in fact, the feature presented here teaches the limitation of "wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time; wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time" in the instant application).

The prior art further teaches that the optical path of the present invention may include optical links coupling pairs of adjacent nodes, said optical links being of the passive type, wherein said optical links may include optical fibres; the main station and the processing nodes may be included in a mobile radio communications system and each of said processing nodes may be adapted to generate and receive radio signals serving at least a sector of a cell site of the mobile radio communications system; and each optical channel signal may carry sub-data streams each destined to a corresponding node of the respective sub-group, the sub-data streams being organized according to a time division multiplexing technique, wherein the propagating of said multiplexed signal may include: generating a first optical channel signal having a first carrier wavelength and associated with a first sub-group of nodes, said first channel signal being associated with a first electrical digital signal (Se1) comprising a plurality of sub-data streams (S.sub.1-1-S.sub.1-4), each node (AU1, AU9, AU17, AU25) of the first sub-group being associated with at least one corresponding sub-data stream, and sending said first channel signal (So1) together with the other channel signals on said optical path, wherein the serving of each node of each sub-group of nodes may include: processing at a first node (AU1), included in the first sub-group, the first channel signal (So1) for extracting a first sub-data stream (S.sub.1-1), generating from said extracted first sub-data stream a corresponding first downlink radio signal (Sr) to be radiated, radiating said corresponding first downlink radio signal (column [3] line 47 - column [4] line 11, Boldi; Examiner's Notes: "each optical channel signal may carry sub-data streams each destined to a corresponding node of the respective sub-group" in the prior art teaches the limitation of "a number of downlink channel signals in the first set of downlink channel signals" is unique; in fact, the features presented here teach the limitation of "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals," as Applicants argued).

Based on the fact, Examiner respectfully disagrees that the prior art cited does not teach the independent claim 2 as mentioned by Applicants. The elements of independent claims 11 and 16 that Applicants argue are similar to claim 2's, so the cited passages also teach claims 11 and 16. Furthermore, the cited passages teach dependent claims 3-10, 12-15, and 17-21 as well..

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on November 28, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

DO NOT ENTER: /W.Z/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Shawn Patrick Stapleton et al.
Application No.: 15/223,819
Filed: July 29, 2016
For: DISTRIBUTED ANTENNA SYSTEM
Customer No.: 20350

Confirmation No.: 3273
Examiner: Wei Zhao
Technology Center/Art Unit: 2473

AMENDMENT UNDER 37 CFR § 1.116
EXPEDITED PROCEDURE

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

Commissioner:

In response to the Final Office Action mailed September 29, 2017 on the above-referenced application, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 6 of this paper.

PTO/SB/30EFS (07-14)
Approved for use through 07/31/2016. 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.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	15/223819	Filing Date	2016-07-29	Docket Number (if applicable)	091172-1017552-102440US	Art Unit	2473
First Named Inventor	Shawn Patrick Stapleton			Examiner Name	Wei Zhao		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, to any international application that does not comply with the requirements of 35 U.S.C. 371, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV.

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☒ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☒ Other Amendment Under 37 CFR 1.116 Expedited Procedure, filed November 28, 2017

☒ Enclosed

☒ Amendment/Reply

☐ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 20-1430

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (07-14)
Approved for use through 07/31/2016. 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.

Signature of Registered U.S. Patent Practitioner			
Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2017-12-21
Name	Kelvin B. Catmull	Registration Number	57535

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

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

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

Electronic Patent Application Fee Transmittal					
Application Number:	15223819				
Filing Date:	29-Jul-2016				
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM				
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton				
Filer:	Kelvin B. Catmull/Brian Kanter				
Attorney Docket Number:	091172-1017552-102440US				
Filed as Small Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
Post-Allowance-and-Post-Issuance:					
Extension-of-Time:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 1st Request	2801	1	600	600
		Total in USD ($)		**600**

Electronic Acknowledgement Receipt	
EFS ID:	31304306
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	21-DEC-2017
Filing Date:	29-JUL-2016
Time Stamp:	13:59:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$600
RAM confirmation Number	122217INTEFSW14005600
Deposit Account	201430
Authorized User	IPPayments KilpatrickTownsend
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		AMDafterAdvisory_RCE_102440US.pdf	103543 021ded17dd2cfb3e7ae0bc58d99fee7e47fb97f5	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment Submitted/Entered with Filing of CPA/RCE	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	9

Warnings:					
Information:					
2	Request for Continued Examination (RCE)	RCE.pdf	1378219 4954a0b1a8f7debb60108ac5ec3b150706458bb6	no	3
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30635 0e834d52552d7cdc129289b9484de12ba35cf338	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1512397		

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.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on December 21, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Shawn Patrick Stapleton et al.
Application No.: 15/223,819
Filed: July 29, 2016
For: DISTRIBUTED ANTENNA SYSTEM
Customer No.: 20350

Confirmation No.: 3273
Examiner: Wei Zhao
Technology Center/Art Unit: 2473

RESPONSE ACCOMPANYING REQUEST FOR CONTINUED EXAMINATION (RCE)

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

Commissioner:

In response to the Advisory Action mailed December 11, 2017 and the Final Office Action mailed September 29, 2017, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 7 of this paper.

Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1. (Canceled)

2. (Currently Amended) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit; and

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

3. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

4. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in network conditions, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

5. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on load balancing, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

6. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in subscriber needs, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

7. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

8. (Previously Presented) The host unit of claim 2, wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface.

9. (Previously Presented) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

10. (Previously Presented) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal in compliance with the Common Public Radio Interface (CPRI) standard.

11. (Currently Amended) A system for transporting wireless communications, comprising:

a host unit;

a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals; and

wherein the host unit is capable of receiving digital signals from each of the plurality of remote units.

12. (Previously Presented) The system of claim 11, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

13. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through a direct connection.

14. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through an indirect connection.

15. (Previously Presented) The system of claim 11, wherein each remote unit comprises at least one interface to communicatively couple the remote unit to another one of the plurality of remote units in a daisy-chain configuration.

16. (Currently Amended) A method for providing digital signals in a Distributed Antenna System (DAS), comprising:

transmitting from a host unit, at a first point in time, digital representations of a first set of downlink channel signals to a first remote unit, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

transmitting from the host unit, at a second point in time, digital representations of a second set of downlink channel signals to the first remote unit, the second set of downlink channel signals for transmission at the antenna of the first remote unit;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

17. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a change in network conditions from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

18. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on load balancing from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

19. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a schedule from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

20. (Previously Presented) The method of claim 16, wherein the downlink channel signals are packetized.

21. (Previously Presented) The method of claim 20, wherein the downlink channel signals are packetized in compliance with the Common Public Radio Interface (CPRI) standard.

REMARKS/ARGUMENTS

Claims 2-21 are pending in this application. Claims 2, 11, and 16 have been amended. No new matter is added.

Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Summary of Final Office Action mailed September 29, 2017

Claims 2, 5-6, 8-9, 11-16, 18, and 20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 and 6 of U.S. Patent No. 8,737,300.

Claims 2-4, 8-17, and 20-21 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger (US 2005/0152695) in view of Boldi (US 8,855,489).

Claims 5-6 and 18 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger in view of Boldi and Casanova (US 6,657,993).

Claims 7 and 19 are rejected under 35 USC 103(a) as being unpatentable over Sulzberger in view of Boldi and Zhang (US 2010/0238904).

Double Patenting Rejections

Applicant acknowledges the double patenting rejections and will determine whether to file a Terminal Disclaimer after overcoming the other rejections in the Office Action.

Rejections Under 35 U.S.C. § 103

Claims 2-10

Claim 2 has been amended to recite:

> "wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit, … wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit, … and wherein a number of downlink channel signals in the first set of

> downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals."

Sulzberger and Boldi fail to teach or suggest these features. For example, Boldi describes a system where nodes are separated into sub-groups and a single sub-data stream is sent to each node (Boldi at col. 3, lines 55-57). Each node processes a channel signal to extract its corresponding sub-data stream, generates a downlink radio signal from the sub-data stream, and radiates the downlink radio signal (Boldi at col. 4, lines 5-11). Because each node radiates a downlink radio signal from a single sub-data stream, Boldi does not send a first number of sub-data streams for transmission at an antenna of a first node and a different number of sub-data streams for transmission at the antenna of the first node. Instead, Boldi sends only a single sub-data stream for transmission at the antenna of each node. Thus, Boldi fails to teach the above features of claim 2.

Sulzberger also fails to teach these features. Applicant respectfully submits that claim 2 and its dependent claims are patentable over Sulzberger and Boldi for at least these reasons.

Claims 11-21

Independent claims 11 and 16 have each been amended to include features similar to those of amended claim 2 discussed above. Thus, Applicant respectfully submits that amended claims 11 and 16, as well as their dependent claims, are patentable over the cited references for at least the same reasons as amended claim 2.

CONCLUSION

In view of the foregoing, Applicant believes all claims now pending in this Application are in condition for allowance and an action to that end is respectfully requested.

Except for the issue fees payable under 37 C.F.R. § 1.18, the Director is authorized to charge any additional fees during pendency of this application, including any required extension of time fees, or credit any overpayment to Deposit Account Number 20-1430. This paragraph is intended to be a constructive petition for extension of time in accordance with 37 C.F.R. § 1.136(a)(3).

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (650) 326-2400 or kcatmull@kilpatricktownsend.com.

Respectfully submitted,

/Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

KBC:bsk

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	**STATEMENT OF SUBSTANCE OF INTERVIEW**
Customer No.: 20350	

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

Commissioner:

The undersigned thanks Examiner Zhao for the helpful telephone interview conducted on November 27, 2017. During the interview, the pending rejections and cited art were discussed. No specific agreement was reached with regard to patentability.

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (650) 326-2400 or kcatmull@kilpatricktownsend.com.

Respectfully submitted,

/Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

KBC:bsk

70421080V.1

Electronic Acknowledgement Receipt	
EFS ID:	31306254
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull/Brian Kanter
Filer Authorized By:	Kelvin B. Catmull
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	21-DEC-2017
Filing Date:	29-JUL-2016
Time Stamp:	14:43:01
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	Applicant summary of interview with examiner	INTERVSUM_15223819.pdf	72842 0d92af331323 4feabdca4cc177c904a6967a d7bf	no	1
Warnings:					

Information:	
Total Files Size (in bytes):	72842

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/223,819	Filing Date 07/29/2016	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT	12/21/2017	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $40 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $210 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

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

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

LIE
CAROL BARNES

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	15223819
Filing Date	29-Jul-2016
First Named Inventor	Shawn Stapleton
Attorney Docket Number	091172-1017552-102440US
Title of Invention	DISTRIBUTED ANTENNA SYSTEM

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
DALI WIRELESS, INC.	100%

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

8737300

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.
Applicant claims the following fee status: ◉ Small Entity ○ Micro Entity ○ Regular Undiscounted 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.
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application Registration Number 57535 ○ A sole inventor ○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ○ A joint inventor; all of whom are signing this request

Signature	/Kelvin B. Catmull/
Name	Kelvin B. Catmull

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	15223819
Filing Date:	29-Jul-2016
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Filer:	Kelvin B. Catmull
Attorney Docket Number:	091172-1017552-102440US

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	2814	1	160	160
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 15223819

Filing Date: 29-Jul-2016

Applicant/Patent under Reexamination: Stapleton

Electronic Terminal Disclaimer filed on January 24, 2018

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt	
EFS ID:	31595704
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	24-JAN-2018
Filing Date:	29-JUL-2016
Time Stamp:	16:31:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$160
RAM confirmation Number	012518INTEFSW16312200
Deposit Account	201430
Authorized User	IP eFiling
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	33509 e3cfcc41a110ebd9510c663c061dc8adc2159c31	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30621 d7a73e2b4af7df46995bb94be00c0ce8833414a3	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	64130		

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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
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NOTICE OF ALLOWANCE AND FEE(S) DUE

20350 7590 02/01/2018

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER
ZHAO, WEI

ART UNIT	PAPER NUMBER
2473	

DATE MAILED: 02/01/2018

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

TITLE OF INVENTION: DISTRIBUTED ANTENNA SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0	$0	$500	05/01/2018

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

PTOL-85 (Rev. 02/11)

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)

20350 7590 02/01/2018
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

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.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

TITLE OF INVENTION: DISTRIBUTED ANTENNA SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0	$0	$500	05/01/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
ZHAO, WEI	2473	370-328000

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

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

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

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

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

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

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

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

20350 7590 02/01/2018

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

DATE MAILED: 02/01/2018

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

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

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

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

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

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

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

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

Examiner-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN B. CATMULL*. (4)_____.

Date of Interview: *24 January 2018*.

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

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

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

Claim(s) discussed: *2,3 and 11*.

Identification of prior art discussed: *of the record*.

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

During the examination process, the examiner reached out to the Applicant's representative to discuss the different views on claim limitations and issues under the ODP.
The discussion was resumed after Applicant's representative had a discussion with the inventor. An agreement was reached on the patentability based on the filing of a terminal disclaimer to overcome the ODP rejection.

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

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

☐ Attachment

/WEI ZHAO/ Primary Examiner, Art Unit 2473	

Notice of Allowability	Application No. 15/223,819	Applicant(s) STAPLETON ET AL.	
	Examiner WEI ZHAO	Art Unit 2473	AIA (First Inventor to File) Status No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *12/21/2017*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *2-21*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

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

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

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

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

/WEI ZHAO/
Primary Examiner, Art Unit 2473

DETAILED ACTION

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

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on November 28, 2017 was filed after the mailing date of the previous office action. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Terminal Disclaimer

3. Acknowledgment is made of Applicant's submission of terminal disclaimer, dated January 24, 2018 and is accepted.

Response to Amendment

4. Acknowledgment is made of Applicant's submission of claim amendment with the request for continued examination December 21, 2017. Claims 2, 11, and 16 have been amended. Claims 2-21 are pending. This communication is considered fully responsive and sets forth below:

5. Claim Double Patenting Rejection: Applicants submitted the terminal disclaimer in compliance with 37 C.F.R. 1.321. The previous claim double patenting rejection is withdrawn.

6. Claims Art Rejections: Applicants' amendments with arguments filed December 21, 2017 have been fully considered and they are persuasive. See the following for examiner's statement of allowance.

Allowable Subject Matter

7. Claims 2-21 are allowed. The following is the reason for examiner's statement of allowance:

The closest prior art on record, Sulzberger et al. (US 2005/0152695) and Boldi et al. (US 8,855,489) are generally directed to various aspects of the radio base station with multiple radio frequency heads; and the communications method between a main station and processing nodes includes interconnecting the main station and the nodes in an optical path defining adjacent nodes and non-adjacent nodes.

However, in consideration of the terminal disclaimer filed January 24, 2018 and further search, no prior art reference or a combination of prior art references disclose or suggest the combination of limitations specified in the independent claims including:

"the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit;" and "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals," in claim 1.

Claim 11 includes similar limitations.

"transmitting from the host unit, at a second point in time, digital representations of a second set of downlink channel signals to the first remote unit, the second set of downlink channel signals for transmission at the antenna of the first remote unit;" and "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals," in claim 16.

Dependent claims 2-10, 12-15, and 17-21 are also allowable for incorporating the features recited in the independent claims.

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

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to WEI ZHAO whose telephone number is (571)270-5672. The examiner can normally be reached on Monday-Friday, 7:30am-4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KWANG B. YAO can be reached on 571-272-3182. 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.

/Wei Zhao/
Primary Examiner
Art Unit 2473

Examiner-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN B. CATMULL*. (4)_____.

Date of Interview: *24 January 2018*.

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

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

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

Claim(s) discussed: *2,3 and 11*.

Identification of prior art discussed: *of the record*.

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

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☐ Attachment

/WEI ZHAO/ Primary Examiner, Art Unit 2473	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	Art Unit
	WEI ZHAO	2473

CPC- SEARCHED		
Symbol	Date	Examiner
H04W 40/02, 72/04; H04B 7/022	5/25/2017, 5/26, 9/22, 1/23/2018	wz

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

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

SEARCH NOTES		
Search Notes	Date	Examiner
searched in usocr, fprs, pgpub, uspat, ip.com, and ieee xplore	5/25/2017, 5/26, 9/22, 1/23/2018	wz
fmid search	5/25/2017, 9/22, 1/23/2018	wz
odp search in palm resource center	5/25/2017	wz
updated text search	9/22/2017, 1/23/2018	wz

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

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
H04W	72/04	5/26/2017, 1/23/2018	wz

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

CPC								
Symbol							**Type**	**Version**
H04W		40	/	02			F	2013-01-01
H03F		1	/	3247			I	2013-01-01
H03F		3	/	24			I	2013-01-01
H03F		2200	/	336			A	2013-01-01
H03F		2200	/	57			A	2013-01-01
H03F		2201	/	3224			A	2013-01-01
H03F		2201	/	3233			A	2013-01-01
H04L		25	/	03343			I	2013-01-01
H04L		27	/	362			I	2013-01-01
H04W		24	/	02			I	2013-01-01
H04B		1	/	0475			I	2013-01-01
H04W		24	/	04			I	2013-01-01
H04W		40	/	00			I	2013-01-01
H04L		27	/	2618			I	2013-01-01
H04L		2025	/	03414			A	2013-01-01
H04W		72	/	0453			I	2013-01-01
H04B		2001	/	0425			A	2013-01-01
H04B		7	/	022			I	2013-01-01
H04W		72	/	04			I	2013-01-01

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/WEI ZHAO/ Primary Examiner.Art Unit 2473	01/24/2018	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No. 20180122

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		H	0	4	W	40 / 02 (2009.01.01)						
CROSS REFERENCE(S)												
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/WEI ZHAO/ Primary Examiner.Art Unit 2473	01/24/2018	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No. 20180122

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	Examiner	**Art Unit**
	WEI ZHAO	2473

☒ 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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/WEI ZHAO/ Primary Examiner.Art Unit 2473	01/24/2018	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No. 20180122

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-8,548,526	B2	10-01-2013	Schmidt et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	2.	US-2011/0241425	A1	10-06-2011	Hunter, JR. et al.	
	3.	US-2010/0291949	A1	11-18-2010	Shapira et al.	
	4.	US-2014/0126914	A1	05-08-2014	Berlin et al.	
	5.	US-2011/0135013	A1	06-09-2011	Wegener	
	6.	US-2009/0003196	A1	01-01-2009	Capece et al.	
	7.	US-2010/0178936	A1	07-15-2010	Wala et al.	
	8.	US-2012/0281565	A1	11-08-2012	Sauer	
	9.	US-2011/0249708	A1	10-13-2011	Maca	
	10.	US-2005/0143091	A1	06-30-2005	Shapira et al.	
	11.	US-2002/0191565	A1	12-19-2002	Mani et al.	
	12.	US-2017/0214420	A1	07-27-2017	Phillips et al.	
	13.	US-2008/0058018	A1	03-06-2008	Scheinert	
	14.	US-2011/0281579	A1	11-17-2011	Kummetz	
	15.	US-2011/0223958	A1	09-15-2011	Chen et al.	
	16.	US-2011/0069657	A1	03-24-2011	Gholmieh et al.	
	17.	US-2009/0274085	A1	11-05-2009	Wang et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	18.	101394647	CN	A	03-25-2009	Datang Mobile Comm Equip Co		
	19.	10-1996-0702978	KR	A	05-23-1996	ADC Telecommunications, Inc.		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

Receipt date: 11/28/2017

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

PTO/SB/08a (01-10)
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	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	20.	Office Action for Chinese Patent Application No. 201510531485.1 mailed on November 2, 2017, 6 pages.	
	21.	Notice of Allowance for Korean Patent Application No. 10-2015-7024302, mailed November 10, 2017, 5 pages.	

EXAMINER SIGNATURE			
Examiner Signature /WEI ZHAO/		Date Considered 01/24/2018	

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L9	1	"15223819"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/25 09:36
L10	28	"39563020".fmid.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/25 09:36
S2862	1236	(CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:25
S2863	597	(CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04W72/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:25
S2864	449	(CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:26
S2866	114	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:28
S2867	23	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04W72/040$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:29
S2868	23	(plurality or multiple) with channels and	US-PGPUB;	ADJ	OFF	2018/01/22

		(CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04W72/0406$.cpc.	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			10:36
S2869	40	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04W72/08$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:36
S2870	24	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04W72/085$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:37
S2871	124	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04B7/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:37
S2872	95	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04B7/06$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:38
S2873	58	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04B7/062$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:38
S2874	57	(plurality or multiple) with channels and (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04B7/0626$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:38
S2875	52	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) same measur$3 with power$1 and H04B7/0626$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/22 10:39
S2876	35	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04B7/0626$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	OFF	2018/01/22 10:40

			IBM_TDB			
S2886	3	(PRACH or (physical with random with access$3 with channel$1)) same (BS or NB or NodeB or eNB or eNodeB) and (RAR or (random with access$3 with response)) with response with (messag$3 or signal$1) and (DMRS or DM-RS or (demodulat$3 with reference$1 with signal$3)) with scrambl$3 and scrambl$3 with sequenc$3 with (initialization or initializ$3) and (SI or (system$1 with information)) same broadcast$3 and (PDCCH or (physical with downlink$1 with control$3 with channel$1)) with (MTC or (machine$1 with type$1 with communicat$3)) and (SIB or (system$1 with information with block$1)) same coverag$3 with level$1 and repetition$1 and (SIB$1 or (system with information)) with chang$3 with (broadcast$3 or multicast$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 14:32
S2887	14	(PRACH or (physical with random with access$3 with channel$1)) same (BS or NB or NodeB or eNB or eNodeB) and (RAR or (random with access$3 with response)) with response with (messag$3 or signal$1) and (DMRS or DM-RS or (demodulat$3 with reference$1 with signal$3)) with scrambl$3 and scrambl$3 with sequenc$3 with (initialization or initializ$3) and (SI or (system$1 with information)) same broadcast$3 and H04W72/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 14:34
S2888	15	(RAN or (random with access$3 with (network$3 or procedure$1 or process$3))) and select$3 same second$3 with cell and master and H04W12/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 14:36
S2889	18	(PRACH or (physical with random with access$3 with channel$1)) same (BS or NB or NodeB or eNB or eNodeB) and (RAR or (random with access$3 with response)) with response with (messag$3 or signal$1) and (DMRS or DM-RS or (demodulat$3 with reference$1 with signal$3)) with scrambl$3 and scrambl$3 with sequenc$3 with (initialization or initializ$3) and (SI or (system$1 with information)) same broadcast$3 and (PDCCH or (physical with downlink$1 with control$3 with channel$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 14:43
S2891	3	(PRACH or (physical with random with access$3 with channel$1)) same (BS or NB or NodeB or eNB or eNodeB) and (RAR or (random with access$3 with response)) with response with (messag$3 or signal$1) and (DMRS or	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	OFF	2018/01/24 14:48

		DM-RS or (demodulat$3 with reference$1 with signal$3)) with scrambl$3 and scrambl$3 with sequenc$3 with (initialization or initializ$3) and (SI or (system$1 with information)) same broadcast$3 and (PDCCH or (physical with downlink$1 with control$3 with channel$1)) with (MTC or (machine$1 with type$1 with communicat$3)) and (SIB or (system$1 with information with block$1)) same coverag$3 with level$1 and repetition$1 and (SIB$1 or (system with information)) with chang$3	IBM_TDB			
S2892	18	(PRACH or (physical with random with access$3 with channel$1)) same (BS or NB or NodeB or eNB or eNodeB) and (RAR or (random with access$3 with response)) with response with (messag$3 or signal$1) and (DMRS or DM-RS or (demodulat$3 with reference$1 with signal$3)) with scrambl$3 and scrambl$3 with sequenc$3 with (initialization or initializ$3) and (SI or (system$1 with information)) same broadcast$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 14:50
S2893	105	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 with (DL or downlink$1) with channel$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:53
S2894	6	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 with (DL or downlink$1) with channel$1 and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:54
S2895	11	(DAS or (distribut$3 with antenna$1 with system$1)) and remot$3 with (DL or downlink$1) with channel$1 and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:54
S2896	26	(DAS or (distribut$3 with antenna$1 with system$1)) and remot$3 same (DL or downlink$1) with channel$1 and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:55
S2897	15	(DAS or (distribut$3 with antenna$1 with system$1)) and remot$3 same (DL or downlink$1) with channel$1 and H04W40/02$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:55
S2898	107	(DAS or (distribut$3 with antenna$1 with	US-PGPUB;	ADJ	OFF	2018/01/24

		system$1)) and remot$3 same (DL or downlink$1) with channel$1 and H04W72/$.cpc.	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			18:55
S2899	92	(DAS or (distribut$3 with antenna$1 with system$1)) and remot$3 same (DL or downlink$1) with channel$1 and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:55
S2900	36	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:55
S2901	66	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04B7/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:56
S2902	27	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04B7/02$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:56
S2903	10	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04B7/022$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/01/24 18:56

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	8	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04W40/$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/25 09:02
L2	6	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04W40/02$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/25 09:02
L3	3	"8855489"	US-PGPUB; USPAT	ADJ	OFF	2018/01/25 09:02
L4	27	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and	USPAT	ADJ	OFF	2018/01/25 09:34

		H04B7/$.cpc.				
L5	12	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04B7/02$.cpc.	USPAT	ADJ	OFF	2018/01/25 09:35
L6	25	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04B7/02$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/25 09:35
L7	9	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04B7/022$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/25 09:35
L8	1	"15223819"	US-PGPUB; USPAT	ADJ	OFF	2018/01/25 09:36
S2877	14	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04B7/0626$.cpc.	USPAT	ADJ	OFF	2018/01/22 10:41
S2878	30	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04B7/0626$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:47
S2879	66	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04L5/$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:47
S2880	35	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04L5/003$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:48
S2881	33	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04L5/0035$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:48
S2882	36	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04W72/$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:48
S2883	32	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04W72/04$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:49
S2884	10	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04W72/040$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:49
S2885	21	(plurality or multiple) with (CSI or (channel$1 with state with information)) with (RS or (reference$1 with signal$1)) with measur$3 with power$1 and H04W72/08$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/22 10:49
S2904	9	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04B7/022$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/24 18:56
S2905	25	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or	US-PGPUB;	ADJ	OFF	2018/01/24 18:56

		downlink$1) with channel$1 and H04B7/02$.cpc.	USPAT			
S2906	35	(DAS or (distribut$3 with antenna$1 with system$1)) same remot$3 same (DL or downlink$1) with channel$1 and H04W72/04$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/01/24 18:57

1/25/2018 9:38:11 AM
C:\Users\wzhao\Documents\EAST\Workspaces\temp.wsp

Examiner-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN B. CATMULL*. (4)_____.

Date of Interview: *08 February 2018*.

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

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

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

Claim(s) discussed: *2 and 3*.

Identification of prior art discussed: *of the record*.

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

The examiner reached out to Applicant's representative; discussed the prior art and indicated one of the publications listed on the IDS submitted May 22, 2017 should be changed from publication number from US2012/2057572 to US2012/0057572. Applicant's representative validated and conformed the correction.

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

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

☐ Attachment

/WEI ZHAO/ Primary Examiner, Art Unit 2473	

Receipt date: 05/22/2017

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-8,583,100	B2	11-12-2013	Koziy et al.	
	2.	US-8,346,160	B2	01-01-2013	Kummetz	
	3.	US-8,032,148	B2	10-04-2011	Hettstedt et al.	
	4.	US-8,010,099	B2	08-30-2011	Ma et al.	
	5.	US-7,650,112	B2	01-19-2010	Utsumi et al.	
	6.	US-7,639,982	B2	12-29-2009	Wala	
	7.	US-7,339,897	B2	03-04-2008	Larsson et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	8.	US-2012/0127938	A1	05-24-2012	Lv et al.	
this should be US 2012/0057572 /W.Z/	9.	~~US-2012/2057572~~	A1	03-08-2012	Evans et al.	
	10.	US-2011/0135308	A1	06-09-2010	Tarlazzi et al.	
	11.	US-2010/0278530	A1	11-04-2010	Kummetz et al.	
	12.	US-2010/0177759	A1	07-15-2010	Fischer et al.	
	13.	US-2010/0157901	A1	06-24-2010	Sanderovitz et al.	
	14.	US-2010/0002661	A1	01-07-2010	Schmidt et al.	
	15.	US-2009/0286484	A1	11-19-2009	Phung et al.	
	16.	US-2009/0252136	A1	10-08-2009	Mahany et al.	
	17.	US-2008/0107014	A1	05-08-2009	Huang et al.	
	18.	US-2007/0066234	A1	03-22-2007	Lastinger et al.	
	19.	US-2002/0187809	A1	12-12-2002	Mani et al.	

FOREIGN PATENT DOCUMENTS

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

Receipt date: 05/22/2017

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

EXAMINER SIGNATURE			
Examiner Signature /WEI ZHAO/		Date Considered 05/25/2017	

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

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

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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Craig C. Largent/	Date (YYYY-MM-DD)	2017-05-22
Name/Print	Craig C. Largent	Registration Number	56,400

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	15/223,819	Filing Date	2016-07-29	Docket Number (if applicable)	091172-1017552-102440US	Art Unit	2473
First Named Inventor	Shawn Patrick Stapleton			Examiner Name	Wei Zhao		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☐ Amendment/Reply
- ☒ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☐ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No _____

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

Signature of Registered U.S. Patent Practitioner			
Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2018-05-01
Name	Kelvin B. Catmull	Registration Number	57535

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

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

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on May 1, 2018.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 3273
Shawn Patrick Stapleton et al.	Examiner: Wei Zhao
Application No.: 15/223,819	Technology Center/Art Unit: 2473
Filed: July 29, 2016	
For: DISTRIBUTED ANTENNA SYSTEM	
Customer No.: 20350	INFORMATION DISCLOSURE STATEMENT

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

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patent and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application, and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information.

Applicant believes that no fee is required for submission of this statement. However, if any additional fees are due for the submission of this Information Disclosure Statement, please deduct those fees from Deposit Account No. 20-1430.

Respectfully submitted,

/Kelvin B. Catmull/

Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-6,804,540	B1	10-12-2004	Shepherd et al.	
	2.	US-8,842,649	B2	09-23-2014	Liu et al.	
	3.	US-8,532,242	B2	09-10-2013	Fischer et al.	

U.S. PATENT APPLICATION PUBLICATIONS

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	4.	2010133942	WO	A1	11-25-20110	Teko Telcom S P A		
	5.	1774094	CN	A	05-17-2006	Huawei Tech Co Ltd.		
	6.	201307942	CN	Y	09-09-2009	Comba Telecom Systems China LTD		
	7.	101621806	CN	A	01-06-2010	Comba Telecom Systems(China) Ltd.		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	8.	Petition for Inter Partes Review of U.S. Patent No. 9,531,473 Under 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 41.100 ET SEQ., filed February 2, 2018, 95 pages.	
	9.	ACAMPORA, Anthony, "Declaration of Dr. Anthony Acampora" in support of Inter Partes Review of U.S. Patent No. 9,531,473, Feb 2, 2018, 190 pages.	
	10.	"Comprehensive Dictionary of Electrical Engineering",1999, CRC Press & IEEE Press, 4 pages.	
	11.	"Computer Dictionary. The Comprehensive Standard for Business, School, Library and Home", 1991, Microsoft Press, ISBN 1-55615-231-0, 6 pages.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

	12.	"Wiley Electrical and Electronics Engineering Dictionary", 2004, Wiley & Sons, Inc., 7 pages.	
	13.	"McGraw-Hill Dictionary of Scientific and Technical Terms", (5th ed.), 1994, McGraw-Hill, Inc., ISBN 0-07-042333-4, 6 pages.	
	14.	Excerpts from Patent Owner's Invalidity Contentions regarding U.S. Patent No. 7,639,982 served in related matter CommScope Technologies LLC v. Dali Wireless, Inc., Case No. 3:16-cv-00477-B (N.D. Tex.) ("Patent Owner's Invalidity Contentions Ex. C"), 410 pages.	
	15.	HORAK, Ray, "Telecommunications and Data Communications Handbook", 2007, Wiley & Sons, Inc., 55 pages.	
	16.	SPURGEON, Charles E., "Ethernet, The Definitive Guide", 2000, O'reilly & Assoc., Inc., 112 pages.	
	17.	"Dali Wireless, Inc.'s claim construction brief", in: CommScope Technologies LLC v. Dali Wireless, Inc., Case No. 3:16-cv-00477-B (N.D. Tex.), June 30, 2017, 36 pages.	
	18.	"Dali Wireless, Inc.'s responsive claim construction brief", in: CommScope Technologies LLC v. Dali Wireless, Inc., Case No. 3:16-cv-00477-B (N.D. Tex.), August 18, 2017, 30 pages.	
	19.	Office Action for Chinese Patent Application No. 201610011597.9, mailed March 29, 2018, 5 pages	

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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

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

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2018-05-01
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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

Electronic Patent Application Fee Transmittal				
Application Number:	15223819			
Filing Date:	29-Jul-2016			
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM			
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton			
Filer:	Kelvin B. Catmull/Brian Kanter			
Attorney Docket Number:	091172-1017552-102440US			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 2ND AND SUBSEQUENT REQUEST	2820	1	950	950
		Total in USD ($)		**950**

Electronic Acknowledgement Receipt	
EFS ID:	32500477
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	01-MAY-2018
Filing Date:	29-JUL-2016
Time Stamp:	16:19:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$950
RAM confirmation Number	050218INTEFSW16203300
Deposit Account	201430
Authorized User	IP eFiling
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	NPL_Petition-for-InterPartes-Review-US9531473.pdf	6594379 63cb7b22a5b57269e9667f7af5e4244f9de1b961	no	95
Warnings:					
Information:					
2	Non Patent Literature	NPL_CS1003_ExpertDeclarationAnthonyAcampora_uspto_r1.pdf	15178520 6d0b9570a44818b8e5a911761e99afcc903fe86c	no	190
Warnings:					
Information:					
3	Non Patent Literature	NPL_CS1022_Comprehensive-DictionaryOf-EE.pdf	889635 0665f3dd7b706529c3991f3bed564d885ba6b24e	no	4
Warnings:					
Information:					
4	Non Patent Literature	NPL_CS1023_ComputerDictionary_TCS4BSLH_1991.pdf	760888 3642b818b9692cab867fca2550873d88d071b9fe	no	6
Warnings:					
Information:					
5	Non Patent Literature	NPL_CS1024_KAPLAN_WileyElectricaand-EE_Dictionary.pdf	1339775 4bf7999a2af66815e536f08a658bae4c9098f018	no	7
Warnings:					
Information:					
6	Non Patent Literature	NPL_CS1025_Dictionary_of_ScientificandTehcnicalTerms_5thed.pdf	1539846 2a12dc8fe7c8fcdf5c85927b2996b694bc5e94ad	no	6
Warnings:					
Information:					

7	Non Patent Literature	NPL_CS1026_ExcerptsFromDaliInvaliditCont_uspto.pdf	15487895 eb66b30f96073b1047ad48a9674ddb0fde2936c4	no	410
Warnings:					
Information:					
8	Non Patent Literature	NPL_CS1027_HORAK_TelecomAndDataCommHandbook.pdf	9137924 d011a981811b79363bca9f72abf6178a4898fa32	no	55
Warnings:					
Information:					
9	Non Patent Literature	NPL_CS1028_SPURGEON_Ethernet-Guide.pdf	17756001 6247cc8482e94d3a90b29bb018bf0f56302b08f9	no	112
Warnings:					
Information:					
10	Non Patent Literature	NPL_CS1030_DWIClaimConstructBrief.pdf	12013868 c60a0a2d28a24edd81feee2fbb994da09cdf3490	no	36
Warnings:					
Information:					
11	Non Patent Literature	NPL_CS1031_DWI_ResponsiveClaimConstBrief.pdf	10294510 0cf7ee0bd0a2c31f90a72a799ab14958c14bd997	no	30
Warnings:					
Information:					
12	Foreign Reference	WO_2010133942_A1.pdf	1294275 589b2fe7c58d3307bf6349f19083606a4878871a	no	27
Warnings:					
Information:					
13	Foreign Reference	CN_1774094_A.pdf	1181319 fc57e025b95ca8a6d198ace8d75619cda8ef993f	no	23
Warnings:					
Information:					

14	Foreign Reference	CN_101621806_A.pdf	1266082 9d66f187820ee8af17ebb66841d49b90b4660f53	no	18
Warnings:					
Information:					
15	Non Patent Literature	NPL_CN_201610011597-9_OA_03292018.pdf	1218413 415ac05aa9e4626cf9769572f5c8f953457ba83f	no	5
Warnings:					
Information:					
16	Foreign Reference	CN_201307942_Y_.pdf	506911 d3e8925661098ec67c306c4adb3b8d31ea4a01f1	no	12
Warnings:					
Information:					
17	Request for Continued Examination (RCE)	RCE_102440US.pdf	1349760 e6eb295a5904e9c7637eb673c1b8f74fd46ce3a9	no	3
Warnings:					
Information:					
18		IDS_102440US.pdf	171999 f55234f65b9ffe8693692f0cccba3898474bde65	yes	5
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	5	
Warnings:					
Information:					
19	Fee Worksheet (SB06)	fee-info.pdf	30660 21ae87c0ee883c52cd16f52f97d794cfebb7ff10	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	98012660		

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.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 November 2010 (25.11.2010)

PCT

(10) International Publication Number
WO 2010/133942 A1

(51) International Patent Classification:
H04B 10/12 (2006.01) *H04W 88/08* (2009.01)

(21) International Application Number:
PCT/IB2010/001150

(22) International Filing Date:
17 May 2010 (17.05.2010)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:
MO2009A000135 19 May 2009 (19.05.2009) IT

(71) Applicant *(for all designated States except US)*: **TEKO TELECOM S.P.A.** [IT/IT]; Via Meucci, 24/A, I-40024 Castel San Pietro Terme (BO) (IT).

(72) Inventor; and

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

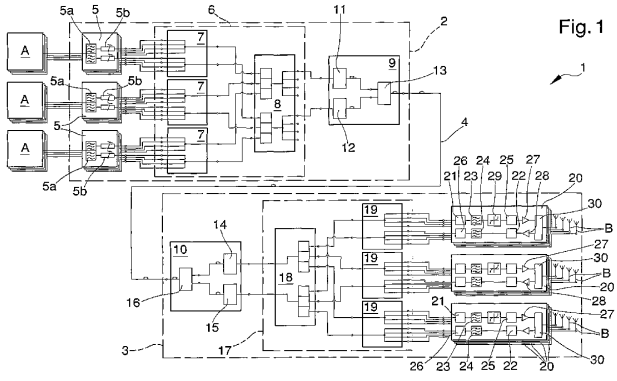
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU,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

Published:

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

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title**: SYSTEM AND METHOD FOR THE DISTRIBUTION OF RADIO-FREQUENCY SIGNALS



(57) **Abstract**: A machine (10) for cutting and/or creasing a sheet (11) of relatively rigid material comprises movement means (17, 18) able to move the sheet (11) at least in a defined direction of advance, and cutting and/or creasing means (16) movable in a direction substantially transverse to the first direction of advance, and able to carry out on the sheet (11) at least a first working of cutting and/or creasing. The machine (10) also comprises a command and control unit (30), operatively connected to the cutting and/or creasing means (16), and able to selectively activate and/or move them according to a pre-loaded work program. The machine (10) comprises motion reversal means, kinematically connected to the movement means (17, 18), and means to rotate the sheet (11) by a desired angle before imparting to it a reverse motion. The command and control unit (30) is able to selectively activate and move the cutting and/or creasing means (16) according to the actual direction of advance determined by the reversal means, in order to carry out on the sheet (11) also a second working, subsequent to the first working, on the basis of the work program.

WO 2010/133942 A1

SYSTEM AND METHOD FOR THE DISTRIBUTION OF RADIO-FREQUENCY SIGNALS

Technical Field

The present invention relates to a system and a method for the distribution of radio-frequency signals.

Background Art

With reference to the telecommunications sector and, in particular, to the mobile phone sector, the use is known of communication systems for both the indoor and outdoor distribution of one or more radio-frequency signals.

The known systems of communication are usable, in particular, to carry out the so-called remotization of the signals coming from one or more base radio stations (Base Transceiver Station) or from similar sets, for the outdoor coverage of signals both within a single frequency band and within several frequency bands and/or for different operators.

The use is further known of so-called DAS (Distributed Antenna System) communication systems for the distribution of signals within buildings, underground railways, airports and, in general, inside all those areas in which it is hard to guarantee adequate radio coverage using conventional methods.

The known communication systems are generally composed of one or more remote units, suitably installed in the proximity of an area in which radio coverage is to be provided, and of a main unit connected to the remote units by means of a communication channel.

Generally speaking, the remote units are provided with respective antennas for the transmission of signals or, in the case of indoor type systems, are connected to a passive signal distribution network.

With particular reference to the remotization of radio-frequency signals, a communication system of known type commonly comprises:

- at least a communication channel in optical fibre connecting the main unit to at least a corresponding remote unit;
- a main unit interfaced with one or more BTS stations or similar sets and suitable for converting the signals coming from the receiver into corresponding optical signals, or vice versa;

- one or more remote units, each of which suitable for converting the optical signals into corresponding electrical signals, or vice versa, and amplifying such electrical signals, before sending them towards a transmission antenna.

In use, first of all, each of the BTS stations present generates a respective signal, within a specific frequency band and for a specific operator, subsequently sent to the main unit.

The main unit converts such electrical signals received into corresponding optical signals and sends them towards a corresponding remote unit through the optical fibre communication channel.

The transmission of the optical signals between the main unit and the remote unit can be made both by means of a modulation of analogue type and by means of a modulation of digital type.

In the first case, the intensity of the optical signal is modulated according to the electrical signal to be transmitted.

In the second case, the main unit performs a conversion from analogue to digital of the electrical signals to be transmitted, before sending these by means of the optical fibre or, alternatively, the electrical signals to be transmitted are delivered by the BTS station to the main unit already in digital format.

The remote unit converts the optical signals received into corresponding electrical signals, which are then amplified and sent to a transmission antenna.

The known radio-frequency signal distribution systems have, however, several drawbacks.

In particular, the analogue transmission of the signals from the main unit towards the remote units and, subsequently, towards the antennas, does not allow an independent control of the signals.

This aspect is definitely of considerable importance within the ambit of mobile phones, whenever the need or the demand exists for independent antennas usable for different operators and/or frequency bands; in this case the different signals transmitted must necessarily be made available for the different operators for distribution to the end consumers.

Digital transmission, on the other hand, presents the technical limit of the

maximum sampling frequency and, consequently of the band available for the transmission of signals on the optical fibre.

In this case, therefore, the available band is restricted and this makes the system suitable for remotizing signals contained in a narrow frequency band and usable typically in the case of mobile phone application, for just one operator.

Description of the Invention

The main aim of the present invention is to provide a system and a method for the distribution of radio-frequency signals that allow an independent control of the different distributed signals and, at the same time, allow the use of a broad frequency band for the simultaneous transmission of several signals between the main unit and the remote units.

Another object of the present invention is to provide a system and a method for the distribution of radio-frequency signals which allow overcoming the mentioned drawbacks of the state of the art within the ambit of a simple, rational, easy and effective to use as well as low cost solution.

The above objects are all achieved by the present system for the distribution of radio-frequency signals, comprising:

- at least a main unit associated with at least a first radio communication set;
- at least a remote unit associated with at least a second radio communication set installed in a preset area, for the radio coverage of said area;
- at least a communication channel associated with said main unit and with said remote unit;

wherein said main unit and said remote unit have analogue modulation means of the signals to be sent on said communication channel, characterized by the fact that said remote unit comprises at least a selective amplification unit associated with said second radio communication set and having:

- analogue/digital conversion means of the signals coming from said main unit, through said communication channel, and/or of the signals coming from said second radio communication set;
- digital filtering means of the digital signals coming out of said

analogue/digital conversion means;

- amplification means of the signals coming from said main unit, through said communication channel, and/or of the signals coming from said second radio communication set.

The above objects are all achieved by the present method for the distribution of radio-frequency signals, comprising:

- at least a first reception/transmission phase of signals between a main unit and at least a first radio communication set;
- at least a communication phase with analogue modulation of the signals between said main unit and at least a remote unit, through at least a communication channel;
- at least a second reception/transmission phase of signals between said remote unit and at least a second radio communication set installed in a predetermined area, for the radio coverage of said area;

characterized by the fact that it comprises:

- at least an analogue/digital conversion phase of the signals coming from said main unit, through said communication channel, and/or of the signals coming from said second radio communication set;
- at least a digital filtering phase of said signals, after said analogue/digital conversion phase;
- at least an amplification phase of the signals coming from said remote unit, through said communication channel, and/or of the signals coming from said second radio communication set.

Brief Description of the Drawings

Other characteristics and advantages of the present invention will become more evident from the description of two preferred, but not sole, embodiments of a system and a method for the distribution of radio-frequency signals, illustrated purely as an example but not limited to the annexed drawings in which:

figure 1 is a block diagram of a first embodiment of the system according to the invention;

figure 2 is a block diagram of a second embodiment of the system according to the invention.

Embodiments of the Invention

With reference to such figures, globally indicated by 1 is a system for the distribution of radio-frequency signals, that can be used in particular within the ambit of mobile phones for the remotization of the signals coming from a plurality of base radio stations (Base Transceiver Station), for various frequency bands, relating to different communication standards (such as GSM, UMTS or the like), and for different phone operators.

Different applications of the system 1 according to the invention cannot however be ruled out such as, e.g., the indoor distribution of signals in buildings, underground railways, airports and, in general, all those areas where it is hard to ensure adequate radio coverage using conventional methods.

With reference to a first possible embodiment, shown in figure 1, the system 1 comprises:

- a main unit, generally indicated by the reference 2, associated with at least a first radio communication set A, composed of a base radio station (Base Transceiver Station) or of a similar appliance;
- at least a remote unit, generally indicated by the reference 3, associated directly or by means of a passive distribution network with a plurality of second radio communication sets B, composed of antennas or the like, suitable for allowing the radio coverage inside a predetermined area;
- a communication channel 4 between the main unit 2 and the remote unit 3, preferably composed of one or more optical fibre cables.

The system 1 comprises one or more remote units 3, suitably distributed in an area where the radio coverage is to be provided, connected to the main unit 2 by means of the communication channel 4.

The main unit 2 comprises a plurality of interface modules 5 connected to respective base radio stations A.

Each base radio station A, in point of fact, produces a respective radio-frequency signal relating to a specific frequency band and to a specific operator, and sends it to the interface modules 5.

The main unit 2 therefore presents a plurality of distinct interface modules 5, each of which suitable for controlling the signals coming from the base radio

stations A for just one specific frequency band and for just one operator.

Each of the interface modules 5 can comprise, both at input and output, a filter 5a and an attenuator 5b of the signals received or to be sent.

Usefully, as shown in figure 1, each of the interface modules 5 can be associated with a respective base radio station A by means of a single cable usable to simultaneously send or receive radio-frequency signals. Alternatively, the use cannot be ruled out of two distinct cables, a first cable for the signals coming from the base radio station A and sent towards the respective interface module 5 and a second cable for the signals coming from an interface module 5 and sent towards the base radio station A.

The main unit 2 also comprises first combiner/separator means, generally indicated by the reference 6, placed between the interface modules 5 and the communication channel 4.

The first combiner/separator means 6 are suitable for combining a plurality of input signals coming from the respective interface modules 5 into a single output signal to be sent through the communication channel 4 and/or for separating a single input signal coming from the communication channel 4 into a plurality of output signals to be sent to respective interface modules 5.

In particular, the first combiner/separator means 6 comprise three first combiner/separator modules 7 associated with respective groups of interface modules 5.

The use of first combiner/separator modules 7, in different numbers depending on the number of the frequency bands supported by the optical fibre communication channel 4 cannot however be ruled out.

Each of the first combiner/separator modules 7 is suitable for combining a plurality of input signals relating to just one frequency band and to several operators into a single output signal to be sent towards the communication channel 4 and/or for separating just one input signal coming from the communication channel 4 and relating to just one frequency band into a plurality of output signals relating to just one frequency band and to several operators to be sent to respective interface modules 5.

The first combiner/separator means 6 also comprise a second

combiner/separator module 8 placed in between the first combiner/separator modules 7 and the communication channel 4.

The second combiner/separator module 8 is suitable for combining a plurality of input signals relating to different frequency bands into a single output signal to be sent through the communication channel 4 and/or for separating a single input signal coming from the communication channel 4 into a plurality of output signals relating to different frequency bands.

Advantageously, the main unit 2 and the remote unit 3 have analogue modulation means for modulating the signals sent on the communication channel 4, composed of a first and a second converter module 9 and 10 respectively, suitable for modulating the intensity of the optical signal sent on the communication channel 4 according to the electrical signals received upstream, and vice versa.

The use of an analogue type modulation of the signals to be sent on the communication channel 4, in particular, allows using a broad frequency band and, therefore, performing the simultaneous transmission/reception of several signals between the main unit 2 and the remote unit 3.

The first converter module 9, in particular, has a first electrical/optical converter 11 suitable for converting an electrical input signal coming from the second combiner/separator module 8 into a corresponding optical output signal to be sent through the optical fibre cable 4, and also has a first optical/electrical converter 12 suitable for converting an optical input signal coming from the optical fibre cable 4 into a corresponding electrical output signal to be sent to the second combiner/separator module 8.

The first converter module 9 also comprises a first multiplexer/demultiplexer 13 for simultaneously sending and receiving optical signals on the optical fibre cable 4, which is associated with the first electrical/optical converter 11 and with the first optical/electrical converter 12 and which uses, e.g., a multiplexing of the WDM (Wavelength Division Multiplexing) type.

The second converter module 10, in the same way, has a second optical/electrical converter 14 suitable for converting an optical input signal coming from the optical fibre cable 4 into a corresponding electrical output

signal and, furthermore, it has a second electrical/optical converter 15 suitable for converting an electrical input signal into a corresponding optical output signal to be sent through the optical fibre cable 4.

The second converter module 10 also comprises a second multiplexer/demultiplexer 16 for simultaneously sending and receiving optical signals on the optical fibre cable 4, which is associated with the second optical/electrical converter 14 and with the second electrical/optical converter 15 and which uses, e.g., a multiplexing of the WDM (Wavelength Division Multiplexing) type.

Usefully, the remote unit 3 comprises second combiner/separator means, generally indicated by the reference 17, associated with the communication channel 4.

The second combiner/separator means 17 comprise, in particular, a third combiner/separator module 18 suitable for separating a single input signal coming from the communication channel 4 into a plurality of output signals relating to different frequency bands or, vice versa, for combining a plurality of input signals relating to different frequency bands into a single output signal to be sent through the communication channel 4.

The second combiner/separator means 17 also comprise three fourth combiner/separator modules 19 associated with the third combiner/separator module 18.

The use of fourth combiner/separator modules 19, in different numbers depending on the number of the frequency bands supported by the optical fibre communication channel 4 cannot however be ruled out.

Each of the fourth combiner/separator modules 19 is suitable for separating a single input signal coming from the third combiner/separator module 18 and relating to just one frequency band into a plurality of output signals relating to several operators or, vice versa, for combining a plurality of input signals relating to just one frequency band and to several operators into a single output signal to be sent towards the third combiner/separator module 18.

Advantageously, the remote unit 3 comprises at least a selective amplification unit 20 associated with a respective antenna B and having:

- analogue/digital conversion means for converting the signals coming from the main unit 2, through the communication channel 4, and/or of the signals coming from the antenna B;
- digital filtering means for filtering the digital signals coming out of the analogue/digital conversion means;
- digital/analogue conversion means of the filtered digital signals;
- amplification means for amplifying the signals coming from the remote unit 3, through the communication channel 4, and/or the signals coming from the antenna B.

In particular, each of the remote units 3 used comprises several selective amplification units 20 associated with the fourth combiner/separator modules 19, each of which dedicated to a specific frequency band and to a specific operator.

In point of fact, each selective amplification unit 20 converts into digital signals the analogue signals coming from the communication channel 4 or from the antenna B and, afterwards, filters such digital signals to select the data of interest.

This therefore permits an independent control of the different signals distributed, for each operator and inside each of the frequency bands relating to different frequency bands.

In particular, for each of the selective amplification units 20, the analogue/digital signal conversion means are composed of a first analogue/digital converter 21 for converting the signals coming from one of the fourth combiner/separator modules 19, and of a second analogue/digital converter 22 for converting the signals coming from the antenna B and directed towards the main unit 2.

The digital filtering means are composed of a first and a second digital filter 23 and 24 arranged downstream of the first and the second analogue/digital converter 21 and 22 respectively.

The digital/analogue conversion means comprise a first digital/analogue converter 25 arranged downstream of the first digital filter 23 and a second analogue/digital converter 26 arranged downstream of the second digital filter

24 suitable for converting the filtered digital signals into a corresponding analogue signal before sending towards the antenna B or the fourth combiner/separator modules 19 respectively.

The amplification means of the selective amplification units 20, furthermore, are made up of a first amplifier 27 arranged downstream of the first digital filter 23 and of a second amplifier 28, of the Low-Noise Amplifier type, arranged downstream of the antenna B and upstream of the second analogue/digital converter 22.

Advantageously, with reference to the sending of signals from the base radio stations A to the antennas B, each of the selective amplification units 20 comprises a digital pre-distortion device 29, arranged downstream of the first digital filter 23 and upstream of the first digital/analogue converter 25, suitable for changing the output signal from the first digital filter 23 so as to reduce to the utmost the effect of the amplification disturbances on the end signal due to the first amplifier 27, before the transmission by means of the antenna B.

Each of the selective amplification units 20 also comprises a combiner/separator device 30, of the type of a duplexer or the like, associated with the antenna B and suitable for simultaneously allowing sending and receiving signals.

With reference to a second possible embodiment of the invention, shown in figure 2, the system 1 is of the type of a MIMO (Multiple Input Multiple Output) system able to control the reception of several signals by means of a plurality of supplementary antennas B' connected to each of the selective amplification units 20.

In this case, each of the selective amplification units 20 comprises:

- a supplementary amplifier 28', of a Low-Noise Amplifier type, arranged downstream of the supplementary antenna B';
- a supplementary analogue/digital converter 22', arranged downstream of the supplementary amplifier 28' and suitable for converting the analogue signals coming from the supplementary antenna B' into corresponding digital signals directed towards the main unit 2;
- a supplementary digital filter 24' arranged downstream of the supplementary analogue/digital converter 22';

- a supplementary digital/analogue converter 26' arranged downstream of the supplementary digital filter 24' and suitable for converting the filtered digital signal into a corresponding analogue signal, before sending towards the fourth combiner/separator modules 19.

Each of the selective amplification units 20 also comprises an input filter 30' arranged upstream of the supplementary amplifier 28' and suitable for filtering the signal coming from the supplementary antenna B'.

The second combiner/separator means 17, in the particular solution shown in figure 2, combine together the signals received from the supplementary antennas B' and coming from respective selective amplification units 20 into a single output signal to be sent through the communication channel 4.

The second converter module 10 has a supplementary electrical/optical converter 15' suitable for converting the electrical signal coming from the second combiner/separator means 17 and relating to the signals coming from the supplementary antennas B' into a corresponding optical output signal to be sent through the optical fibre cable 4.

The second multiplexer/demultiplexer 16 is associated with the second optical/electrical converter 14, with the second electrical/optical converter 15 and with the supplementary electrical/optical converter 15' and is suitable for simultaneously sending and receiving optical signals on the optical fibre cable 4.

In the same way, the first converter module 9 has a supplementary optical/electrical converter 12' suitable for converting the optical signal coming from the optical fibre cable 4 and relating to the signals coming from the supplementary antennas B' into a corresponding electrical output signal to be sent towards the base radio stations A.

The first multiplexer/demultiplexer 13 is associated with the first electrical/optical converter 11, with the first optical/electrical converter 12 and with the supplementary optical/electrical converter 12' and is suitable for simultaneously sending and receiving the optical signals on the optical fibre cable 4.

The first combiner/separator means 6, in the particular solution shown in figure

2, separate the signal received from the first converter module 9 and related to the signals coming from the supplementary antennas B' into a plurality of output signals to be sent to respective interface modules 5.

Usefully, each of the interface modules 5 comprises a supplementary filter 5a' and a supplementary attenuator 5b' usable to filter and attenuate a respective signal coming from one of the supplementary antennas B'.

Furthermore, each of the interface modules 5 is associated with the respective base radio station A by means of a further connection cable for sending the signal from one of the supplementary antennas B'.

Usefully, the system 1 may have a further connection branch between the base radio stations A and the antennas B (and, if necessary, the supplementary antennas B') used to transport control commands of the remote unit 3 and of the antennas B. Such further branch can be used, in particular, for the so-called "tilt" of the antennas B, i.e., to change their positioning and orientation, and/or to control any device downstream of the remote unit 3.

The method for the distribution of radio-frequency signals according to the invention comprises:

- a first reception/transmission phase of signals between the main unit 2 and at least one base radio station A;
- a communication phase with analogue modulation of the signals between the main unit 2 and at least a remote unit 3, through the communication channel 4;
- a second reception/transmission phase of signals between the remote unit 3 and the antennas B.

Usefully, during the above first and second reception/transmission phase, a plurality of signals is received and transmitted and each signal is modulated inside a respective frequency band, for a specific frequency band, and relates to a specific operator.

The method also envisages a first combination/separation phase performed by means of the first combiner/separator means 6, suitable for:

- combining the input signals coming from the base radio stations A, in particular from the interface modules 5, into a single output signal;

- separating a single input signal coming from the communication channel 4, in particular from the first converter module 9, into a plurality of outputs signals relating to several frequency bands and to several operators to be sent to the base radio stations A.

The above communication phase comprises a first conversion phase, carried out by means of the first converter module 9, of an electrical input signal coming from the first combiner/separator means 6 into a corresponding optical output signal to be sent through the optical fibre cable 4 or, vice versa, into an optical input signal coming from the optical fibre cable 4 into a corresponding electrical output signal to be sent towards first combiner/separator means 6.

The above communication phase also comprises a second conversion phase, carried out by means of the first converter module 9, of an optical input signal coming from the optical fibre cable 4 into a corresponding electrical output signal to be sent towards the second combiner/separator means 17 or, vice versa, of an electrical input signal coming from the second combiner/separator means 17 into a corresponding optical output signal to be sent through the optical fibre cable 4.

The method also envisages a second combination/separation phase performed by means of second combiner/separator means 17, suitable for:

- separating a single input signal coming from the communication channel 4 into a plurality of output signals relating to several frequency bands and several operators, to be sent to respective selective amplification units 20;
- combining a plurality of input signals coming from respective selective amplification units 20 into a single output signal to be sent by means of the communication channel 4.

Advantageously, the method according to the invention also comprises the following phases performed by means of each of the selective amplification units 20:

- an analogue/digital conversion phase of the signals coming from the main unit 2 through the communication channel 4 and/or of the signals coming from the antennas B;

- a digital filtering phase of the digital signals, subsequent to the analogue/digital conversion phase;
- a digital/analogue conversion phase of the digital signals, subsequent to the filtering phase;
- an amplification phase of the signals coming from the remote unit 3 through the communication channel 4 and/or of the signals coming from the antennas B.

In particular, with reference to the sending by means of the antennas B of the signals coming from the base radio stations A, the analogue/digital conversion phase envisages the conversion by means of the first analogue/digital converter 21 of the signals coming from the second combiner/separator means 17 and directed towards the antennas B.

Subsequently, the method envisages the digital filtering by means of the first digital filter 23, the digital pre-distortion by means of the digital pre-distortion device 29, the conversion from digital to analogue of the signal thus obtained by means of the first digital/analogue converter 25 and, finally, the amplification of the signal by means of the first amplifier 27.

In the same way, with reference to the signals received from the antennas B, the analogue/digital conversion phase envisages the conversion by means of the second analogue/digital converter 22 of the signals coming from the antennas B and directed towards the second combiner/separator means 17.

Subsequently, the method envisages the digital filtering by means of the second digital filter 24 and the conversion from digital to analogue of the signal thus obtained by means of the second digital/analogue converter 26.

The amplification of the signal is in this case made before the analogue/digital conversion by means of the second amplifier 28.

It has in fact been ascertained how the described invention achieves the set objects.

In particular, it is clear how the use of an analogue modulation of the signals for sending/receiving through the optical fibre communication channel allows using a broad frequency band for the simultaneous transmission/reception of several signals between the main unit and the remote units.

At the same time, the digitalization and subsequent filtering of the signals by means of the selective amplification units, before the distribution of the signals by means of the respective antennas, allow the independent control of the different signals distributed for each of the frequency bands used and for each of the operators.

Another advantage of the invention is that it provides the possibility of using a dedicated antenna connected to a respective selective amplification unit, for each operator and for each frequency band.

Another advantage of the invention is that it provides the possibility of maintaining high power levels at the antenna input, because amplification is done separately for each operator and for each frequency band.

A further advantage of the invention is that it provides the possibility of making the pre-distortion of the digital signal so as to upgrade the results of the amplification.

Another advantage is that it provides the possibility of making statistical readings of the filtered digital signals so as to obtain measurements of the traffic and power of the signals.

A further advantage is that it provides the possibility of reducing the noise produced, reducing the gain of the amplifiers inside the unused channels.

CLAIMS

1) System (1) for the distribution of radio-frequency signals, comprising:

- at least a main unit (2) associated with at least a first radio communication set (A);
- at least a remote unit (3) associated with at least a second radio communication set (B) installed in a preset area, for the radio coverage of said area;
- at least a communication channel (4) associated with said main unit (2) and with said remote unit (3);

wherein said main unit (2) and said remote unit (3) have analogue modulation means (9, 10) of the signals to be sent on said communication channel (4), characterized by the fact that said remote unit (3) comprises at least a selective amplification unit (20) associated with said second radio communication set (B) and having:

- analogue/digital conversion means (21, 22) of the signals coming from said main unit (2), through said communication channel (4), and/or of the signals coming from said second radio communication set (B);
- digital filtering means (23, 24) of the digital signals coming out of said analogue/digital conversion means (21, 22);
- amplification means (27, 28) of the signals coming from said main unit (2), through said communication channel (4), and/or of the signals coming from said second radio communication set (B).

2) System (1) according to the claim 1, characterized by the fact that said selective amplification unit (20) comprises digital/analogue conversion means (25, 26) of the filtered digital signals.

3) System (1) according to one or more of the preceding claims, characterized by the fact that said analogue/digital conversion means (21, 22) comprise at least a first analogue/digital converter (21) suitable for converting the signals coming from said main unit (2) and directed towards said second radio communication set (B).

4) System (1) according to one or more of the preceding claims, characterized by the fact that said digital filtering means (23, 24) comprise at least a first

digital filter (23) arranged downstream of said first analogue/digital converter (21).

5) System (1) according to one or more of the preceding claims, characterized by the fact that said digital/analogue conversion means (25, 26) comprise at least a first digital/analogue converter (25) arranged downstream of said first digital filter (23).

6) System (1) according to one or more of the preceding claims, characterized by the fact that said amplification means (27, 28) comprise at least a first signal amplifier (27) arranged downstream of said first digital/analogue converter (25).

7) System (1) according to one or more of the preceding claims, characterized by the fact that said selective amplification unit (20) comprises at least a digital pre-distortion device (29) arranged downstream of said first digital filter (23) and upstream of said first amplifier (27).

8) System (1) according to one or more of the preceding claims, characterized by the fact that said analogue/digital conversion means (21, 22) comprise at least a second analogue/digital converter (22) suitable for converting the signals coming from said second radio communication set (B) and directed towards said main unit (2).

9) System (1) according to one or more of the preceding claims, characterized by the fact that said digital filtering means (23, 24) comprise at least a second digital filter (24) arranged downstream of said second analogue/digital converter (22).

10) System (1) according to one or more of the preceding claims, characterized by the fact that said digital/analogue conversion means (25, 26) comprise at least a second digital/analogue converter (26) arranged downstream of said second digital filter (24).

11) System (1) according to one or more of the preceding claims, characterized by the fact that said amplification means (27, 28) comprise at least a second signal amplifier (28) arranged downstream of said second radio communication set (B).

12) System (1) according to one or more of the preceding claims, characterized by the fact that said main unit (2) comprises at least an interface module (5)

associated with said first radio communication set (A), said first radio communication set (A) being suitable for sending at least an electrical signal towards said interface module (5), or vice versa.

13) System (1) according to one or more of the preceding claims, characterized by the fact that it comprises a plurality of said interface modules (5), suitable for receiving/sending respective signals from/towards said first radio communication set (A) relating to different frequency bands and/or different operators.

14) System (1) according to one or more of the preceding claims, characterized by the fact that said main unit (2) comprises first combiner/separator means (6) placed in between said interface modules (5) and said communication channel (4), said first combiner/separator means (6) being suitable for combining a plurality of input signals coming from respective interface modules (5) in a single output signal to be sent to said communication channel (4) and/or for separating a single input signal coming from said communication channel (4) into a plurality of output signals to be sent to respective interface modules (5).

15) System (1) according to one or more of the preceding claims, characterized by the fact that said communication channel (4) comprises at least an optical fibre cable (4).

16) System (1) according to one or more of the preceding claims, characterized by the fact that said analogue modulation means (9, 10) of the main unit (2) comprise at least a first converter module (9) associated with said optical fibre cable (4) and suitable for converting an electrical input signal coming from said first radio communication set (A) into a corresponding optical output signal to be sent through said optical fibre cable (4) or, vice versa, suitable for converting an optical input signal coming from said optical fibre cable (4) into a corresponding electrical output signal to be sent towards said first radio communication set (A).

17) System (1) according to one or more of the preceding claims, characterized by the fact that said analogue modulation means (9, 10) of the remote unit (3) comprise at least a second converter module (10) associated with said optical fibre cable (4) and suitable for converting an input optical signal coming from

said optical fibre cable (4) into a corresponding electrical output signal to be sent to said selective amplification module or, vice versa, suitable for converting an electrical input signal coming from said selective amplification module into a corresponding optical output signal to be sent through said optical fibre cable (4).

18) System (1) according to one or more of the preceding claims, characterized by the fact that said remote unit (3) comprises a plurality of said selective amplification units (20), suitable for receiving/sending signals from/towards said second radio communication set (B) relating to different frequency bands and/or different operators.

19) System (1) according to one or more of the preceding claims, characterized by the fact that said remote unit (3) comprises second combiner/separator means (17) placed in between said communication channel (4) and said selective amplification units (20), said second combiner/separator means (17) being suitable for separating a single input signal coming from said communication channel (4) into a plurality of output signals to be sent to respective selective amplification units (20) and/or for combining a plurality of input signals coming from respective selective amplification units (20) into a single output signal to be sent towards said communication channel (4).

20) System (1) according to one or more of the preceding claims, characterized by the fact that it comprises at least a supplementary connection branch between said main unit (2) and said remote unit (3) suitable for transporting control commands of the remote unit (3) itself and/or of the devices associated with it.

21) Method for the distribution of radio-frequency signals, comprising:

- at least a first reception/transmission phase of signals between a main unit (2) and at least a first radio communication set (A);
- at least a communication phase with analogue modulation of the signals between said main unit (2) and at least a remote unit (3), through at least a communication channel (4);
- at least a second reception/transmission phase of signals between said remote unit (3) and at least a second radio communication set (B) installed in a predetermined area, for the radio coverage of said area;

characterized by the fact that it comprises:

- at least an analogue/digital conversion phase of the signals coming from said main unit (2), through said communication channel (4), and/or of the signals coming from said second radio communication set (B);
- at least a digital filtering phase of said signals, after said analogue/digital conversion phase;
- at least an amplification phase of the signals coming from said remote unit (3), through said communication channel (4), and/or of the signals coming from said second radio communication set (B).

22) Method according to the claim 21, characterized by the fact that it comprises at least a digital/analogue conversion phase of said signals, after said digital filtering phase.

23) Method according to the claim 22, characterized by the fact that said analogue/digital conversion phase is suitable for converting the signals coming from said main unit (2), through said communication channel (4), and directed towards said second radio communication set (B).

24) Method according to the claim 23, characterized by the fact that said amplification phase is performed after said digital filtering phase.

25) Method according to the claim 24, characterized by the fact that it comprises at least a digital pre-distortion phase of said signals performed after said digital filtering phase and before said amplification phase.

26) Method according to the claim 25, characterized by the fact that said analogue/digital conversion phase is suitable for converting the signals coming from said second radio communication set (B) and directed towards said main unit (2).

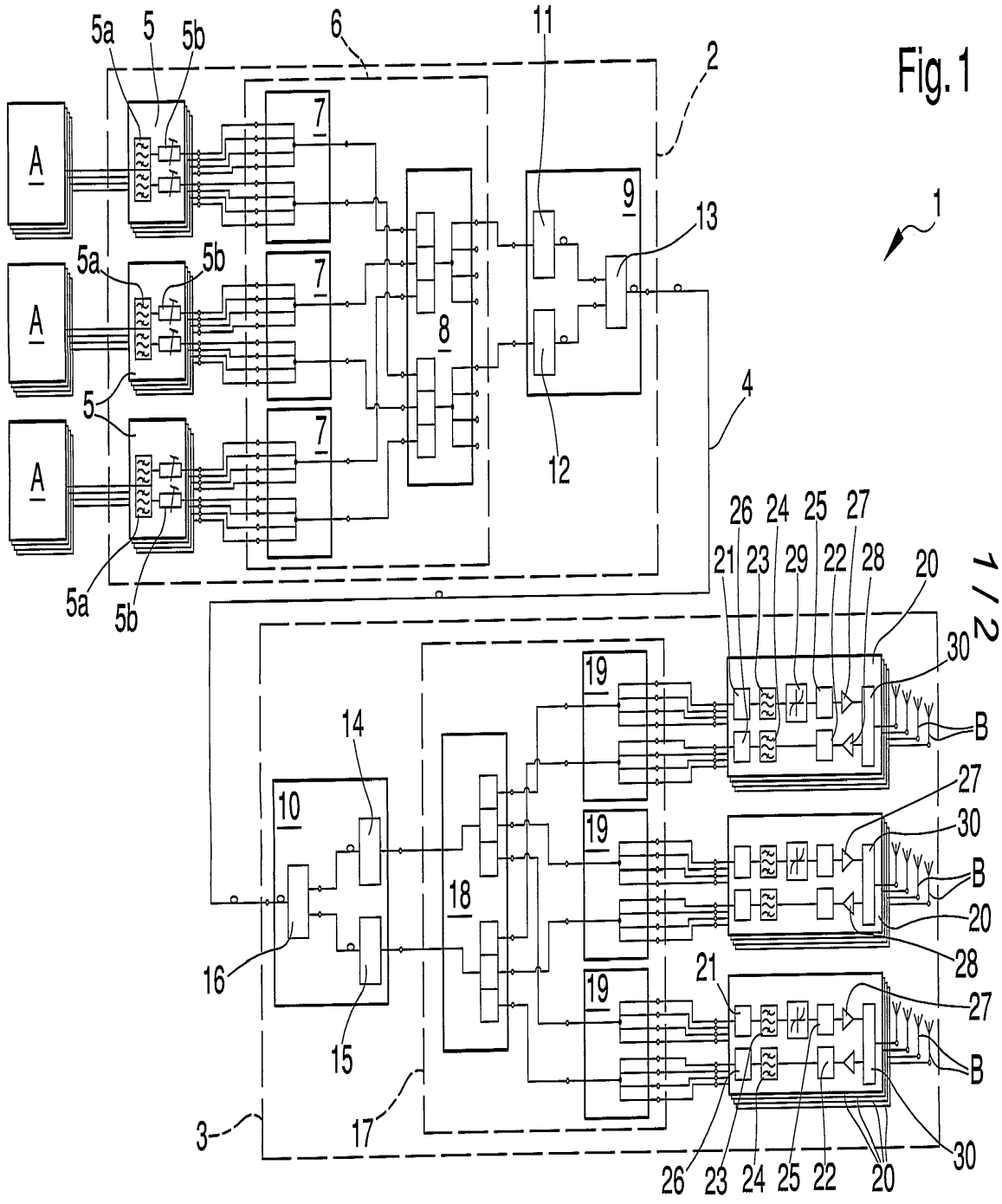
27) Method according to the claim 26, characterized by the fact that said amplification phase is performed before said analogue/digital conversion phase.

28) Method according to one or more of the claims from 21 to 27, characterized by the fact that it comprises at least a first combination/separation phase suitable for combining a plurality of input signals coming from said first radio communication set (A) into a single output signal, before said communication phase, and/or suitable for separating a single input signal into a plurality of

output signals to be sent to said first radio communication set (A), after said communication phase.

29) Method according to one or more of the claims from 21 to 28, characterized by the fact that it comprises at least a second combination/separation phase suitable for separating a single input signal coming from said communication channel (4) into a plurality of output signals to be sent to said second radio communication set (B) and/or for combining a plurality of input signals coming from said second radio communication set (B) into a single output signal to be sent towards said communication channel (4).

Fig.1


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A
B

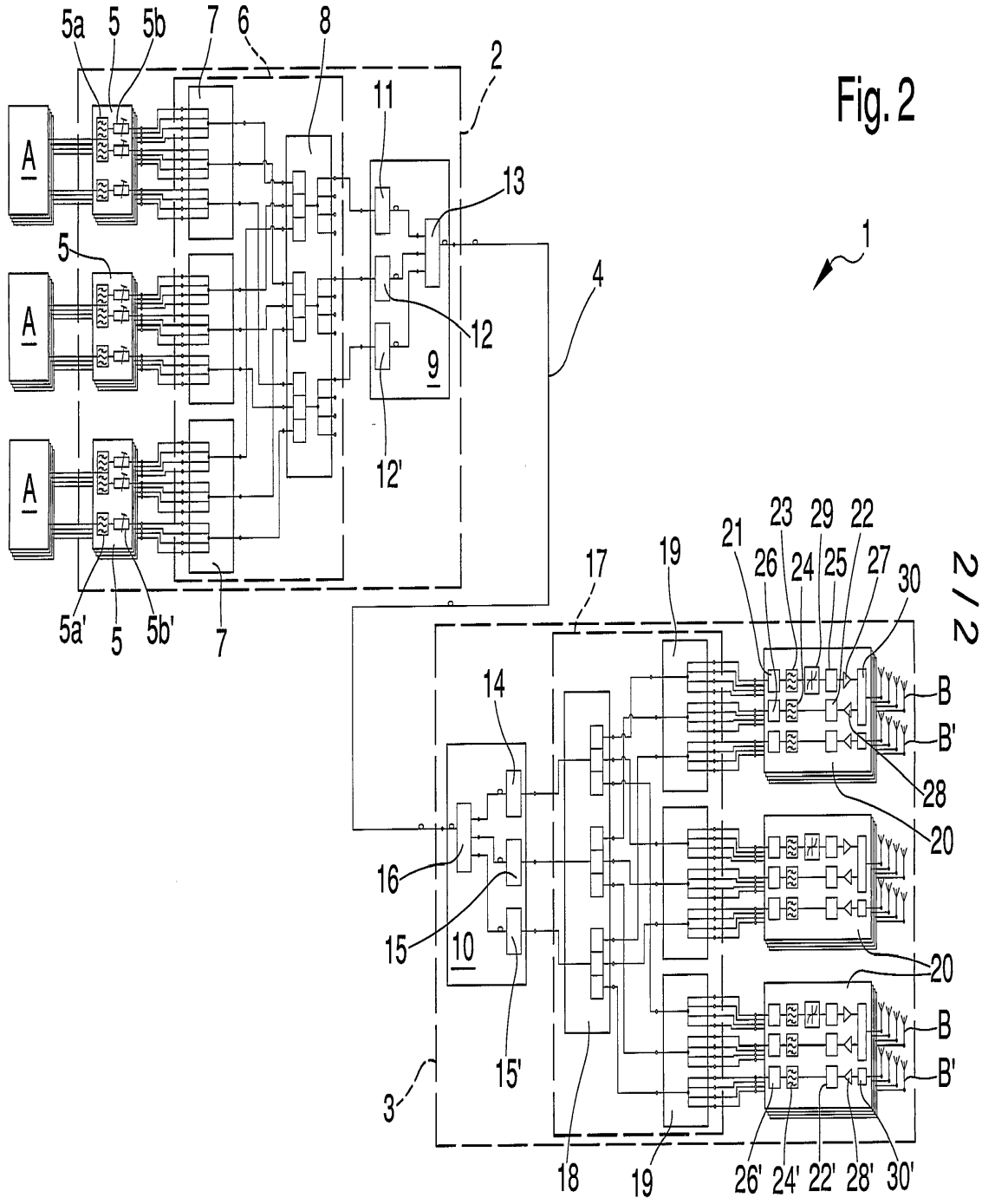

5a
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5b
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13
1
A
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4
12
9
12'
5a'
5
5b'
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B'
15'
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26'
24'
22'
28'
30'

Fig. 2

2 / 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/001150

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B10/12 H04W88/08
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B H04W

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/110534 A1 (CHUNG SAE-YOUNG [US] ET AL) 10 June 2004 (2004-06-10) paragraph [0016] paragraph [0061] - paragraph [0062] paragraph [0065] figures 4,5	1-29
A	WO 98/16054 A (MVS INC [US]) 16 April 1998 (1998-04-16) page 6, line 6 - line 14 page 7, line 14 - page 9, line 5 page 9, line 29 - line 32 figures 1,3	1-29
A	US 5 657 374 A (RUSSELL DAVID S [US] ET AL) 12 August 1997 (1997-08-12) * abstract figure 29	1-29

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 September 2010	15/09/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ribbe, Åsa

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2008/012865 A (MATSUSHITA ELECTRIC IND CO LTD [JP]; ODA KATSUYA; TOHGOH HITOMARO) 31 January 2008 (2008-01-31) * abstract figures 3,7 -----	1-29

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2010/001150

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004110534 A1	10-06-2004	NONE	
WO 9816054 A	16-04-1998	CA 2268309 A1	16-04-1998
		DE 69735724 T2	12-04-2007
		EP 0944990 A1	29-09-1999
		ES 2262192 T3	16-11-2006
		US 6324391 B1	27-11-2001
		US 6016426 A	18-01-2000
US 5657374 A	12-08-1997	US 5621786 A	15-04-1997
		US 5642405 A	24-06-1997
		US 5852651 A	22-12-1998
		US 5644622 A	01-07-1997
WO 2008012865 A	31-01-2008	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

Espacenet

Bibliographic data: CN1774094 (A) — 2006-05-17

A radio base station system and its transmitting and receiving information method

Inventor(s): HU QIANG DUAN [CN] ± (QIANG,DUAN HU)

Applicant(s): HUAWEI TECH CO LTD [CN] ± (HUAWEI TECHNOLOGY CO., LTD)

Classification: **- international:** ***H04B10/12; H04B10/2575; H04W88/08***
- cooperative:

Application number: CN2004192038 20041108

Priority number(s): CN2004192038 20041108

Abstract of CN1774094 (A)

A radio base station system comprises a base band unit, a radio frequency remote end unit and a light interface. Its signal receiving method includes converting received electric signal to be light signal by radio frequency remote end unit then sending it to base band unit, converting received light signal to be electric signal by base band unit and then processing electric signal; its signal emitting method includes converting electric signal to be light signal by base band unit then sending it to radio frequency remote end unit, converting receiving light signal to be electric signal by radio frequency remote end unit and then emitting electric signal .

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04Q 7/30 (2006.01)
H04B 10/12 (2006.01)

[12] 发明专利申请公开说明书

[21] 申请号 200410092038.2

[43] 公开日 2006 年 5 月 17 日

[11] 公开号 CN 1774094A

[22] 申请日 2004.11.8
[21] 申请号 200410092038.2
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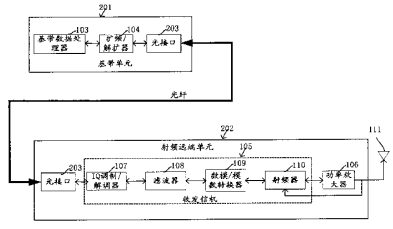
权利要求书 3 页 说明书 11 页 附图 7 页

[54] 发明名称

一种无线基站系统及其发射和接收信息的方法

[57] 摘要

本发明公开了一种无线基站系统，包括：至少一个基带单元，且集中设置；以及至少一个射频远端单元；所述每个基带单元和射频远端单元中分别包括至少一个用于光/电信号互换的光接口；利用各自的光接口，基带单元与射频远端单元通过光纤连接。 本发明还公开了上述系统收发信息的方法，发送方法为：A. 基带单元将需发送的电信号转化为光信号，再发送给射频远端单元；B. 射频远端单元将接收到的光信号转化为电信号之后，再处理发射。接收方法为：a. 射频远端单元将接收的电信号转化为光信号再传送给基带单元；b. 基带单元将收到的光信号转化为电信号后，再对该电信号进行处理。本发明能集中管理基带单元，使射频单元分布覆盖通讯区域，节省成本，提高处理效率。



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1、一种无线基站系统，该系统包括：至少一个基带单元，以及至少一个射频远端单元；其特征在于，

所述基带单元集中设置；

所述每个基带单元和射频远端单元中分别包括至少一个用于光/电信号互换的光接口；利用各自的光接口，基带单元与射频远端单元通过光纤连接。

2、如权利要求 1 所述的无线基站系统，其特征在于，所述基带单元中包括多个光接口，每一个光接口通过光纤分别与不同的射频远端单元连接。

3、如权利要求 1 或 2 所述的无线基站系统，其特征在于，多个所述射频远端单元通过光纤级联，且其中至少一个射频远端单元通过光纤与所述基带单元的光接口连接。

4、如权利要求 3 所述的无线基站系统，其特征在于，所述基带单元和射频远端单元中分别进一步包括通用公共无线接口 CPRI 逻辑单元，用于对数据进行 CPRI 格式转换和解析；

所述基带单元中的 CPRI 逻辑单元将需发送给射频远端单元的数据转换为 CPRI 格式，添加到 CPRI 数据帧中发送给基带单元的光接口，并接收基带单元的光接口收到的射频远端单元发来的数据进行解析；

射频远端单元中的 CPRI 逻辑单元接收射频远端单元的光接口收到的来自基带单元的数据，解析出自身需要的数据，并将从外界接收的数据转换为 CPRI 格式插入到 CPRI 数据帧，发送至射频远端单元的光接口。

5、如权利要求 1 所述的无线基站系统，其特征在于，所述每一个射频远端单元与一个基带单元连接，且所有的基带单元集中设置在一个基带设备中。

6、一种无线基站系统发射信息的方法，其特征在于，所述无线基站系统包括至少一个基带单元和射频远端单元，基带单元集中设置，并且通过光纤与射频远端单元连接；

该方法包括：

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A、基带单元将需发送给射频远端单元的电信号转换为光信号，根据预先设置的每个射频远端单元与其自身信号的对应关系将所述光信号发送给对应的射频远端单元；

B、射频远端单元收到光信号后，将光信号转换为电信号，进行信息发射处理。

7、如权利要求 6 所述的方法，其特征在于，所述对应关系为每一个射频远端单元对应基带单元中的一个光接口；

步骤 A 所述信号发送过程为：基带单元将需发送给射频远端单元的信号发送至自身中与该射频远端单元对应的光接口。

8、如权利要求 6 所述的方法，其特征在于，所述基带单元和射频远端单元之间的传输信号为数据帧的形式，所述对应关系为每个射频远端模块对应数据帧中的一个时隙，

步骤 A 所述信号发送过程为：基带单元将需发送给射频远端单元的数据置于数据帧的对应时隙中，并转换为光信号后向射频远端单元发送；

步骤 B 中所述射频远端单元将接收到的光信号转换为电信号后进一步包括：从数据帧形式的电信号中读出自身对应时隙的数据，进行信息发射处理。

9、如权利要求 8 所述的方法，其特征在于，所述数据帧符合通用公共无线接口格式。

10、一种无线基站系统接收信息的方法，其特征在于，所述无线基站系统包括至少一个基带单元和射频远端单元，基带单元集中设置，并且通过光纤与射频远端单元连接；

该方法包括：

a、射频远端单元对从外界接收的信息进行射频处理后，将电信号转化为光信号，向基带单元发送；

b、基带单元收到光信号后，将光信号转化为电信号，并根据预先设置的每个射频远端单元与其自身信号的对应关系确定每个信号对应的射频远端单元，

进行基带处理。

11、如权利要求 10 所述的方法，其特征在于，所述对应关系为每一个射频远端单元对应基带单元中的一个光接口；

步骤 b 中所述确定过程为：基带单元根据收到每个光信号的光接口确定每个信号对应的射频远端单元。

12、如权利要求 10 所述的方法，其特征在于，所述基带单元和射频远端单元之间的传输信号为数据帧的形式，所述对应关系为每个射频远端模块对应数据帧中的一个时隙；

步骤 a 中所述射频远端单元对从外界接收的信息进行射频处理后进一步包括：将得到的数据添加到数据帧与该射频远端单元对应的时隙中；

步骤 b 中所述确定过程为：基带单元根据数据帧中各时隙与射频远端单元的对应关系获知每个时隙中的数据所对应的射频远端单元。

13、如权利要求 12 所述的方法，其特征在于，所述数据帧符合通用公共无线接口格式。

一种无线基站系统及其发射和接收信息的方法

技术领域

本发明涉及无线通讯系统中的组网技术，尤其涉及一种的无线基站系统及其发射和接收信息的方法。

背景技术

目前，在第三代无线通讯系统（3G）的组网过程中，例如码分多址（CDMA）通讯系统和宽带码分多址通讯系统（WCDMA）的组网过程中，三扇区方式是主流配置方式，即每个站址都采用宏基站进行信号覆盖，多个宏基站组成一种无线基站系统。参见图 1，现有的宏基站中，主要包括：基带单元 101 和射频单元 102，它们之间通过电缆连接。其中，基带单元 101 又包括：基带数据处理器 103，用于处理基带数据；以及扩频/解扩器 104，用于对发送的基带数据进行扩频后传输到射频单元 102，并对接收到的数据进行解扩后传输到基带数据处理器 103。射频单元 102 又包括：收发信机 105，用于接收和发送射频信号；功率放大器 106，用于放大所要发送的射频信号。其中收发信机 105 又包括：IQ 调制/解调器 107、滤波器 108、数模/模数转换器 109 和射频器 110。

上述现有宏基站发送数据的过程为：基带数据处理器 103 将基带数据发送到扩频/解扩器 104 进行扩频，扩频后的基带数据发送到射频单元 102，在射频单元 102 中，该基带数据先经过 IQ 调制/解调器 107 调制，之后发送到滤波器 108 中进行滤波，再由数模/模数转换器 109 转换为模拟信号，该模拟信号经射频器 110 射频，并通过功率放大器 106 放大后，由天线 111 发送出去。

上述现有宏基站接收数据的过程为：天线 111 接收到的信号直接进入射频器 110 进行射频处理，再由数模/模数转换器 109 转换为数据信号，经滤波器 108 滤波后由 IQ 调制/解调器 107 进行解调，解调信号发送到基带单元 101 的扩频/

解扩器 104 进行解扩，解扩后的数据送到基带数据处理器中进行处理。

由于上述现有技术的宏基站中，基带单元 101 和射频单元 102 之间通过电缆连接，且由于电缆传输信号的衰减特性，使得基带单元 101 和射频单元 102 不能相隔太远，因此目前业界一般将基带单元 101 和射频单元 102 放置在一起，导致宏基站占用较大的机房面积。参见图 2，现有的组网需在每个站址都要放置宏基站，并采用蜂窝结构覆盖整个需要覆盖的通讯区域。因此该宏基站所占空间较大，需要专门的机房和天线用地，不但用地成本高，而且目前机房资源相当匮乏，寻找机房的难度大。另外，由于一个基带单元只能配合一个射频单元，因此现有的宏基站无法对基带单元进行集中管理，处理效率低下。

发明内容

有鉴于此，本发明的主要目的是提供一种无线基站系统，能对基站的基带单元进行集中管理，使射频单元分布式覆盖通讯区域，节省成本，提高处理效率。

本发明的另一目的是提供上述无线基站系统发射和接收信息的方法，同样能对基站的基带单元进行集中管理，使射频单元分布式覆盖通讯区域，节省成本，提高处理效率。

为了实现上述目的，本发明的技术方案为：

一种无线基站系统，该系统包括：至少一个基带单元，以及至少一个射频远端单元；所述基带单元集中设置；所述每个基带单元和射频远端单元中分别包括至少一个用于光/电信号互换的光接口；利用各自的光接口，基带单元与射频远端单元通过光纤连接。

作为本发明所述无线基站系统的一种优选方案，所述基带单元中包括多个光接口，每一个光接口通过光纤分别与不同的射频远端单元连接。

作为本发明所述无线基站系统的另一优选方案，多个所述射频远端单元通过光纤级联，且其中至少一个射频远端单元通过光纤与所述基带单元的光接口连接。

所述基带单元和射频远端单元中分别进一步包括通用公共无线接口 CPRI 逻辑单元，用于对数据进行 CPRI 格式转换和解析；

所述基带单元中的 CPRI 逻辑单元将需发送给射频远端单元的数据转换为 CPRI 格式，添加到 CPRI 数据帧中发送给基带单元的光接口，并接收基带单元的光接口收到的射频远端单元发来的数据进行解析；

射频远端单元中的 CPRI 逻辑单元接收射频远端单元的光接口收到的来自基带单元的数据，解析出自身需要的数据，并将从外界接收的数据转换为 CPRI 格式插入到 CPRI 数据帧，发送至射频远端单元的光接口。

作为本发明所述无线基站系统的再一优选方案，所述每一个射频远端单元与一个基带单元连接，且所有的基带单元集中设置在一个基带设备中。

一种无线基站系统发射信息的方法，所述无线基站系统包括至少一个基带单元和射频远端单元，基带单元集中设置，并且通过光纤与射频远端单元连接；

该方法包括：

A、基带单元将需发送给射频远端单元的电信号转换为光信号，根据预先设置的每个射频远端单元与其自身信号的对应关系将所述光信号发送给对应的射频远端单元；

B、射频远端单元收到光信号后，将光信号转换为电信号，进行信息发射处理。

作为上述无线基站系统发射信息方法的一种优选方案，所述对应关系为每一个射频远端单元对应基带单元中的一个光接口；

步骤 A 所述信号发送过程为：基带单元将需发送给射频远端单元的信号发送至自身中与该射频远端单元对应的光接口。

作为上述无线基站系统发射信息方法的又一种优选方案，所述基带单元和射频远端单元之间的传输信号为数据帧的形式，所述对应关系为每个射频远端模块对应数据帧中的一个时隙，

步骤 A 所述信号发送过程为：基带单元将需发送给射频远端单元的数据置

于数据帧的对应时隙中，并转换为光信号后向射频远端单元发送；

步骤 B 中所述射频远端单元将接收到的光信号转换为电信号后进一步包括：从数据帧形式的电信号中读出自身对应时隙的数据，进行信息发射处理。

所述数据帧符合通用公共无线接口格式。

一种无线基站系统接收信息的方法，所述无线基站系统包括至少一个基带单元和射频远端单元，基带单元集中设置，并且通过光纤与射频远端单元连接；

该方法包括：

a、射频远端单元对从外界接收的信息进行射频处理后，将电信号转化为光信号，向基带单元发送；

b、基带单元收到光信号后，将光信号转化为电信号，并根据预先设置的每个射频远端单元与其自身信号的对应关系确定每个信号对应的射频远端单元，进行基带处理。

作为上述无线基站系统接收信息方法的一种优选方案，所述对应关系为每一个射频远端单元对应基带单元中的一个光接口；

步骤 b 中所述确定过程为：基带单元根据收到每个光信号的光接口确定每个信号对应的射频远端单元。

作为上述无线基站系统接收信息方法的一种优选方案，所述基带单元和射频远端单元之间的传输信号为数据帧的形式，所述对应关系为每个射频远端模块对应数据帧中的一个时隙；

步骤 a 中所述射频远端单元对从外界接收的信息进行射频处理后进一步包括：将得到的数据添加到数据帧与该射频远端单元对应的时隙中；

步骤 b 中所述确定过程为：基带单元根据数据帧中各时隙与射频远端单元的对应关系获知每个时隙中的数据所对应的射频远端单元。

所述数据帧符合通用公共无线接口格式。

由于本发明采用光接口和光纤连接基带单元和射频单元，利用光纤远距离传输信号的优点，使得基带单元和射频单元从一个设备中分离，射频单元可以

放置在距基带单元十几公里、甚至几十公里之外，因此可以用射频单元进行分布式覆盖，即在组网中的每个站址只要放置室外的、且用地面积较小的射频单元和天线既可覆盖通讯区域，从而解决了机房资源匮乏问题，降低了用地成本；同时，射频单元对应的多个基带单元可放置在一个中心机房的设备中，全部的运行维护可以在该设备中集中进行，不但提高了维护处理效率，并且节省了大量的机房资源和维护工作量。

另外，本发明可利用现有的丰富的光纤资源连接基带单元和射频单元，投入成本低。

附图说明

图 1 为现有宏基站的结构示意图；

图 2 为现有技术利用宏基站覆盖通讯区域的组网示意图；

图 3 为本发明实施例所述无线基站系统的结构示意图；

图 4 为利用本发明实施例所述无线基站系统覆盖通讯区域的组网示意图；

图 4A 为所示本发明实施例所述基带柜的结构示意图；

图 5 为本发明实施例所述基带单元与射频远端单元通过星形方式组网的示意图；

图 6 为本发明实施例所述基带单元与射频远端单元通过级联方式组网的示意图；

图 7 为本发明实施例所述采用星形方式组网的无线基站系统发送信息的流程图；

图 8 为本发明实施例所述采用星形方式组网的无线基站系统接收信息的流程图；

图 9 为本发明实施例所述采用级联方式组网的无线基站系统发送信息的流程图；

图 10 为本发明实施例所述采用级联方式组网的无线基站系统接收信息

的流程图。

具体实施方式

下面结合附图和具体实施例进一步说明本发明的实施方法。

参见图 3，本实施例所述的无线基站系统中包括：基带单元 201 和射频单元 202，它们之间通过光纤连接，由于本实施例的射频单元 202 放置在基带单元 201 的远端，因此以下将射频单元 202 称为射频远端单元 202。其中，基带单元 201 又包括：基带数据处理器 103，用于处理基带数据；扩频/解扩器 104，用于对发送的基带数据进行扩频，对收到的射频数据进行解扩；至少一个光接口 203，用于将基带单元产生的电信号转化为可由光纤传输的光信号，并将来自射频远端单元 202 的光信号转化为可供基带单元处理的电信号。射频远端单元 202 又包括：至少一个光接口 203，用于将接收到的光信号转化为电信号，并将发送的电信号转化为光信号；收发信机 105，用于发送和接收射频信号；功率放大器 106，用于放大所要发送的射频信号。其中收发信机 105 又包括：IQ 调制/解调器 107、滤波器 108、数模/模数转换器 109 和射频器 110，由于所述收发信机的组成部分和工作原理为现有公知技术，此处不再详述。

本实施例所述的基站系统中包括至少一个基带单元 201，每个基带单元 201 分别对应至少一个不同的射频远端单元 202，每个射频远端单元 202 通过光接口和光纤与基带单元 201 相连，该基带单元 202 对不同射频远端单元的数据进行集中处理，而射频远端单元 202 可以通过光纤拉远到十几甚至几十公里外的远端，且由于体积较小，可以分步拉远放置在各个覆盖通讯小区中，不必设置专用的机房，既满足了覆盖小区的目的，又节省了机房资源。

参见图 4，鉴于本实施例的上述特点，本实施例可充分利用运营商已有的丰富的光纤资源，采用射频远端单元 202 对通讯区域进行分布式覆盖，在网络规划的站址处只需要放置室外的射频远端单元 202 和天线，替代现有的宏基站，不需要租用机房，从而解决了机房占地的问题；同时，考虑到射频单元部分已经通过光纤拉远，如果无线基站系统中有多个基带单元，可将多个基带单元集

中装置在本地的一个基带柜 401 里，该基带柜可以放置在一个中心机房中，各个站点的射频远端单元可通过运营商的光纤资源连接到一个中心机房的基带柜 401 上；全部的运行维护可以在该基带柜 401 侧进行，节省了大量的机房资源并降低维护的工作量。

图 4A 所示为基带柜 401 的结构示意图，参见图 4A，该基带柜 401 为分层结构，所述无线基站系统中的多个基带单元 201 分别放置在该基带柜 401 的各层上，该多个基带单元 201 的运行维护都在该基带柜 401 中集中进行。

在本实施例所述的无线基站系统中，基带单元 201 和射频远端单元 202 之间通过光纤连接组网主要基于两种基本的方式，一种为星形组网方式，另一种为级联组网方式。

图 5 为基带单元 201 与射频远端单元 202 通过星形方式组网的示意图。如图 5 所示：

所述基站系统中的一个基带单元 201 包括多个光接口 203，每一个光接口 203 连接一对光纤，每个光接口 203 通过一对光纤连接一个射频远端单元，且每个光接口 203 固定对应一个射频远端单元，该固定关系可以预先设定。这样，一个基带单元就可根据该光接口 203 的标识辨别出所接收的是哪一个射频远端单元的数据，以及向一射频远端单元发送的数据应该通过哪一个光接口 203 发送出去。

图 6 为基带单元 201 与射频远端单元 202 通过级联方式组网的示意图，如图 6 所示：所述基站系统中的一个基带单元 201 包括至少一个光接口 203，每个光接口 203 连接一对光纤，一对光纤可以支持级联至少一个射频远端单元 202。一对光纤所支持的射频远端单元 202 数与实际应用设计有关，一般来说，一对光纤可以最多支持 4 个射频拉远单元的信息，多个射频远端单元 202 可以通过级联的形式连接，即：与基带单元 201 最近的射频远端单元 202 通过光纤与基带单元 201 直接相连，其他射频远端单元 202 通过光纤一一级联；中间射频远端单元 202 都具有两个光接口 203，其中一个光接口 203 与基带单元 201

或上一级射频远端单元202连接，另一个光接口203与下一级射频远端单元202连接；最远端的射频远端单元202可设置一个光接口203。另外，所述级联在基带单元201上的射频远端单元202可根据地域等条件划分不同的组，不同组的射频远端单元202，级联在基带单元201的不同光接口203上；同一组的射频远端单元202级联在基带单元201的同一光接口203，且预先设定射频远端单元202所对应的基带单元201的光接口203，因此，属于同一组射频远端单元的数据可通过同一个光接口203发送。

如图6所示，在级联组网的方式中，为了使基带单元201通过一个光接口203连接多个射频远端单元202，需要在基带单元201和射频远端单元202中增加通用公共无线接口（CPRI）逻辑单元204，该CPRI逻辑单元204可以为CPRI逻辑芯片，用于将发送的数据转换为CPRI格式的数据帧，及解析接收到的CPRI格式的数据帧。所述CPRI为一种标准接口，本实施例中，每个射频远端单元202的数据位于该CPRI数据帧中的固定时隙中，且每个射频远端单元202与CPRI数据帧中的各个时隙的对应关系预先设定。发送数据时，CPRI逻辑单元将各个射频远端单元202的数据分别置于CPRI数据帧的对应的时隙中；接收数据时，CPRI逻辑单元再将CPRI数据帧各个时隙中的数据取出来，从而对应获取各个射频远端单元202的数据。

图7为本实施例所述采用星形方式组网的无线基站系统发射信息的流程图，参见图5和图7，该发射信息的流程包括：

步骤701、基带数据处理器将发送到各个射频远端单元202的数据传输到扩频/解扩单元进行扩频，并根据预先设定的各个光接口203与各个射频远端单元202的对应关系，将发送到各个射频远端单元202的数据发送到各个射频远端单元202所对应的光接口203。

步骤702、基带单元201中接收到发送数据的光接口203将电信号数据转化为光信号数据，通过光纤发送到与该光接口203对应连接的射频远端单元202。

步骤 703、射频远端单元 202 的光接口 203 接收到光信号数据后，将该光信号数据转化为电信号数据，将该电信号数据经过收发信机处理成射频信号，并经过功率放大器 106 放大后，通过天线 111 发射出去。

图 8 为本实施例所述采用星形方式组网的无线基站系统接收信息的流程图，如图 5 和图 8 所示，该接收信号的流程包括:

步骤 801、射频远端单元 202 通过天线 111 接收到射频信号，通过收发信机 105 转化为电信号数据后，经光接口 203 转化为光信号数据，并通过光纤将该光信号数据发送到基带单元 201 对应的光接口 203。

步骤 802、基带单元 201 的光接口 203 收到光信号数据后，将该光信号数据转化为电信号数据，并通过扩频/解扩器 104 解扩后，发送到基带数据处理器 103。

步骤 803、基带数据处理器 103 判断接收的数据来自哪一个光接口 203，根据预先设定的该光接口 203 与射频远端单元 202 的对应关系，获知所接收到的数据信号来自哪一个射频远端单元 202，并进行相应的数据处理。

图 9 为本实施例所述采用级联方式组网的无线基站系统发射信息的流程图，参见图 6 和图 9，该流程包括以下步骤:

步骤 901、基带数据处理器 103 将发送到各个射频远端单元 202 的数据传输到扩频/解扩器 104 进行扩频。

步骤 902、基带单元 201 中的 CPRI 逻辑芯片 204 将发送的数据转化为 CPRI 格式的数据帧；在 CPRI 格式的数据帧中，发向不同射频远端单元 202 的数据分别位于数据帧中不同的时隙，且每个射频远端单元 202 的数据在数据帧中所对应的时隙位置相对固定，并将转化后的数据帧传送给光接口 203。

在本步骤中，由于对于不同组的射频远端单元 202，连接在基带单元 201 的不同光接口 203，同一组的射频远端单元 202 连接在基带单元 201 的同一光接口 203。因此根据组与光接口的对应关系，属于同一组射频远端单元 202 的数据在转化为 CPRI 数据帧后，通过同一个光接口 203 发送；属于不同组射频

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远端单元 202 的数据转化为 CPRI 数据帧后，通过不同的光接口 203 发送。

步骤 903、基带单元 201 的光接口 203 将需发送的电信号数据帧转化为光信号数据帧，并通过光纤将光信号数据帧发送到与基带单元 201 直接相连的射频远端单元 202，将该射频远端单元 202 作为当前射频远端单元 202。

步骤 904、当前射频远端单元 202 的光接口 203 接收到所要发送的光信号数据帧后，将该光信号数据帧转化为电信号数据帧，之后当前射频远端单元 202 的 CPRI 逻辑单元 204 解析该电信号数据帧，即判断该电信号数据帧中与该当前射频远端单元 202 对应的时隙有无数据，如果有，则读取该数据，将读取到的数据通过收发信机 105 和功率放大器 106 处理后，由天线发射出去，执行下一步骤；否则，执行下一步骤。

步骤 905、当前射频远端单元 202 判断所述电信号数据帧的其它时隙中是否有数据，如果有，则说明该电信号数据帧中还有其它射频远端单元 202 的数据，执行步骤 906，否则，则说明所述电信号数据帧中没有其他射频远端单元 202 的数据，因此结束发射流程。

由于组网结构相对固定，一个光接口 203 上级联几个射频远端单元 202 以及射频远端单元 202 的连接顺序预先已经设置固定，因此，本步骤也可替换为：当前射频远端单元 202 判断自身是否为级联关系中的末级射频远端单元 202，如果是，则执行步骤 906，否则，结束发送流程。

步骤 906、当前射频远端单元 202 不对电信号数据帧中其它时隙的数据进行任何改动，利用与下一级射频远端单元 202 相连的光接口 203 将该电信号数据帧转化为光信号数据帧，并通过光纤继续向下一级射频远端单元 202 转发该光信号数据帧，此时该下一级射频远端单元 202 为当前射频远端单元 202，返回步骤 904。

图 10 为本实施例所述采用级联方式组网的无线基站系统接收信息的流程图，参见图 6 和图 10，该接收信号的流程包括以下步骤：

步骤 1001、射频远端单元 202 将天线接收到的信息通过收发信机 105 进行

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射频处理。

步骤 1002、射频远端单元 202 判断是否收到下一级射频远端单元 202 发送的符合 CPRI 格式的光信号数据帧，如果是，则执行步骤 1003，否则执行步骤 1004。

步骤 1003、射频远端单元 202 利用光接口 203 将收到的光信号数据帧转化为电信号数据帧，并将自身收到的信息通过 CPRI 逻辑单元 204 添加到该电信号数据帧中对应的时隙中，再将添加信息后的电信号数据帧通过光接口 203 转化为光信号数据帧，执行步骤 1005。

步骤 1004、射频远端单元 202 将自身收到的信息通过 CPRI 逻辑单元 204 转化为符合 CPRI 格式的电信号数据帧，并通过光接口 203 将该电信号数据帧转化为光信号数据帧，执行步骤 105。

步骤 1005、射频远端单元 202 通过光接口 203 和光纤将光信号数据帧发送到与该射频远端单元 202 直接连接的上一级射频远端单元 202 或者基带单元 201。

步骤 1006、基带单元 201 的光接口 203 接收到光信号数据帧后，将该光信号数据帧转化为电信号数据帧，再通过 CPRI 逻辑芯片 204 解析该电信号数据帧，即将该电信号数据帧中各个时隙中的数据取出，并将各个时隙取出的数据作为该时隙对应的射频远端单元 202 的数据，经扩频/解扩器 104 解扩后，由基带数据处理器 103 进行处理。

上述分别介绍了采用星形方式组网和采用级联方式组网时，本发明所述无线基站系统的结构和收发信息的流程。基于上述两种组网方式，本发明也可灵活设置不同的组网方式，例如采用星形和级联相混合的方式组网，同样可以达到本发明的目的，其收发信息的流程分别与上述的流程相同或相似。

以上所述，仅为本发明较佳的具体实施方式，但本发明的保护范围并不局限于此，任何熟悉该技术的人在本发明所揭露的技术范围内，可轻易想到的变化或替换，都应涵盖在本发明的保护范围之内。

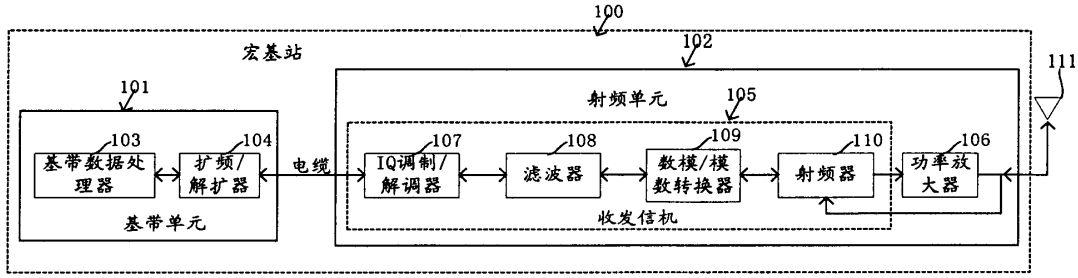

100
宏基站
102
111
101
射频单元
105
103
104
107
108
109
110
106
基带数据处理器
扩频/解扩器
电缆
IQ调制/解调器
滤波器
数模/模数转换器
射频器
功率放大器
基带单元
收发信机

图 1

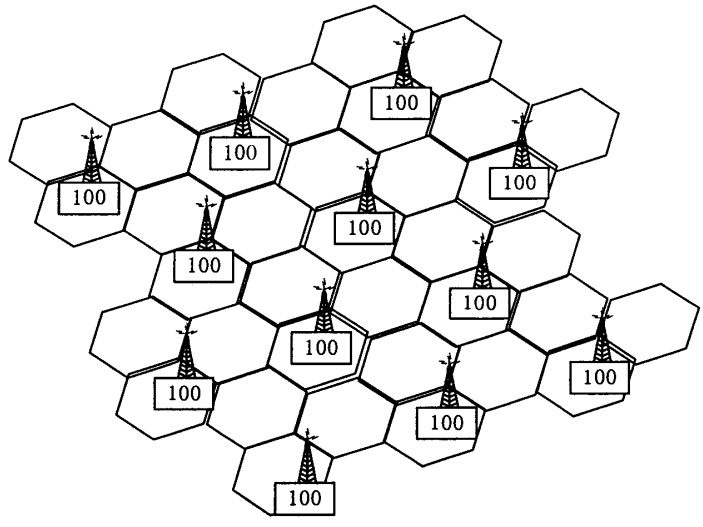

100

图 2

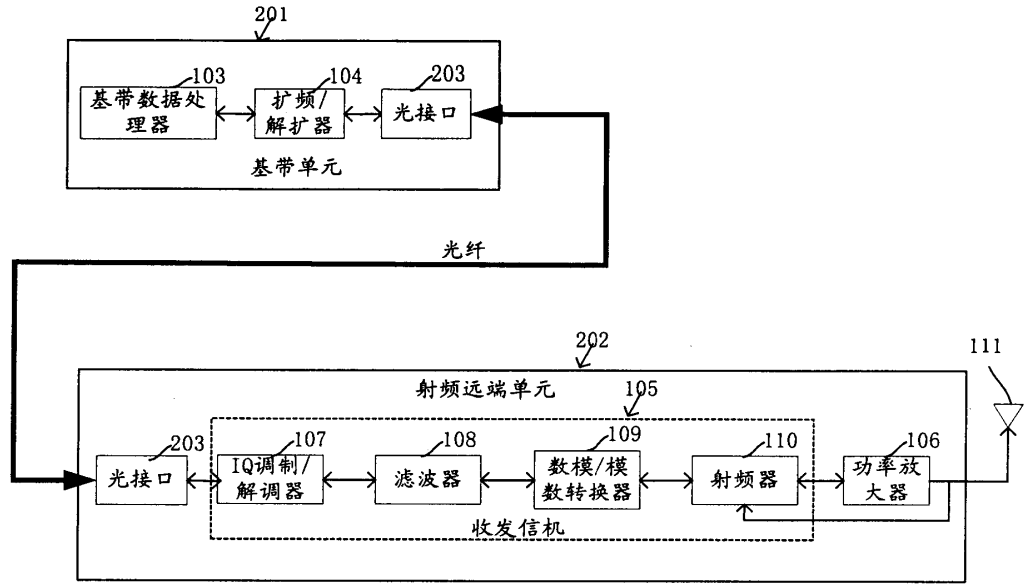

201
103
104
203
基带数据处理器
扩频/解扩器
光接口
基带单元
光纤
202
111
射频远端单元
105
203
107
108
109
110
106
光接口
IQ调制/解调器
滤波器
数模/模数转换器
射频器
功率放大器
收发信机

图 3

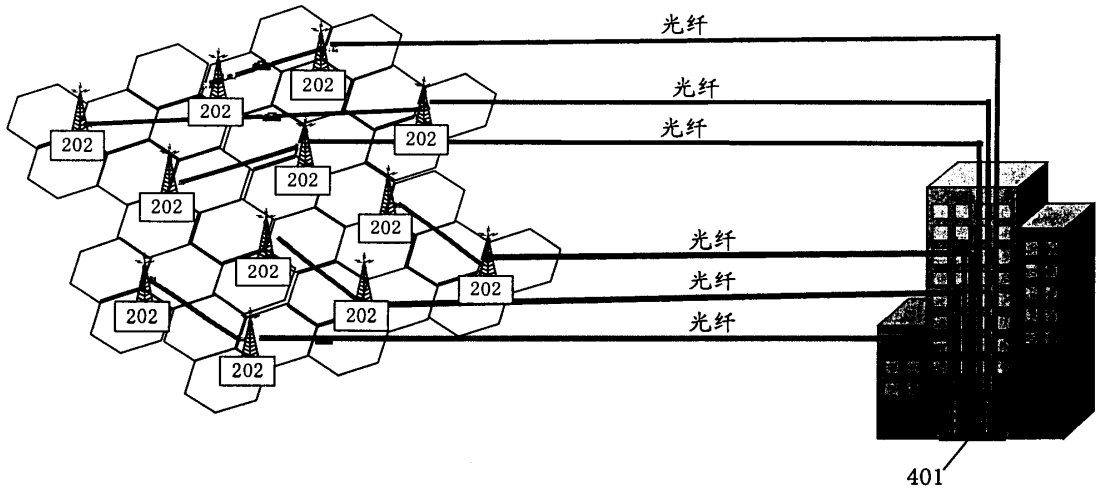

光纤
光纤
光纤
光纤
光纤
光纤
202
401

图 4

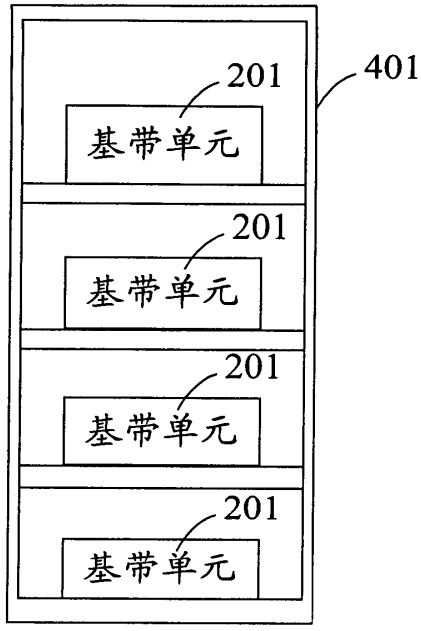

401
201
基带单元
201
基带单元
201
基带单元
201
基带单元

图 4A

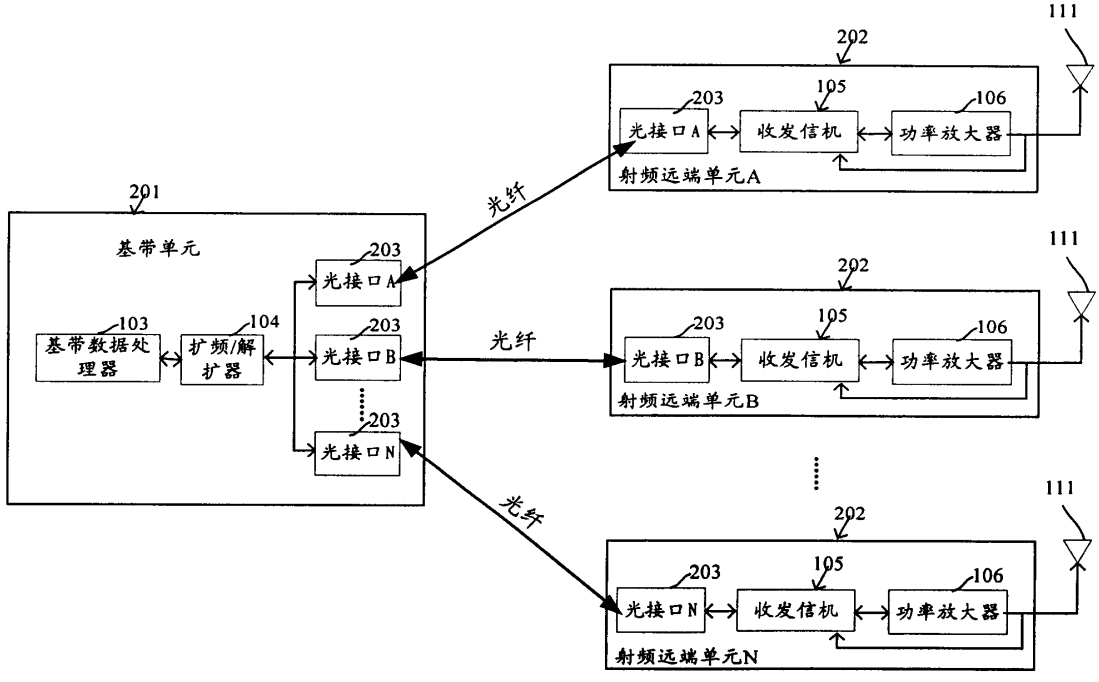

111
202
203
105
106
光接口A
收发信机
功率放大器
射频远端单元A
光纤
201
基带单元
203
光接口A
103
基带数据处理器
104
扩频/解扩器
203
光接口B
光纤
203
光接口N
111
202
203
105
106
光接口B
收发信机
功率放大器
射频远端单元B
光纤
111
202
203
105
106
光接口N
收发信机
功率放大器
射频远端单元N

图 5

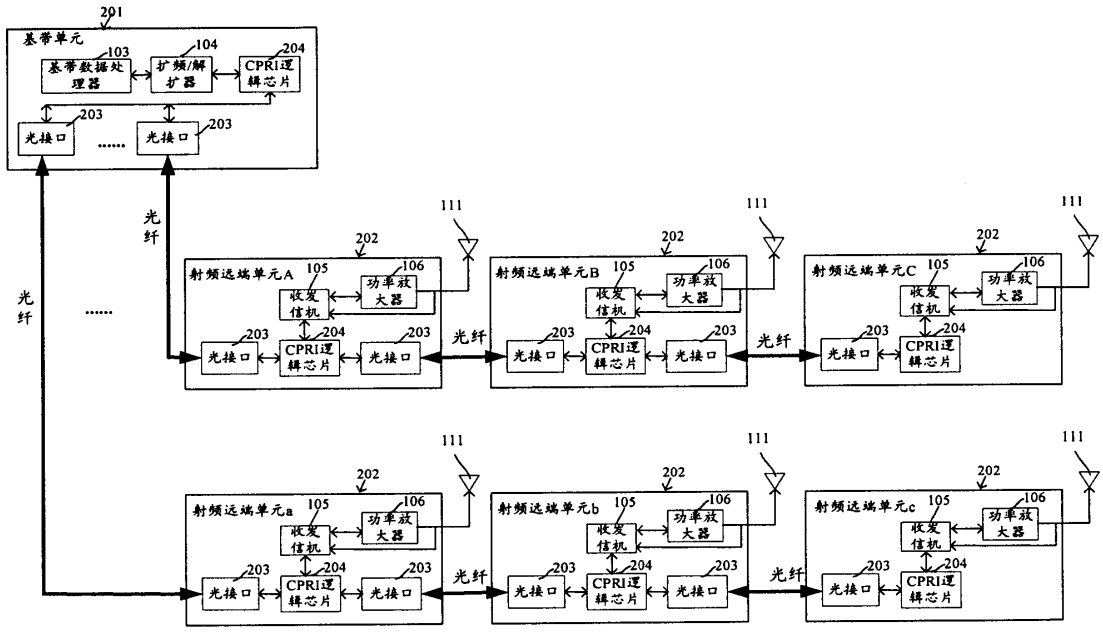

201
基带单元
103
基带数据处理器
104
扩频/解扩器
204
CPRI逻辑芯片
203
光接口
光接口
光纤
光纤
111
202
射频远端单元A
105
收发信机
106
功率放大器
CPRI逻辑芯片
光纤
射频远端单元B
光纤
射频远端单元C
射频远端单元a
射频远端单元b
射频远端单元c

图 6

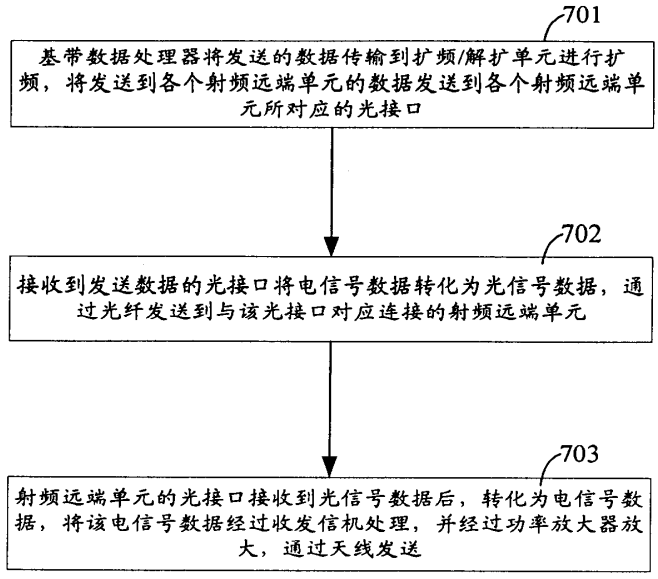

701
基带数据处理器将发送的数据传输到扩频/解扩单元进行扩频，将发送到各个射频远端单元的数据发送到各个射频远端单元所对应的光接口
702
接收到发送数据的光接口将电信号数据转化为光信号数据，通过光纤发送到与该光接口对应连接的射频远端单元
703
射频远端单元的光接口接收到光信号数据后，转化为电信号数据，将该电信号数据经过收发信机处理，并经过功率放大器放大，通过天线发送

图 7

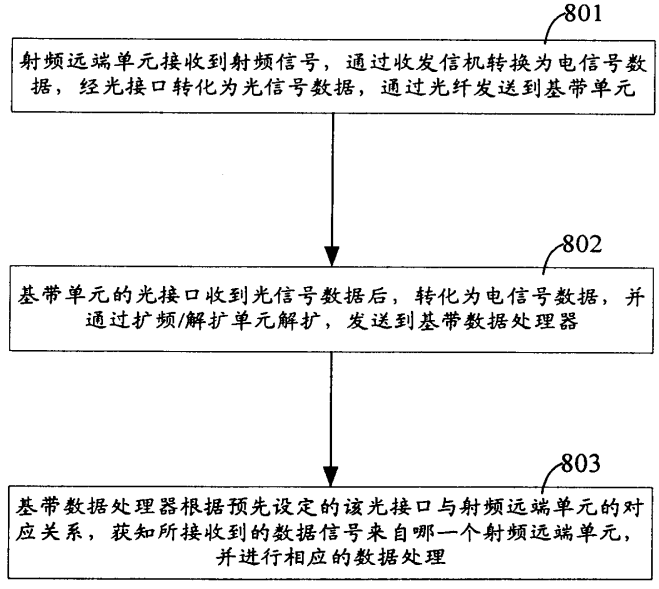

801
射频远端单元接收到射频信号，通过收发信机转换为电信号数据，经光接口转化为光信号数据，通过光纤发送到基带单元
802
基带单元的光接口收到光信号数据后，转化为电信号数据，并通过扩频/解扩单元解扩，发送到基带数据处理器
803
基带数据处理器根据预先设定的该光接口与射频远端单元的对应关系，获知所接收到的数据信号来自哪一个射频远端单元，并进行相应的数据处理

图 8

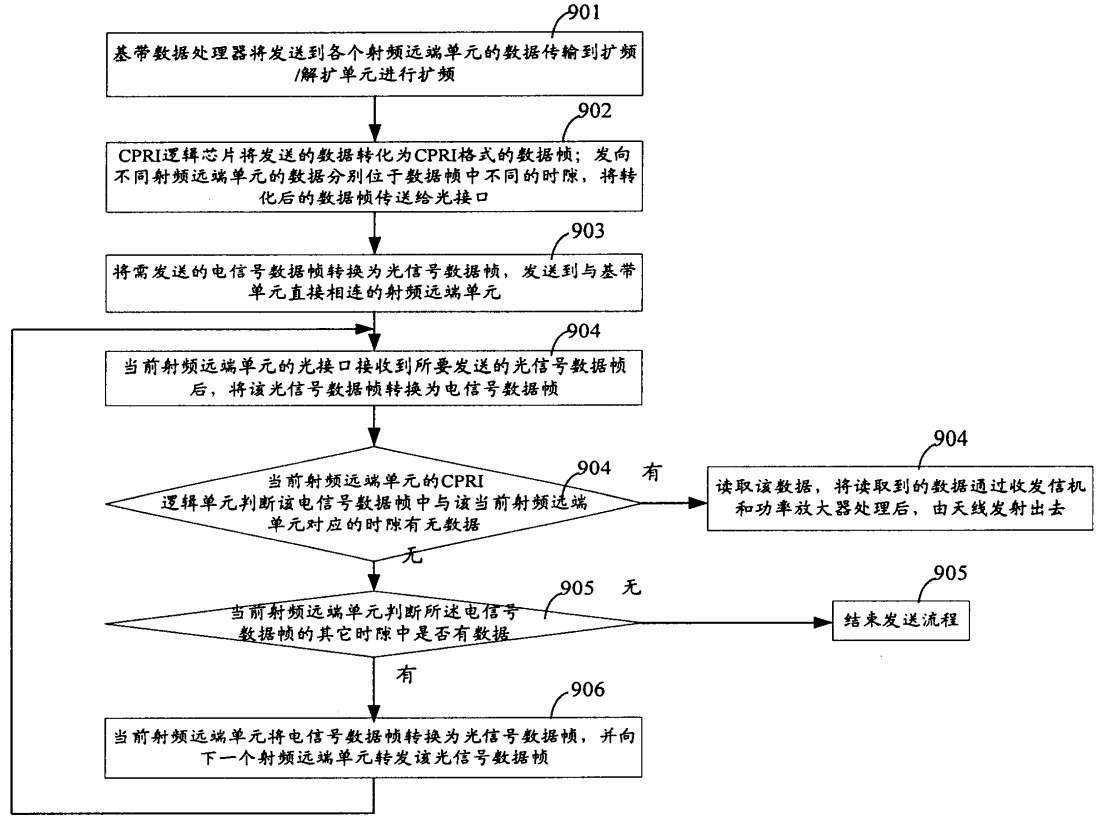

901
基带数据处理器将发送到各个射频远端单元的数据传输到扩频/解扩单元进行扩频
902
CPRI逻辑芯片将发送的数据转化为CPRI格式的数据帧；发向不同射频远端单元的数据分别位于数据帧中不同的时隙，将转化后的数据帧传送给光接口
903
将需发送的电信号数据帧转换为光信号数据帧，发送到与基带单元直接相连的射频远端单元
904
当前射频远端单元的光接口接收到所要发送的光信号数据帧后，将该光信号数据帧转换为电信号数据帧
904
当前射频远端单元的CPRI逻辑单元判断该电信号数据帧中与该当前射频远端单元对应的时隙有无数据
有
904
读取该数据，将读取到的数据通过收发信机和功率放大器处理后，由天线发射出去
无
905
当前射频远端单元判断所述电信号数据帧的其它时隙中是否有数据
无
905
结束发送流程
有
906
当前射频远端单元将电信号数据帧转换为光信号数据帧，并向下一个射频远端单元转发该光信号数据帧

图 9

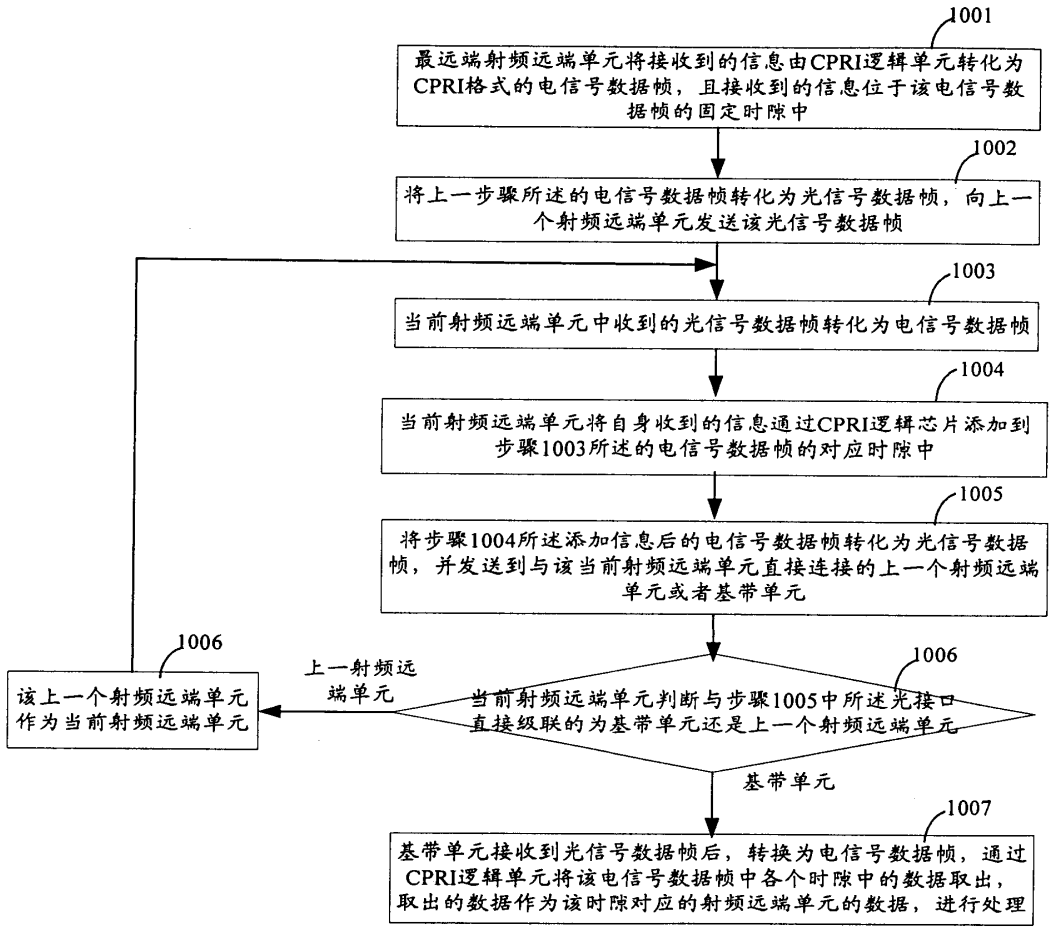

1001
最远端射频远端单元将接收到的信息由CPRI逻辑单元转化为CPRI格式的电信号数据帧，且接收到的信息位于该电信号数据帧的固定时隙中
1002
将上一步骤所述的电信号数据帧转化为光信号数据帧，向上一个射频远端单元发送该光信号数据帧
1003
当前射频远端单元中收到的光信号数据帧转化为电信号数据帧
1004
当前射频远端单元将自身收到的信息通过CPRI逻辑芯片添加到步骤1003所述的电信号数据帧的对应时隙中
1005
将步骤1004所述添加信息后的电信号数据帧转化为光信号数据帧，并发送到与该当前射频远端单元直接连接的上一个射频远端单元或者基带单元
1006
当前射频远端单元判断与步骤1005中所述光接口直接级联的为基带单元还是上一个射频远端单元
上一射频远端单元
1006
该上一个射频远端单元作为当前射频远端单元
基带单元
1007
基带单元接收到光信号数据帧后，转换为电信号数据帧，通过CPRI逻辑单元将该电信号数据帧中各个时隙中的数据取出，取出的数据作为该时隙对应的射频远端单元的数据，进行处理

图 10

Espacenet

Bibliographic data: CN101621806 (A) — 2010-01-06

Intelligent carrier scheduling method applied to GSM network

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Applicant(s): COMBA TELECOM SYSTEM HOLDINGS ± (COMBA TELECOM SYSTEM HOLDINGS LTD)

Classification: **- international:** ***H04W16/06***
- cooperative:

Application number: CN2008129255 20080704

Priority number(s): CN2008129255 20080704

Also published as: CN101621806 (B)

Abstract of CN101621806 (A)

The invention provides an intelligent carrier scheduling method applied to a GSM network, which comprises the following steps that: a monitoring host computer of a radio frequency zooming unit acquires the original telephone traffic data counted by an FPGA chip through a digital board slave machine and converts the original telephone traffic data into standard telephone traffic data; and according to the requirements of the practical engineering application, a scheduling policy in a carrier-supported mode or a carrier standby mode is correspondingly adopted for a target cell so as to achieve the carrier intelligent scheduling.; The method provides a policy of solving the intelligent carrier scheduling, automatically schedules carrier resources on the basis of network telephone traffic bearing conditions by setting correlative parameters for GSM mobile communication network optimization equipment (such as GRRU), and solves the problems of peak congestion of the telephone traffic, idle trough resources and the like, namely solving the problem that the wireless resources of the GSM network are distributed asymmetrically in the aspects of time and space.

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04W 16/06 (2009.01)
H04W 72/12 (2009.01)
H04W 88/08 (2009.01)

[12] 发明专利申请公布说明书

[21] 申请号 200810029255.5

[43] 公开日 2010 年 1 月 6 日

[11] 公开号 CN 101621806A

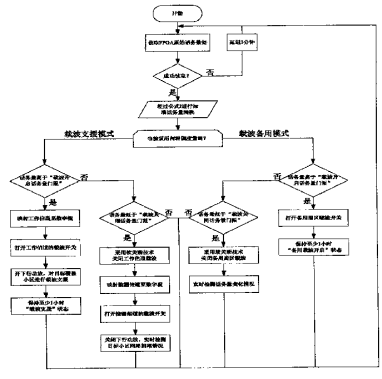
[22] 申请日 2008.7.4
[21] 申请号 200810029255.5
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权利要求书 2 页 说明书 8 页 附图 6 页

[54] 发明名称

应用于 GSM 网络的智能化载波调度方法

[57] 摘要

本发明提供应用于 GSM 网络的智能化载波调度方法，是指射频拉远单元的监控主机通过数字板从机获取 FPGA 芯片统计的原始话务量数据，并转换为标准话务量数据，根据实际工程应用的需要，对目标小区相应采用载波支援模式或者载波备用模式的调度策略，从而实现载波智能调度。 本发明提出一种解决智能化载波调度策略，通过设置 GSM 移动通信网络优化设备(如 GRRU)的相关参数，以网络话务承载情况为依据，自动调配载波资源，解决话务量高峰拥塞、低谷资源空闲等问题，即解决了 GSM 网络无线资源在时间、空间分布不平衡的问题。



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1、应用于GSM网络的智能化载波调度方法，其特征在于包括以下步骤：射频拉远单元的监控主机通过数字板从机获取FPGA芯片统计的原始话务量数据，并转换为标准话务量数据，根据实际工程应用的需要，对目标小区相应采用载波支援模式或者载波备用模式的调度策略，从而实现载波智能调度；

采用载波支援模式时，具体步骤为：

首先判断目标小区的相邻小区的上行标准话务量数据是否高于载波开启话务量门限，如果是，则采用动态信道映射方法映射工作信道至数字板，打开工作信道的载波开关，开下行功放，对目标小区覆盖区域进行载波支援，并保持上、下行功放打开至少持续一小时；继续检测目标小区上行话务量；

如果相邻小区承载的工作信道上行标准话务量数据低于载波关闭话务量门限，则采用软关断方法关闭工作信道载波，采用动态信道映射方法映射检测信道至数字板，打开检测通道的载波开关，关闭下行功放，并实时检测目标小区上行话务量；

采用载波备用模式时，具体步骤为：

首先判断目标小区标准话务量数据是否高于载波开启话务量门限，如果是，则打开主扇区的备用扇区载波开关，保持备用载波开启状态至少一小时，继续检测目标小区话务量；

如果目标小区标准话务量数据低于载波开启话务量门限，采用软关断技术关闭备用扇区的载波，并实时检测目标小区话务量。

2、根据权利要求1所述应用于GSM网络的智能化载波调度方法，其特征在于：所述原始话务量采样数据转换为标准话务量数据的公式为：b=(a/N)*8，其中：原始采样数据为a，a的单位为chips，标准话务量数据为b，b的单位为Erlang，N为采样比例常数，N＝5760000，单位为:chips/Erlang。

3、根据权利要求1所述应用于GSM网络的智能化载波调度方法，其特征在于：所述动态信道映射方法是指：DRU设备的物理信道列表中共设有N个物理信道，在检测目标小区的相邻小区上行话务量时，监控主机控制其映射选择器将检测信道组中的1～N个检测信道编号设置为工作信道，并写入物理信道组，以此来实现对目标小区的相邻小区承载话务量情况的检测；在进行载波支援时，监控主机将其对应的DAU信道编号列表设置为工作信道，并写入物理信道

组，实现数字接入单元的信源拉远覆盖的目的；

监控主机中分别保存DAU信道列表和检测信道列表，物理信道列表保存在数字板从机中；在不同的工作状态下，由监控主机控制映射选择器将DAU信道列表或检测信道列表设置入数字板从机后，则可以实现不同的工作状态，进而实现动态的载波信号映射。

4、根据权利要求1所述应用于GSM网络的智能化载波调度方法，其特征在于：所述软关断方法是指：在一台GRRU设备覆盖端机即射频拉远单元中，在保证主扇区载波下行功率不变的前提下，逐级、缓慢地降低备用扇区的一路或多路载波的下行功率，最后关断其信号，其由监控主机与数字板从机配合处理完成。

5、根据权利要求4所述应用于GSM网络的智能化载波调度方法，其特征在于：所述监控主机与数字板从机配合处理的具体步骤为：首先监控主机发送“启动载波软关断”命令至数字板从机，命令中指明需要软关断几路载波；数字板从机在收到该命令后，解析出软关断载波数量，然后设置关断循环计数器值为20；每隔5秒钟，数字板从机将指定载波功率衰减3dB，并将关断循环级数器进行减1处理；当该计数器值等于0时，逐级衰减工作完成，数字板从机发送“软关断结束”信息至监控主机；监控主机收到后，发送关闭相应载波开关命令到数字板从机；收到该命令后，数字板从机关闭其指定的载波通道，并回复监控主机“关断成功”，至此载波逐级关断功能完成。

应用于GSM网络的智能化载波调度方法

技术领域

本发明涉及一种无线网络资源调度技术的实现方法，具体是指应用于GSM网络的智能化载波调度方法。

背景技术

随着移动通信业务的高速发展，GSM网络话务量也在不断增加，用户对无线载波资源的要求，在空间、时间上存在着分布不平衡、不确定性。因此，有必要将基站扇区（BTS）的载波资源进行统一化、智能化调度，进而实现网络的优化分布，提高无线资源利用率。

目前，实现无线覆盖领域的载波调度主要依靠“载波池”产品实现，虽在一定程度上实现了无线资源跨区域、跨时段的优化调度，但是由于其核心技术还是基于模拟的“切换单元”实现，调度算法仅支持单一的“定时开关”方式，对于突发话务量的骤升现象缺少实时响应能力，因此在制造成本、设备维护及用户操作上都存在不足。

GRRU系列产品核心部件皆基于数字技术实现，易于通过软件控制载波开启、关断及频点配置，为智能载波调度技术提供了必要的硬件条件。同时GRRU产品覆盖端机（DRU）可以统计自身承载话务量，进而了解其覆盖区域GSM网络资源使用情况，为智能载波调度技术的相关算法提供了逻辑处理依据。

发明内容

本发明的目的在于克服上述现有技术的缺点和不足，提供应用于 GSM 网络的智能化载波调度方法，其可较好解决智能化载波调度策略，解决 GSM 网络无线资源在时间、空间分布不平衡的问题。

本发明的目的通过下述技术方案实现：本应用于GSM网络的智能化载波调度方法，其步骤包括：

射频拉远单元的监控主机通过数字板从机获取FPGA芯片统计的原始话务量数据，并转换为标准话务量数据，根据实际工程应用的需要，对目标小区相应采用载波支援模式或者载波备用模式的调度策略，从而实现载波智能

调度；

采用载波支援模式时，具体步骤为：

首先判断目标小区的相邻小区的上行标准话务量数据是否高于载波开启话务量门限，如果是，则采用动态信道映射方法映射工作信道至数字板，打开工作信道的载波开关，开下行功放，对目标小区覆盖区域进行载波支援，并保持上、下行功放打开至少持续一小时；继续检测目标小区上行话务量；

如果相邻小区承载的工作信道上行标准话务量数据低于载波关闭话务量门限，则采用软关断方法关闭工作信道载波，采用动态信道映射方法映射检测信道至数字板，打开检测通道的载波开关，关闭下行功放，并实时检测目标小区上行话务量；

采用载波备用模式时，具体步骤为：

首先判断目标小区标准话务量数据是否高于载波开启话务量门限，如果是，则打开主扇区的备用扇区载波开关，保持备用载波开启状态至少一小时，继续检测目标小区话务量；

如果目标小区标准话务量数据低于载波开启话务量门限，采用软关断技术关闭备用扇区的载波，并实时检测目标小区话务量。

为更好地实现本发明，所述原始话务量采样数据转换为标准话务量数据的公式为：b=(a/N)*8，其中：原始采样数据为a，a的单位为chips，标准话务量数据为b，b的单位为Erlang，N为采样比例常数，N＝5760000，单位为:chips/Erlang。

所述动态信道映射方法是指：DRU设备的物理信道列表中共设有N个物理信道，在检测目标小区的相邻小区上行话务量时，监控主机控制其映射选择器将检测信道组中的1～N个检测信道编号设置为工作信道，并写入物理信道组，以此来实现对目标小区的相邻小区承载话务量情况的检测；在进行载波支援时，监控主机将其对应的DAU信道编号列表设置为工作信道，并写入物理信道组，实现数字接入单元的信源拉远覆盖的目的；

监控主机中分别保存DAU信道列表和检测信道列表，物理信道列表保存在数字板从机中；在不同的工作状态下，由监控主机控制映射选择器将DAU信道列表或检测信道列表设置入数字板从机后，则可以实现不同的工作状态，进而实现动态的载波信号映射。

所述软关断方法是指：在一台GRRU设备覆盖端机即射频拉远单元中，

在保证主扇区载波下行功率不变的前提下，逐级、缓慢地降低备用扇区的一路或多路载波的下行功率，最后关断其信号，其由监控主机与数字板从机配合处理完成；

所述监控主机与数字板从机配合处理的具体步骤为：首先监控主机发送“启动载波软关断”命令至数字板从机，命令中指明需要软关断几路载波；数字板从机在收到该命令后，解析出软关断载波数量，然后设置关断循环计数器值为20；每隔5秒钟，数字板从机将指定载波功率衰减3dB，并将关断循环级数器进行减1处理；当该计数器值等于0时，逐级衰减工作完成，数字板从机发送“软关断结束”信息至监控主机；监控主机收到后，发送关闭相应载波开关命令到数字板从机；收到该命令后，数字板从机关闭其指定的载波通道，并回复监控主机“关断成功”，至此载波逐级关断功能完成。

本发明与现有技术相比，具有如下优点和有益效果：提出一种解决智能化载波调度策略，通过设置GSM移动通信网络优化设备（如GRRU）的相关参数，以网络话务承载情况为依据，自动调配载波资源，解决话务量高峰拥塞、低谷资源空闲等问题，即解决了GSM网络无线资源在时间、空间分布不平衡的问题。

附图说明

图1是本发明应用于GSM网络的智能化载波调度方法采用载波支援模式下行检测相邻小区话务量的工作原理图；

其中，101—光纤，102—射频拉远单元1（DRU），103—BTS1的4个载波（上下行），104—居民区，105—射频馈线，106—射频拉远单元2（DRU），107—BTS2的2个载波上行信号，108—BTS2的2个载波（上下行），109—BTS1载波信源，110—数字接入单元（DAU），111—射频拉远单元3（DRU），112—BTS1的4个载波（上下行），113—度假村，114—办公区，115—BTS2载波信源；

图2是本发明应用于GSM网络的智能化载波调度方法采用载波支援模式下行覆盖相邻小区的工作原理图；

其中，201—光纤，202—射频拉远单元1（DRU），203—BTS1的4个载波（上下行），204—居民区，205—射频馈线，206—射频拉远单元2（DRU），207—BTS1的4个载波（上下行），208—BTS2的2个载波（上下行），209—BTS1载波信源，210—数字接入单元（DAU），211—射频拉远单元3（DRU），

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212—BTS1的4个载波（上下行），213—度假村，214—办公区，215—BTS2载波信源；

图3是本发明应用于GSM网络的智能化载波调度方法采用载波备用模式工作原理；

其中，301—BTS1载波信源（主扇区），302—射频拉远单元1（DRU），303—BTS1的4个载波（上下行），304—居民区，305—合路单元，306—数字接入单元（DAU），307------射频拉远单元2（DRU），308—BTS2的2个载波（上下行），309—BTS1的4个载波（上下行），310—办公区，311—BTS2载波信源（备用扇区），312—射频拉远单元3（DRU），313—BTS2的2个载波（上下行），314—度假村，315—BTS1的4个载波（上下行）；

图4是实现本发明应用于GSM网络的智能化载波调度方法采用的射频拉远单元中监控主板和数字板的结构示意图；

其中，401—监控主机，402—RS-485主从机通信链路，403—数字板，404—数字板从机，405—从机查询FPGA，406—FPGA芯片，407—从机设置FPGA，408—从机设置增益，409—D/A芯片（GC5016）；

图5是本发明应用于GSM网络的智能化载波调度方法的工作流程图；

图6是本发明应用于GSM网络的智能化载波调度方法采用的软关断方法实现流程示意图；

图7是本发明应用于GSM网络的智能化载波调度方法采用的动态信道映射方法的实现流程示意图；

其中，701—DAU信道列表，702—监控主机控制软件，703—DAU信道组，704—检测信道组，705—映射选择器，706—物理信道组，707—物理信道列表，708—检测信道组；

图8是图6所示软关断方法的测试情况图。

具体实施方式

下面结合实施例及附图，对本发明作进一步地详细说明，但本发明的实施方式不限于此。

实施例一

如图 4 所示，给出了载波调度技术实现的各个功能模块组成。

如图4所示，本应用于GSM网络的智能化载波调度方法，在GRRU-1022R

结构中，主要通过401监控主机与403数字板协同完成，首先射频拉远单元的监控主机401通过数字板从机404获取FPGA芯片406统计的原始话务量数据，并转换为标准话务量数据：即数字板从机404经过链路405查询原始话务量采样数据，而后监控主机通过RS-485主从机通信链路402由404数字板从机间接获取FPGA芯片406统计的原始话务量数据，然后监控主机401进行话务数据处理、分析，最后由载波调度算法决定是否设置FPGA芯片406进行检测信道映射或通过数字板从机404设置D/A芯片409进行载波软关断等动作。以上动作由监控主机401下发命令，数字板从机404执行相关功能，最终完成载波智能调度。

如图5所示的公式I，即为原始话务量采样数据转换为标准话务量数据的公式：b=(a/N)*8，其中：原始采样数据为a，a的单位为chips，标准话务量数据为b，b的单位为Erlang，N为采样比例常数，N＝5760000，单位为:chips/Erlang。

根据实际工程应用的需要，对目标小区采用载波支援模式时，以三个不同小区覆盖为例，如图1所示，如果DRU106工作在该种模式下，DRU106首先不对办公区114进行下行信号覆盖，只开其相邻小区BTS2载波信源115的上行载波信道，检测BTS2的上行标准话务量数据107，进而可以了解办公区114中BTS2载波信源115的工作负荷；当该区域5分钟内上行标准话务量数据107高于载波开启话务量门限，则如图2所示，采用动态信道映射方法映射工作信道至数字板403，即远端机将信道切换到209BTS1信源（即工作在210DAU信道下），同时上下行同时打开并至少持续一个小时，用BTS1的4个载波（上下行）207对办公区214进行备用覆盖，以降低BTS2载波信源215的负荷，同时继续检测办公区214上行话务量；

如果BTS2载波信源115承载的工作信道上行标准话务量数据107低于载波关闭话务量门限，则采用软关断方法关闭工作信道载波，采用动态信道映射方法映射检测信道至数字板403，打开检测通道的载波开关，关闭下行功放，并实时检测办公区114上行话务量；

其中，如图7所示，所述动态信道映射方法是指：DRU设备的物理信道列表707中共设有N个物理信道，在检测办公区114的相邻小区BTS2载波信源115上行话务量时，监控主机401的控制软件702控制其映射选择器705将检测信道组704中的1～N个检测信道编号设置为工作信道，并写入物理信道组706，以

此来实现对办公区114的相邻小区BTS2载波信源115承载话务量情况的检测；在进行载波支援时，监控主机401将其对应的DAU信道703编号列表设置为工作信道，并写入物理信道组706，实现数字接入单元的信源拉远覆盖的目的；

监控主机401中分别保存DAU信道列表701和检测信道列表704，物理信道列表707保存在数字板从机404中；在不同的工作状态下，由监控主机401控制软件702控制映射选择器705将DAU信道列表701或检测信道列表704设置入数字板从机404后，则可以实现不同的工作状态，进而实现动态的载波信号映射。

所述软关断方法是指：在一台GRRU设备覆盖端机即射频拉远单元中，如图8所示，在保证主扇区载波801下行功率不变的前提下，逐级、缓慢地降低备用扇区802的一路或多路载波的下行功率，最后关断其信号，其由监控主机401与数字板从机404配合处理完成；

如图4、6所示，所述监控主机与数字板从机配合处理的具体步骤为：首先监控主机401发送“启动载波软关断”命令至数字板从机404，命令中指明需要软关断几路载波（例如共有8路载波）；数字板从机404在收到该命令后，解析出软关断载波数量，然后设置关断循环计数器值为20；每隔5秒钟，数字板从机404将指定载波功率衰减3dB，并将关断循环级数器进行减1处理；当该计数器值等于0时，逐级衰减工作完成，数字板从机404发送“软关断结束”信息至监控主机401；监控主机401收到后，发送关闭相应载波开关命令到数字板从机404；收到该命令后，数字板从机404关闭其指定的载波通道，并回复监控主机401“关断成功”，至此载波逐级关断功能完成。

实施例二

如图3所示，本应用于GSM网络的智能化载波调度方法，采用载波备用模式时，具体步骤为：如图3所示，主扇区信源301和备用扇区信源311经合路单元305合并后进入DAU设备306，经光纤拉远后3个DRU302、307和312共同对居民区304、办公区310和渡假村区314三个小区进行覆盖。当夜间办公区310话务量下降，直至低于“载波关闭话务门限”后，射频拉远单元DRU307将自动关闭该区域的备用扇区信源311的2个载波313，并实时检测目标小区话务量；

如果居民区304在5分钟内突发话务量上升，高于“载波开启话务门限”，则射频拉远单元DRU302将自动打开备用扇区信源311的2个载波308，并至少

持续1小时，并继续检测目标小区话务量，从而实现备用载波资源优化配置同时避免频繁切换。

首先判断目标小区标准话务量数据是否高于载波开启话务量门限，如果是，则打开主扇区的备用扇区载波开关，保持备用载波开启状态至少一小时，继续检测目标小区话务量；

如果目标小区标准话务量数据低于载波开启话务量门限，采用软关断技术关闭备用扇区的载波，并实时检测目标小区话务量。

实施例三

某楼盘采用A、B两个扇区对小区进行信号覆盖。但随着房地产竞争日益激烈化和居民健康意识不断提高，小区配套设施逐步完善，兴建一座健身中心。平时，健身中心一般由少部分居民使用，A扇区载波基本可以满足需求，但是节假日光顾居民明显增多，造成健身中心话务拥塞严重。为此，采用“载波备用模式”进行载波资源时间分布调度。即：如图5所示，平时仅采用A扇区载波覆盖健身中心，判断其标准话务量数据是否高于载波开启话务量门限，当该区域话务量突增后高于载波开启门限，将B扇区载波开关打开，分流话务量，联合支援该区域覆盖，避免拥塞，并保持A、B扇区载波同时处于开启状态至少一小时，继续检测其小区话务量。随着健身中心客流逐渐减少，如果该区域标准话务量数据低于载波开启话务量门限，则采用软关断技术关闭B扇区载波，并实时检测目标小区话务量。

实施例四

某基站有A、B两个扇区，其中A扇区载波通过京信GRRU设备的接入控制单元传送到R1、R2二个射频拉远单元进行覆盖；B扇区直接覆盖风景区平时话务量较小，黄金周等假日话务量突增，经常发生话务拥塞。经过分析，承载A扇区信号的R2距离风景区很近，且平时话务量较低，因此采用载波支援模式用R2对风景区进行网络优化。如图5所示，R2首先判断处在风景区的B扇区的上行标准话务量数据是否高于载波开启话务量门限，如果是，则采用动态信道映射方法映射A扇区信道至数字板，打开相应的载波开关，开下行功放，对风景区进行载波支援，并保持上、下行功放打开至少持续一小时，同时R2检测风景区内A扇区上行话务量，以了解其负荷情况；如果R2所覆盖风景区内A扇区上行标准话务量数据低于载波关闭话务量门限，则R2采用软关断方法关闭A扇区载波，采用动态信道映射方法映射B扇区信道至数字板，

打开检测通道的载波开关，关闭下行功放，并实时检测B扇区承载风景区上行话务情况。

如上所述，便可较好地实现本发明，上述实施例仅为本发明的较佳实施例，并非用来限定本发明的实施范围；即凡依本发明内容所作的均等变化与修饰，都为本发明权利要求所要求保护的范围所涵盖。

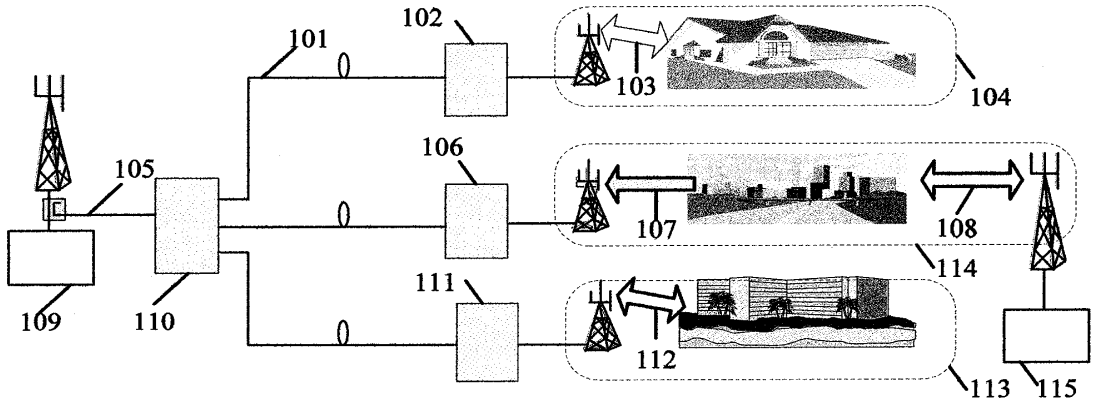

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图 1

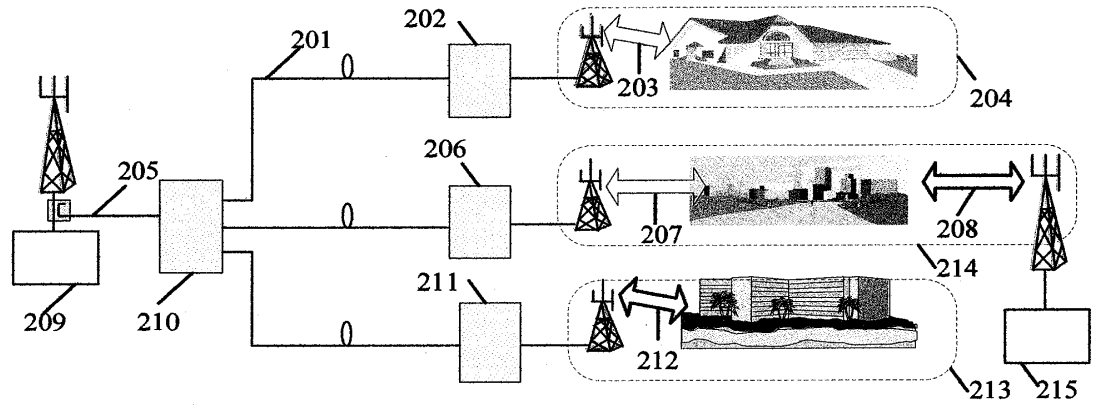

201
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图 2

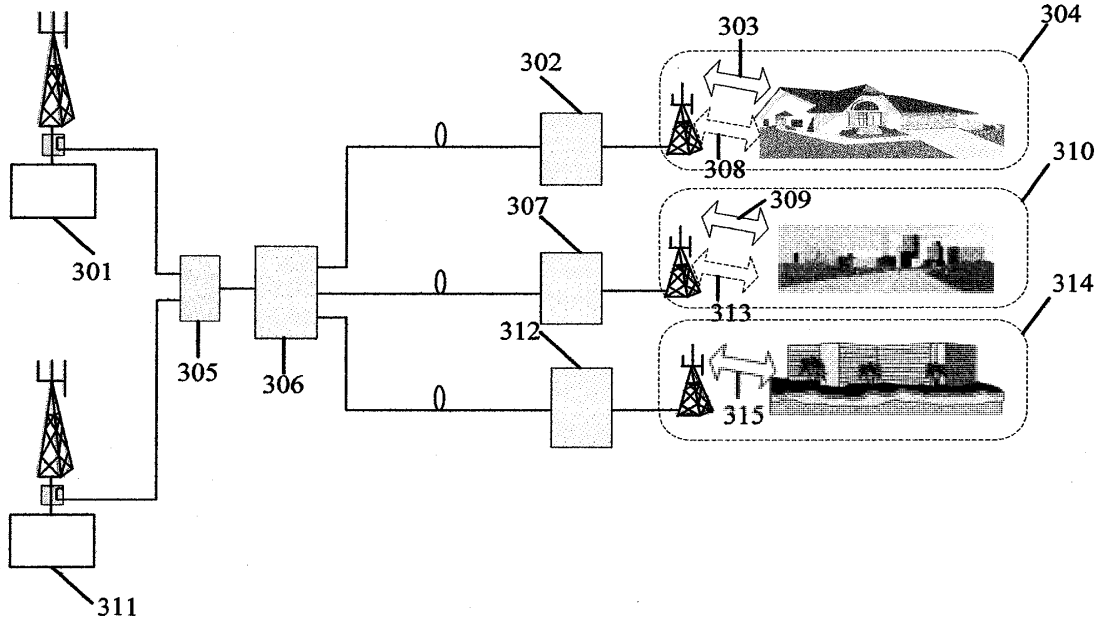

301
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图 3

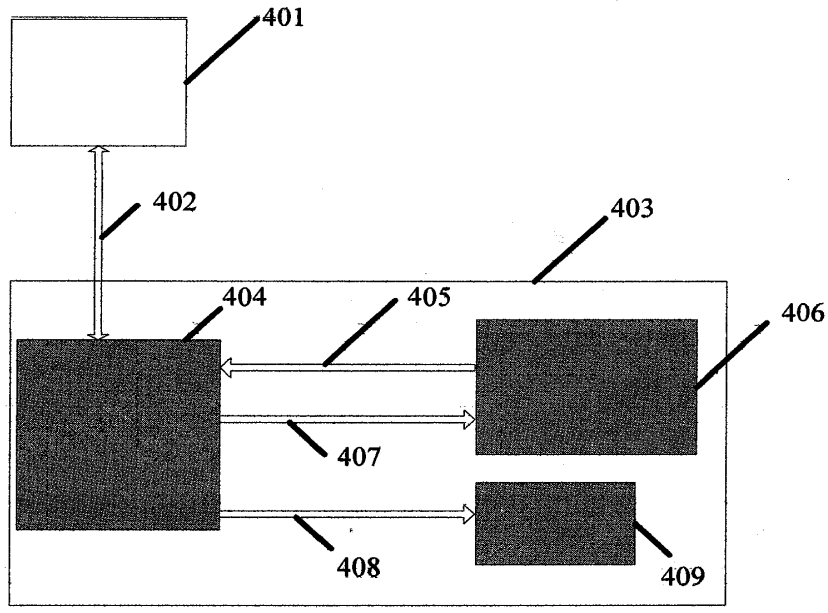

401
402
403
404
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图 4

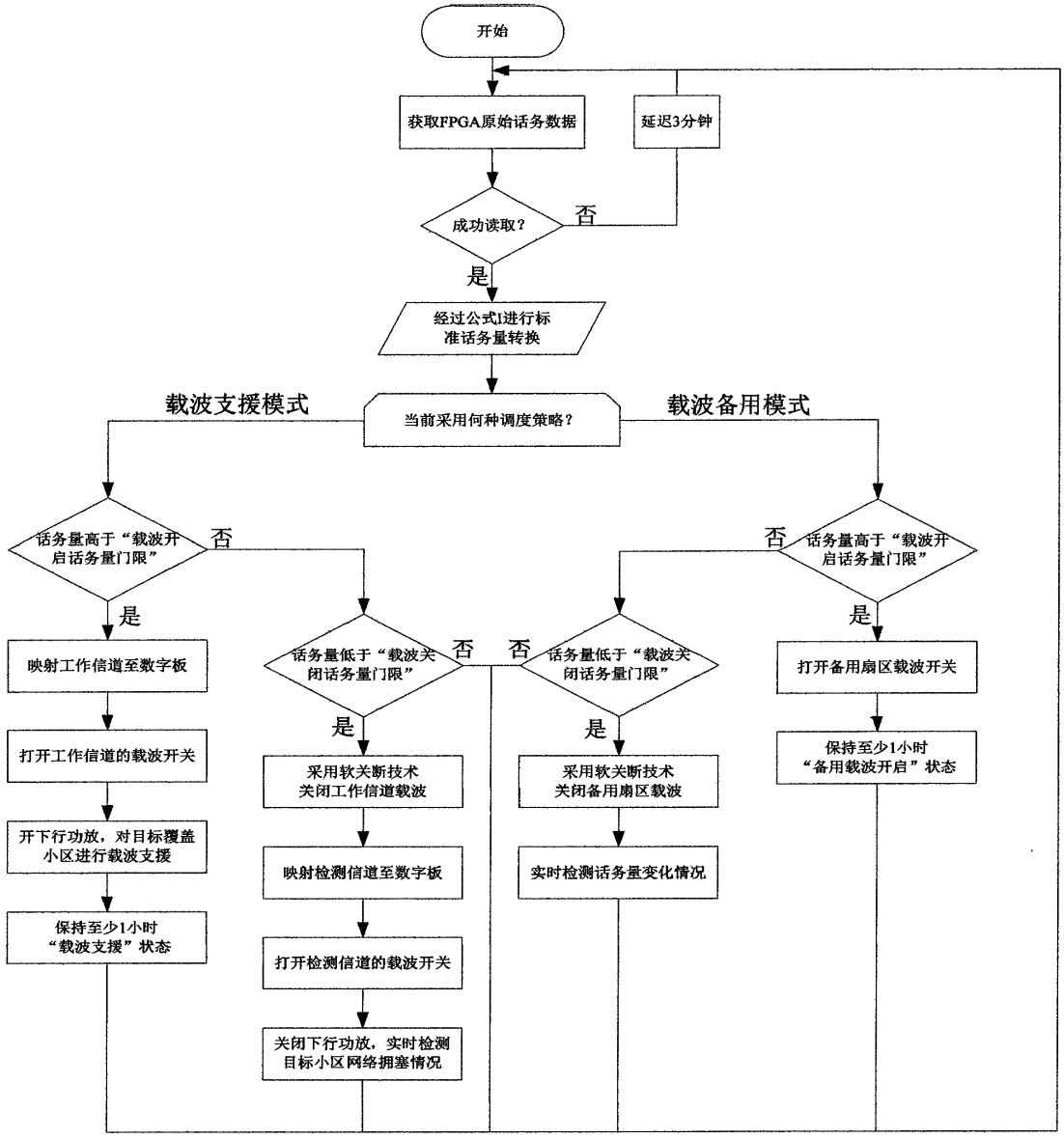

开始
获取FPGA原始话务数据
延迟3分钟
成功读取?
否
是
经过公式1进行标准话务量转换
载波支援模式
当前采用何种调度策略?
载波备用模式
话务量高于“载波开启话务量门限”
否
是
映射工作信道至数字板
打开工作信道的载波开关
开下行功放，对目标覆盖小区进行载波支援
保持至少1小时“载波支援”状态
话务量低于“载波关闭话务量门限”
否
是
采用软关断技术关闭工作信道载波
映射检测信道至数字板
打开检测信道的载波开关
关闭下行功放，实时检测目标小区网络拥塞情况
否
话务量低于“载波关闭话务量门限”
是
采用软关断技术关闭备用扇区载波
实时检测话务量变化情况
否
话务量高于“载波开启话务量门限”
是
打开备用扇区载波开关
保持至少1小时“备用载波开启”状态

图 5

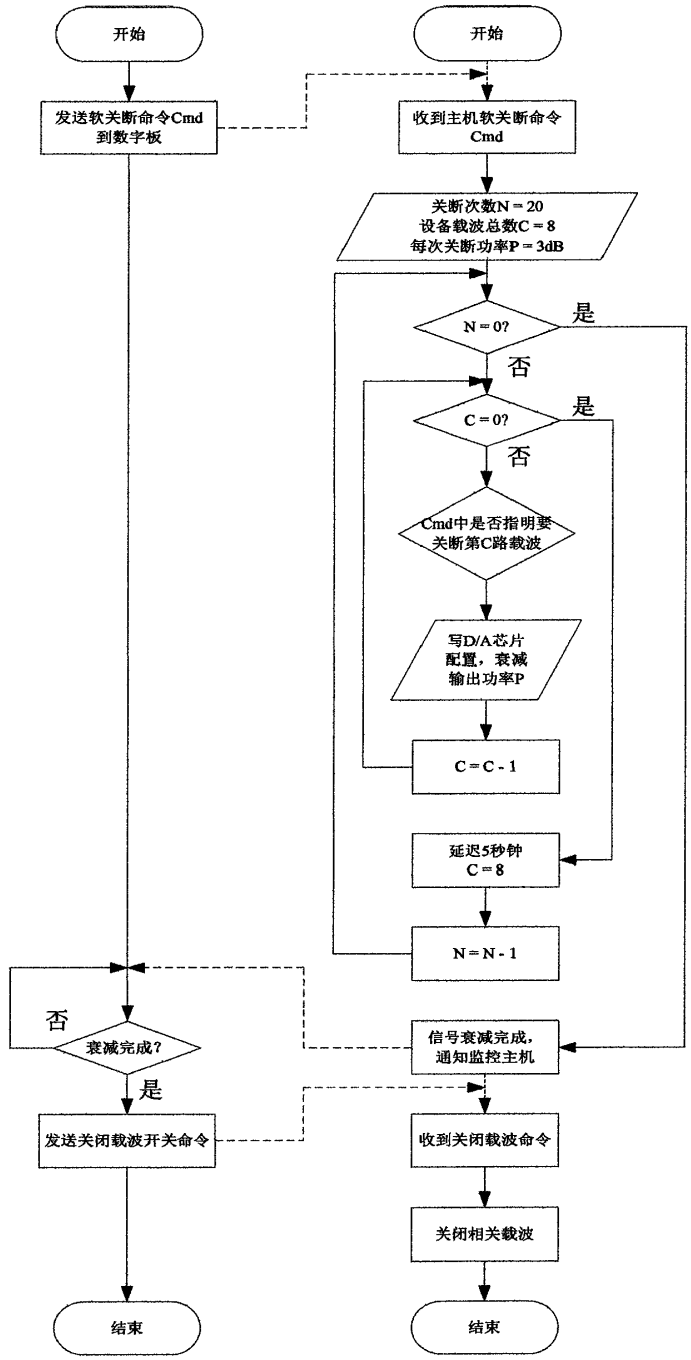

开始
发送软关断命令Cmd到数字板
否
衰减完成?
是
发送关闭载波开关命令
结束
开始
收到主机软关断命令Cmd
关断次数N = 20
设备载波总数C = 8
每次关断功率P = 3dB
N = 0?
是
否
C = 0?
是
否
Cmd中是否指明要关断第C路载波
写D/A芯片配置，衰减输出功率P
C = C - 1
延迟5秒钟
C = 8
N = N - 1
信号衰减完成，通知监控主机
收到关闭载波命令
关闭相关载波
结束

图 6

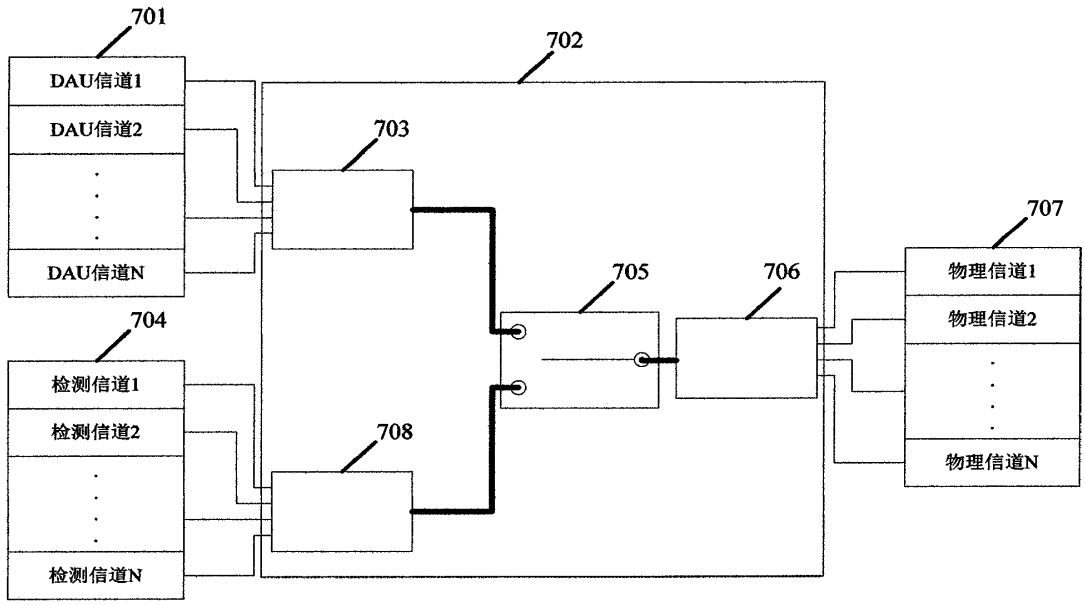

701
DAU信道1
DAU信道2
DAU信道N
702
703
704
检测信道1
检测信道2
检测信道N
705
706
707
物理信道1
物理信道2
物理信道N
708

图 7

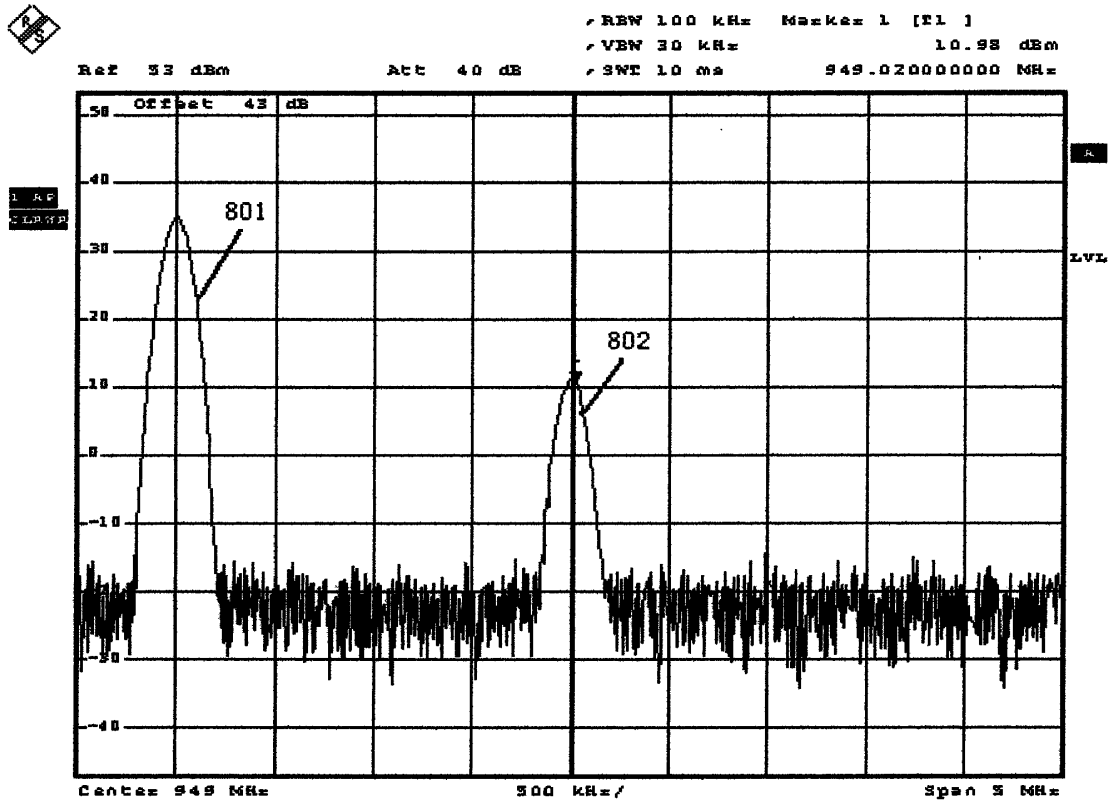

RBW 100 kHz
VBW 30 kHz
SWT 10 ms
Marker 1 [T1]
10.98 dBm
949.020000000 MHz
Ref 53 dBm
Att 40 dB
Offset 43 dB
801
802
LVL
Center 949 MHz
500 kHz/
Span 5 MHz
Date: 15.AUG.2007 15:58:47

图 8

Espacenet

Bibliographic data: CN201307942 (Y) — 2009-09-09

Wireless zone center where RRH (remote radio head) systems realize covering

Inventor(s): BO FENG [CN]; YIBO LIU [CN]; XIONGYING CHEN [CN]; CHONGFENG ZHENG [CN]; KUANPENG MA [CN]; QUANZHAN ZHENG [CN] ± (FENG BO, ; LIU YIBO, ; CHEN XIONGYING, ; ZHENG CHONGFENG, ; MA KUANPENG, ; ZHENG QUANZHAN)

Applicant(s): COMBA TELECOM SYSTEMS CHINA LT [CN] ± (COMBA TELECOM SYSTEMS(CHINA) LTD)

Classification: **- international:**
- cooperative:

Application number: CN20082200635U 20080917

Priority number(s): CN20082200635U 20080917

Abstract of CN201307942 (Y)

The utility model discloses a wireless zone center where RRH systems realize covering. The wireless zone center comprises a BSC (base station controller), BTSs (base transceiver stations) and the RRH systems. One BSC is connected with a plurality of BTSs at the same time, carrier frequency of each BTS is centralized in a center base station, and each BTS respectively covers target residential zones in a corresponding manner by each RRH system. The wireless zone center centralizes the carrier frequency of a plurality of base stations in the center base station to finish construction; by adopting the one-to-multipoint method of the RRH systems, the plurality of base stations of the original covered zone are replaced by a plurality of remote end equipment of the RRH systems, so as to reduce difficulty level of network construction, speed up the construction, reduce investment and maintenance, improve efficiency of maintenance and resources, and solve the problem of unexpected telephone traffic volume.

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04W 88/08 (2009.01)
H04B 7/15 (2006.01)

[12] 实用新型专利说明书

专利号 ZL 200820200635.6

[45] 授权公告日 2009 年 9 月 9 日

[11] 授权公告号 CN 201307942Y

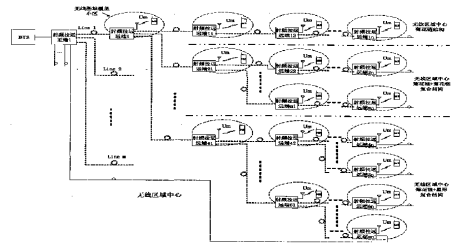
[22] 申请日 2008.9.17
[21] 申请号 200820200635.6
[73] 专利权人 京信通信系统(中国)有限公司
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代理人 李卫东
权利要求书 1 页 说明书 4 页 附图 5 页

[54] 实用新型名称

射频拉远系统实现覆盖的无线区域中心

[57] 摘要

本实用新型公开射频拉远系统实现覆盖的无线区域中心，其包括基站控制器 BSC、收发信基站 BTS、射频拉远系统，一个所述基站控制器 BSC 与多个收发信基站 BTS 同时连接，且各个收发信基站 BTS 的载频集中在一个中心基站内；各个收发信基站 BTS 分别相应通过各个射频拉远系统对目标小区覆盖。本无线区域中心把多个基站的载频集中在一个中心基站内来完成建设，通过射频拉远系统一对多点的方式，原覆盖区域的多个基站由相应的射频拉远系统多个远端设备所取代，从而降低网络建设难度，提高建设速度；减少投资；减少维护量，提高维护效率；提高资源效率，解决突发话务量问题。



1、射频拉远系统实现覆盖的无线区域中心，其特征在于：包括基站控制器 BSC、收发信基站 BTS、射频拉远系统，一个所述基站控制器 BSC 与多个收发信基站 BTS 同时连接，且各个收发信基站 BTS 的载频集中在一个中心基站内；各个收发信基站 BTS 分别相应通过各个射频拉远系统对目标小区覆盖。

2、根据权利要求 1 所述射频拉远系统实现覆盖的无线区域中心，其特征在于：所述各个射频拉远系统对目标小区覆盖方式包括独立采用一点对多点的星型组网方式或点对点链状的菊花链组网方式，或者采用上述两种组网方式的任意排列组合方式。

3、根据权利要求 2 所述射频拉远系统实现覆盖的无线区域中心，其特征在于：采用上述任一种组网方式时，每个射频拉远系统的各个远端机分别通过主路光纤与相应的近端机连接，各个远端机均由末级远端机通过备用光纤与相应的近端机形成环接。

射频拉远系统实现覆盖的无线区域中心

技术领域

本实用新型涉及移动通信网络（GSM）基站子系统（BSS）的组网技术，尤其涉及射频拉远系统实现覆盖的无线区域中心。

背景技术

移动通信网络基本上可以分成两部分：交换子系统（MSC）和基站子系统(包括基站控制器 BSC、基站 BTS 和用户终端 MS)。每个小区有一个收发信基站(BTS)，若干个 BTS 由一个 BSC 控制，一个移动业务交换中心为多个基站控制器 BSC 服务。图 1 是现有的移动通信网络结构示意图，各覆盖区域由宏蜂窝基站完成覆盖；图 3 是现有的宏蜂窝基站机房建设的设备及配套设施的示意图，利用宏蜂窝实现全覆盖的 BSS 缺点在于：需要建设大量的宏蜂窝基站，减缓了网络建设的速度，同时，需要为宏蜂窝基站配备相应配套设施，设备投资大。

现有的 GSM 无线子系统通常是分扇建站，每站分为 3 个扇区，各扇区覆盖一定的区域，容量与每扇区载频数量相关。图 6 是现有的基站组网中各基站的载波容量，如果在区域二发生了突发话务量的现象，由于区域二基站的载波容量仅为两载频，每小时只能承受 7.4 爱尔兰话务量，当覆盖区域总话务量超过 7.4 爱尔兰/小时，就会造成网络堵塞等现象，网络指标急剧恶化。

随着移动通信的飞速发展，为了满足不断增长的用户要求，追求实现全服务区的无缝覆盖，移动通信网络就要进行不断的扩容、增加覆盖小区，这就需要增加大量的移动通信设备和相应配套设施，针对这种情况，我们有必要提出一种既能满足覆盖要求又能大量节约移动设备和配套设施投资的有效组网方式。

实用新型内容

本实用新型的目的在于克服现有技术的缺点与不足，提出了一种射频拉远系统实现覆盖的无线区域中心，无线区域中心把多个基站的载频集中在一个中心基站内完成建设，通过射频拉远系统一对多点的方式，原覆盖区域的多个基站由相应的射频拉远系统多个远端设备所取代，从而降低网络建设难度，提高

建设速度；减少投资；减少维护量，提高维护效率；提高资源效率，解决突发话务量问题。

本实用新型的目的通过下述技术方案实现：本射频拉远系统实现覆盖的无线区域中心，包括基站控制器 BSC、收发信基站 BTS、射频拉远系统，一个所述基站控制器 BSC 与多个收发信基站 BTS 同时连接，且各个收发信基站 BTS 的载频集中在一个中心基站内；各个收发信基站 BTS 分别相应通过各个射频拉远系统对目标小区覆盖。

为更好地实现本实用新型，所述各个射频拉远系统对目标小区覆盖方式包括独立采用一点对多点的星型组网方式或点对点链状的菊花链组网方式，或者采用上述两种组网方式的任意排列组合方式。

本实用新型采用上述任一种组网方式时，每个射频拉远系统的各个远端机分别通过主路光纤与相应的近端机连接，各个远端机均由末级远端机通过备用光纤与相应的近端机形成环接，从而使网络具有自动环路保护功能。

本实用新型与现有技术相比具有如下优点和有益效果：

1、降低网络建设难度，提高建设速度

GSM 无线区域中心覆盖端采用的射频拉远系统取代了原基站，降低了机房建设的要求或取消了机房建设，大大减少了建站周期，为移动通信网络高速发展赢得了宝贵时间。

2、减少投资

射频拉远系统则对机房和配套设施的要求条件很低，只要铺设光纤和电源就可使设备正常工作。

3、减少维护量，提高维护效率

无线区域中心的建设形式是把基站和载频设备集中建设，这就减少了基站的建设数目，这也将会大大缩短维护响应时间，提高维护和巡检效率。

4、提高资源效率，解决突发话务量问题

GSM 无线区域中心是集中建设基站的方式，这样就能够最大程度上的集中载频，对突发话务量的地区，通过中心基站对空闲的载频进行灵活调控，增加话务突发地区覆盖载频，有效的解决突发话务量问题。

5、灵活的组网方式，自动环路保护功能

无线区域中心可实施一点对多点的星型组网方式也具有点对点链状的菊花链组网功能，并可通过备用光纤环接，使网络具有自动环路保护功能。

附图说明

图 1 是现有的移动基站的组网结构示意图；

图 2 是本实用新型射频拉远系统实现覆盖的无线区域中心采用的灵活组网方式的结构示意图，其中包括了星型、菊花链型、菊花链型+星型、自动环路保护方式；

图 3 是现有的机房建设的设备及配套设施示意图；

图 4 是本实用新型射频拉远系统实现覆盖设备及配套设施示意图；

图 5 是无线资源利用率示意图；

图 6 是现有的基站组网方式中各基站的载波容量示意图；

图 7 是本实用新型射频拉远系统实现覆盖的容量示意图。

具体实施方式

下面结合实施例及附图对本实用新型作进一步详细的描述，但本实用新型的实施方式不限于此。

实施例

本射频拉远系统实现覆盖的无线区域中心，包括基站控制器 BSC、收发信基站 BTS、射频拉远系统，一个所述基站控制器 BSC 与多个收发信基站 BTS 同时连接，且各个收发信基站 BTS 的载频集中在一个中心基站内；各个收发信基站 BTS 分别相应通过各个射频拉远系统对目标小区覆盖。

如图 2 所示，所述射频拉远系统由一个近端机（DAU）和若干个远端机（DRU）组成，射频拉远系统对目标小区覆盖所述各个射频拉远系统对目标小区覆盖方式包括独立采用一点对多点的星型组网方式或点对点链状的菊花链组网方式，或者采用上述两种组网方式的任意排列组合方式来进行实现（如图 2 所示，本实施例采用了菊花链、菊花链+菊花链、菊花链型+星型的组合方式，其中，m 为射频拉远星型连接数量，n 为射频拉远菊花链型连接数量）。在每一种组网方式中，采用上述任一种组网方式时，每个射频拉远系统的各个远端机分别通过主路光纤与相应的近端机连接，各个远端机均由末级远端机通过备用光纤与相应的近端机形成环接，当 DRU 到 DRU 之间的主路光纤任意一级开路，只要备用光纤完好，整个通信链路还可以正常工作，从而使网络具有自动环路保护功能。

由图 1、2 所示，无线区域中心的组网方式可以大大减少宏蜂窝基站的机

房建设，这也就加快了网络建设速度。

由图 3、4 所示，无线区域中心的组网方式可以减少宏蜂窝基站的相应配套设施，降低和节约了设备投资。

如图 5 所示，根据巴尔姆表进行计算可得出，在呼损为 2%的情况下，在 4 CH 时的信道利用率是 72%左右，在 8 CH 时的信道利用率是 80%左右，而在 16 CH 时的信道利用率是 90%左右，由此可见随着载频数的增加信道利用率随之增长。所以通过集中建设中心基站的方式，提高了覆盖区的载波容量和无线载频利用率。

如图 6 所示，如果在区域二发生了突发话务量的现象，由于区域二基站的载波容量限制，无法承受突发的话务量，这就会造成网络堵塞等现象，网络指标急剧下降。

如图 7 所示，，由于原区域二和区域三的载波模块集中在区域一的机房中，这三个区域总容量并没有减少，而当区域二或区域三发生话务量突发后，可以在中心机房内通过调配其他区域的空闲载波到话务量突发区域进行相对的扩容覆盖，这样就在不增加总容量的前提下灵活地解决了局部地区的话务量突发现象。

如上所述，便可较好地实现本实用新型，上述实施例为本实用新型较佳的实施方式，但本实用新型的实施方式并不受上述实施例的限制，其他的任何未背离本实用新型的精神实质与原理下所作的改变、修饰、替代、组合、简化，均应为等效的置换方式，都包含在本实用新型的保护范围之内。

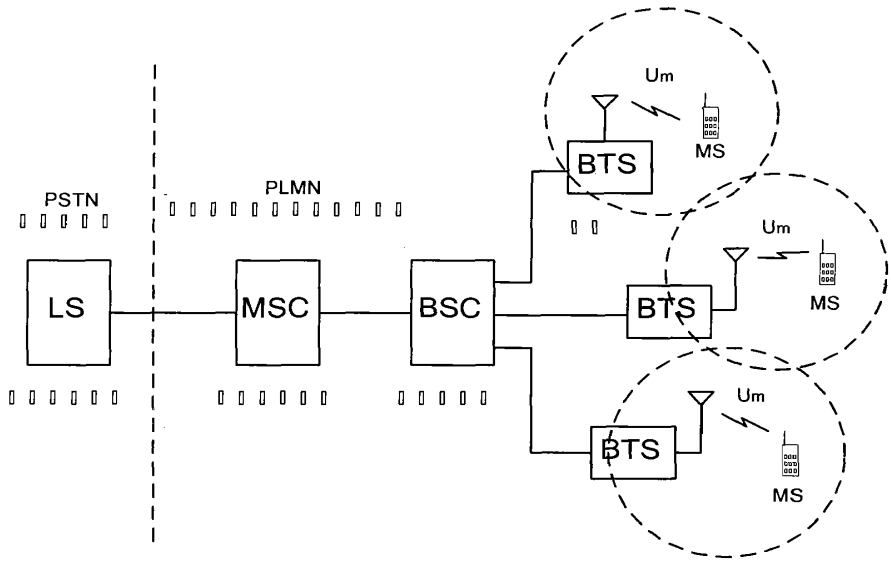


图 1

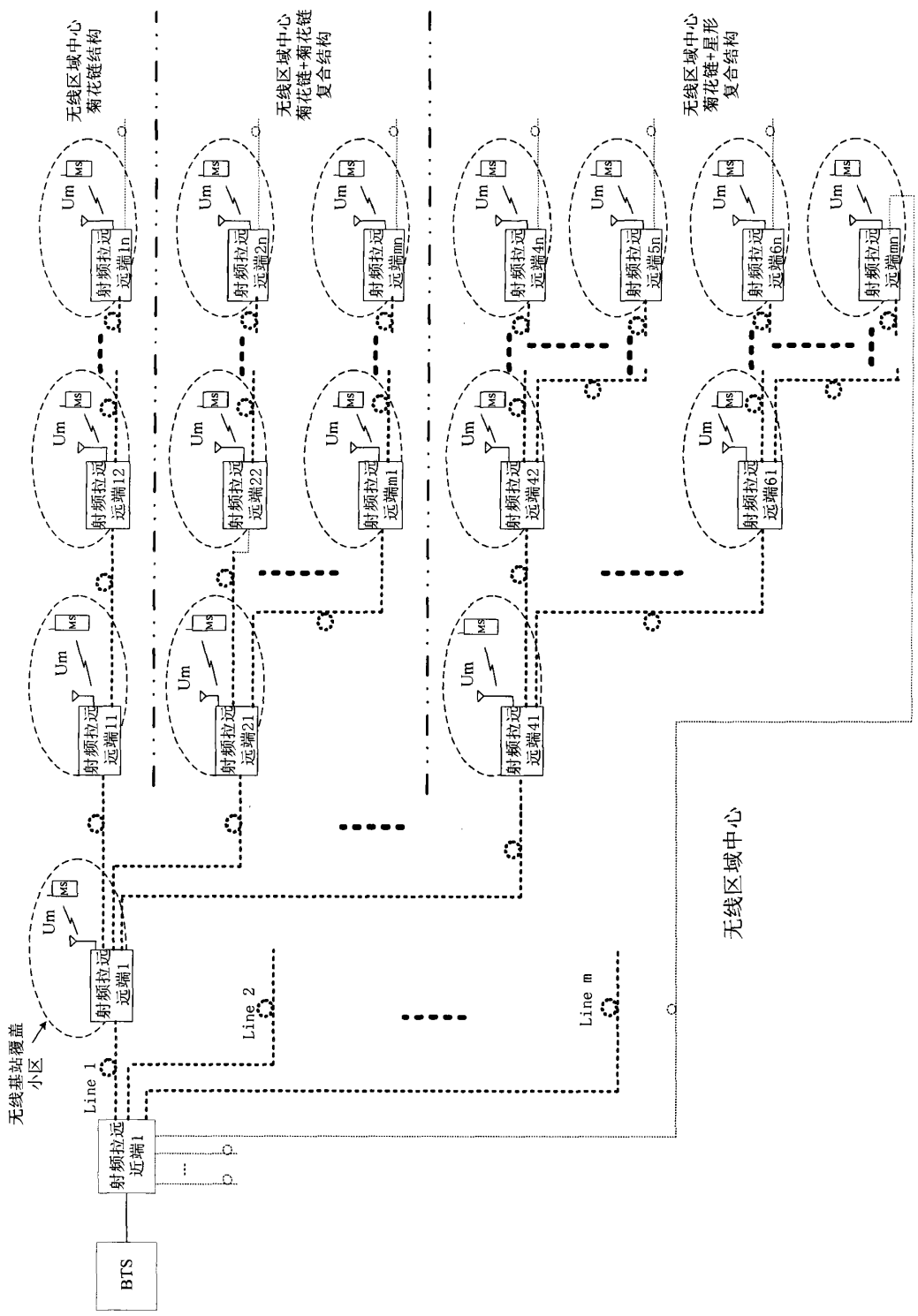

无线区域中心
菊花链结构
无线区域中心
菊花链+菊花链
复合结构
无线区域中心
菊花链+星形
复合结构
无线区域中心
无线基站覆盖
小区
BTS
射频拉远
近端1
射频拉远
远端11
射频拉远
远端12
射频拉远
远端1n
射频拉远
远端21
射频拉远
远端22
射频拉远
远端2n
射频拉远
远端m1
射频拉远
远端mn
射频拉远
远端41
射频拉远
远端42
射频拉远
远端4n
射频拉远
远端5n
射频拉远
远端61
射频拉远
远端6n
射频拉远
远端mn
Um
MS
Line 1
Line 2
Line m

图 2

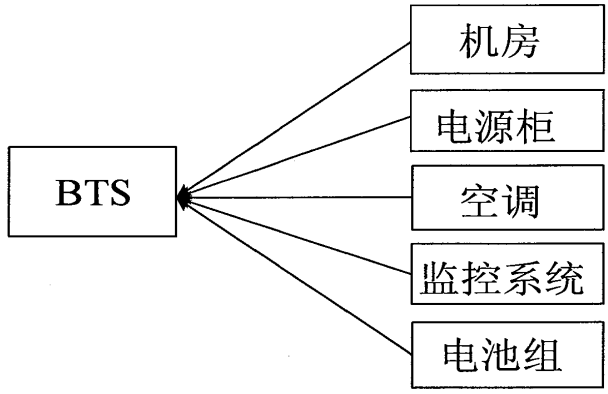


图 3

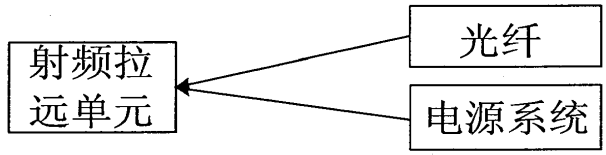


图 4

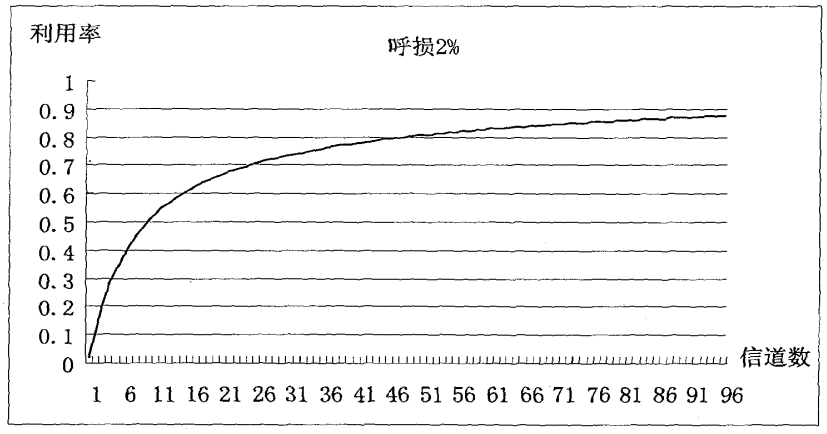

利用率
呼损2%
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
信道数
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96

图 5

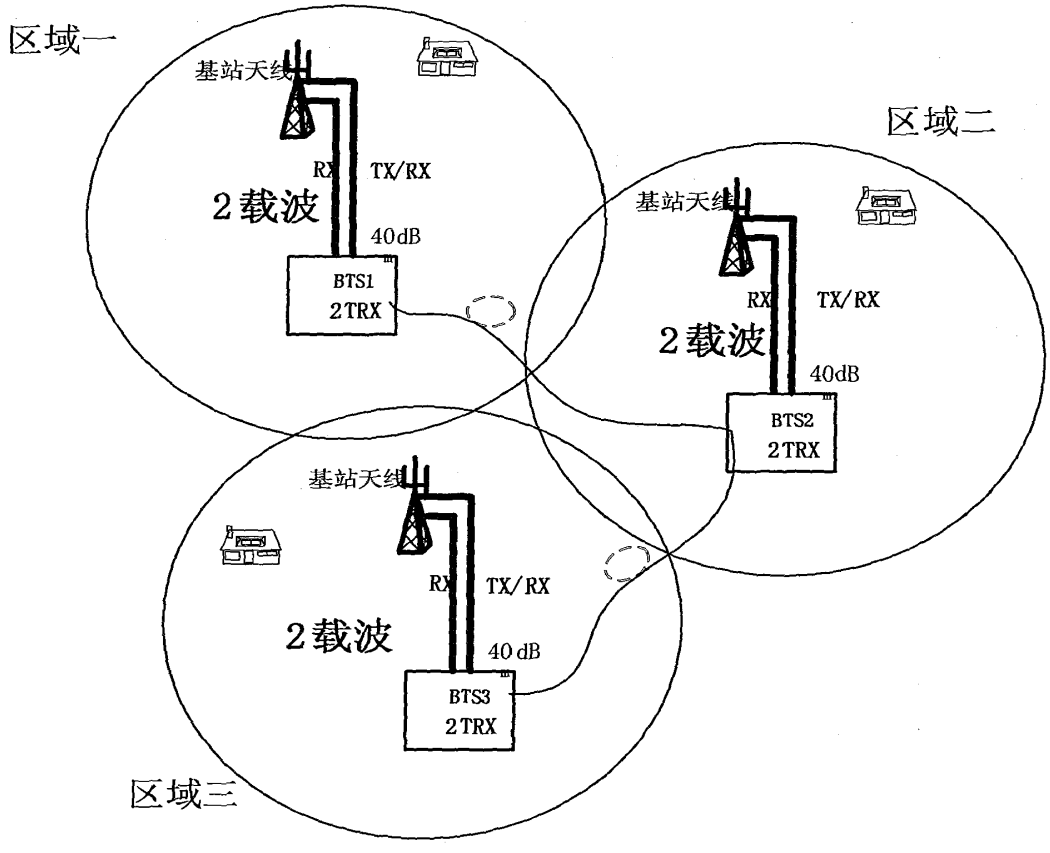

区域一
基站天线
RX
TX/RX
2载波
40dB
BTS1
2TRX
区域二
基站天线
RX
TX/RX
2载波
40dB
BTS2
2TRX
基站天线
RX
TX/RX
2载波
40dB
BTS3
2TRX
区域三

图 6

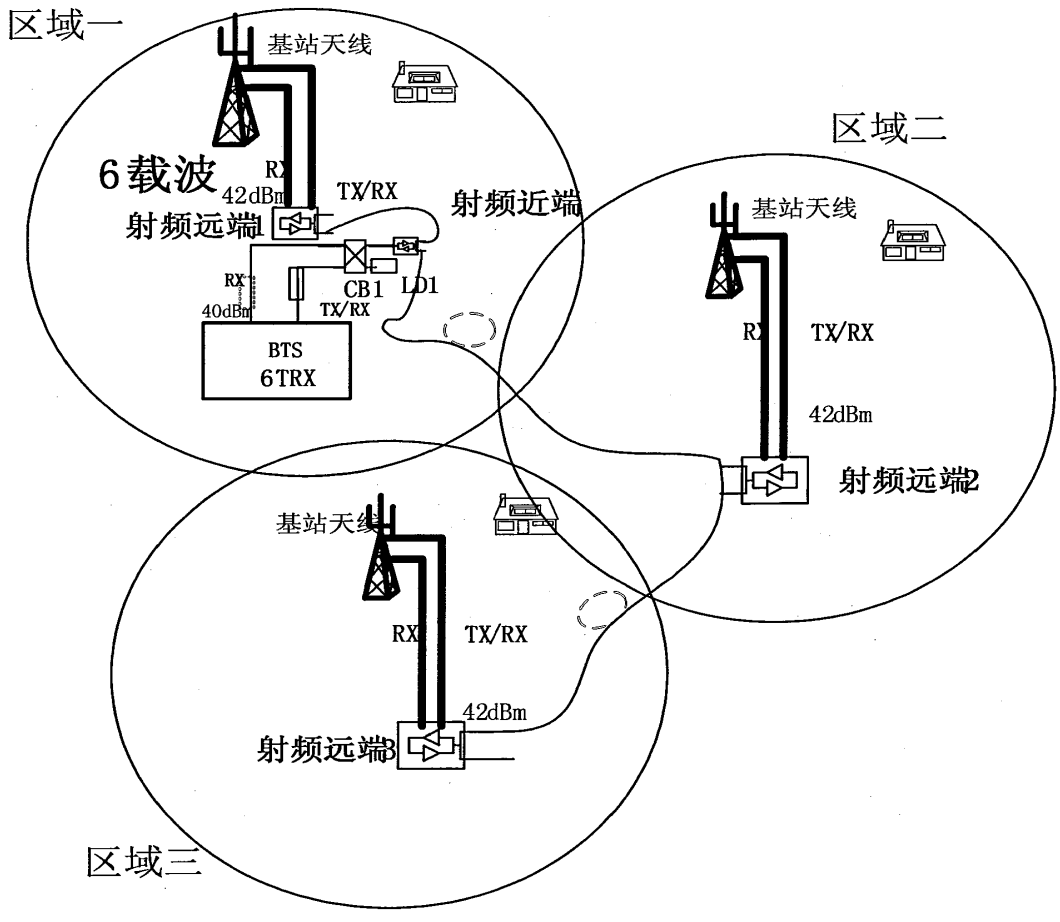

区域一
基站天线
6载波
RX
42dBm
TX/RX
射频近端
射频远端1
RX
40dBm
CB1
LD1
TX/RX
BTS
6TRX
区域二
基站天线
RX
TX/RX
42dBm
射频远端2
基站天线
RX
TX/RX
42dBm
射频远端3
区域三

图 7

PTO/SB/06 (09-11)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/223,819	Filing Date 07/29/2016	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **05/01/2018**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 30	Minus	** 20	= 10	X $50 =	500
Independent (37 CFR 1.16(h))	* 5	Minus	***3	= 2	X $230 =	460
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**960**

AMENDMENT

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

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

SLIE
NICHELE PETERSON

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on May 4, 2018.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Shawn Patrick Stapleton et al.
Application No.: 15/223,819
Filed: July 29, 2016
For: DISTRIBUTED ANTENNA SYSTEM
Customer No.: 20350

Confirmation No.: 3273
Examiner: Wei Zhao
Technology Center/Art Unit: 2473

AMENDMENT ACCOMPANYING REQUEST FOR CONTINUED EXAMINATION (RCE)

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

Commissioner:

In accompaniment with the Request for Continued Examination filed May 1, 2018, please enter the following amendments and consider the following remarks:

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

Remarks/Arguments begin on page 9 of this paper.

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1. (Canceled)

2. (Previously Presented) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit; and

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

3. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable to dynamically change from (a) sending the digital representations of the first set of

downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

4. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in network conditions, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

5. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on load balancing, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

6. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a change in subscriber needs, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

7. (Previously Presented) The host unit of claim 2, wherein the host unit is configurable, based on a schedule, to dynamically change from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

8. (Previously Presented) The host unit of claim 2, wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface.

9. (Previously Presented) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

10. (Previously Presented) The host unit of claim 2, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal in compliance with the Common Public Radio Interface (CPRI) standard.

11. (Previously Presented) A system for transporting wireless communications, comprising:

a host unit;

a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is capable of receiving a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is capable of sending digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals; and

wherein the host unit is capable of receiving digital signals from each of the plurality of remote units.

12. (Previously Presented) The system of claim 11, wherein the host unit is capable of packetizing each digital representation of a downlink channel signal.

13. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through a direct connection.

14. (Previously Presented) The system of claim 11, wherein the host unit is connected to each of the plurality of remote units through an indirect connection.

15. (Previously Presented) The system of claim 11, wherein each remote unit comprises at least one interface to communicatively couple the remote unit to another one of the plurality of remote units in a daisy-chain configuration.

16. (Previously Presented) A method for providing digital signals in a Distributed Antenna System (DAS), comprising:

transmitting from a host unit, at a first point in time, digital representations of a first set of downlink channel signals to a first remote unit, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

transmitting from the host unit, at a second point in time, digital representations of a second set of downlink channel signals to the first remote unit, the second set of downlink channel signals for transmission at the antenna of the first remote unit;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

17. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a change in network conditions from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

18. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on load balancing from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

19. (Previously Presented) The method of claim 16, wherein the host unit dynamically changes based on a schedule from (a) sending the digital representations of the first set of downlink channel signals to the first remote unit to (b) sending the digital representations of the second set of downlink channel signals to the first remote unit.

20. (Previously Presented) The method of claim 16, wherein the downlink channel signals are packetized.

21. (Previously Presented) The method of claim 20, wherein the downlink channel signals are packetized in compliance with the Common Public Radio Interface (CPRI) standard.

22. (New) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is configured to receive a plurality of downlink signals from the at least one signal source, each downlink signal of the plurality of downlink signals comprising a plurality of carriers;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit is configured to send a digital representation of any carrier of any downlink signal it receives to any of the plurality of remote units;

wherein the host unit is configured to transmit a digital representation of a first portion of the plurality of carriers to the first remote unit and a digital representation of a second portion of the plurality of carriers to the second remote unit, wherein the digital representation of the first portion includes destination information identifying the first remote unit and the digital representation of the second portion includes destination information identifying the second remote unit, the first portion being different than the second portion; and

wherein the host unit is configured to receive a digital representation of at least one uplink signal from each of the plurality of remote units.

23. (New) The host unit of claim 22 wherein the host unit is configured to packetize the plurality of downlink signals it receives in compliance with the Common Public Radio Interface (CPRI) standard to provide at least the digital representation of the first portion and the digital representation of the second portion.

24. (New) The host unit of claim 22 wherein the destination information identifying the first remote unit is provided in a header of the digital representation of the first portion, and the destination information identifying the second remote unit is provided in a header of the digital representation of the second portion.

25. (New) The host unit of claim 22 wherein the at least one interface to communicatively couple the host unit to the plurality of remote units comprises an optical interface.

26. (New) The host unit of claim 22 wherein the host unit is configured to I/Q map and frame the plurality of downlink signals it receives to provide at least the digital representation of the first portion and the digital representation of the second portion.

27. (New) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is configured to receive a plurality of downlink signals from the at least one signal source, each downlink signal of the plurality of downlink signals comprising a plurality of carriers;

at least one interface to communicatively couple the host unit to one or more additional host units;

wherein the host unit is configured to send a digital representation of any carrier of any downlink signal it receives to the one or more additional host units;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit is configured to send a digital representation of any carrier of any downlink signal it receives to any of the plurality of remote units;

wherein the host unit is configured to transmit a digital representation of a first portion of the plurality of carriers to the first remote unit and a digital representation of a second portion of the plurality of carriers to the second remote unit, the first portion being different than the second portion; and

wherein the host unit is configured to receive a digital representation of at least one uplink signal from each of the plurality of remote units.

28. (New) The host unit of claim 27 wherein the at least one interface to communicatively couple the host unit to the one or more additional host units comprises an optical interface.

29. (New) The host unit of claim 27 wherein the one or more additional host units includes a plurality of additional host units, and the host unit is connected to at least one of the plurality of additional host units through a direct connection and at least one of the plurality of additional host units through an indirect connection.

30. (New) The host unit of claim 27 wherein the at least one interface to communicatively couple the host unit to the at least one signal source includes a plurality of interfaces to communicatively couple the host unit to a plurality of signal sources.

31. (New) The host unit of claim 27 wherein the digital representation of the first portion includes destination information identifying the first remote unit and the digital representation of the second portion includes destination information identifying the second remote unit.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 2-31 will be pending in this application. New claims 22-31 have been added to secure an appropriate scope of protection for the present application. No new matter is added.

CONCLUSION

Entry of this amendment is respectfully urged since no additional search is required, no more than a cursory review of the record is needed, and the amendments do not require a substantial amount of work on the part of the Office.

Except for the issue fees payable under 37 C.F.R. § 1.18, the Director is authorized to charge any additional fees during pendency of this application, including any required extension of time fees, or credit any overpayment to Deposit Account Number 20-1430. This paragraph is intended to be a constructive petition for extension of time in accordance with 37 C.F.R. § 1.136(a)(3).

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (650) 326-2400 or kcatmull@kilpatricktownsend.com.

Respectfully submitted,

/Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP
KBC:bsk

70779287V.1

Electronic Patent Application Fee Transmittal				
Application Number:	15223819			
Filing Date:	29-Jul-2016			
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM			
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton			
Filer:	Kelvin B. Catmull/Brian Kanter			
Attorney Docket Number:	091172-1017552-102440US			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:				
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	10	50	500
INDEPENDENT CLAIMS IN EXCESS OF 3	2201	2	230	460
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	960

Electronic Acknowledgement Receipt	
EFS ID:	32534985
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	04-MAY-2018
Filing Date:	29-JUL-2016
Time Stamp:	14:14:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	CARD
Payment was successfully received in RAM	$960
RAM confirmation Number	050718INTEFSW14153100
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37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		PrelimAMD_102440US.pdf	99048 2e183d2539421950c4cb4902de78d1c897b9f1c1	yes	9

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment Submitted/Entered with Filing of CPA/RCE	1	1
Claims	2	8
Applicant Arguments/Remarks Made in an Amendment	9	9

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32332 f89a540775da7620be757964d91e41ef4ffd3805	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	131380		

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

20350 7590 05/16/2018

KILPATRICK TOWNSEND & STOCKTON LLP
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1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

NOTIFICATION DATE	DELIVERY MODE
05/16/2018	ELECTRONIC

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

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

ipefiling@kilpatricktownsend.com
KTSDocketing2@kilpatrick.foundationip.com

PTOL-90A (Rev. 04/07)

Applicant-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN CATMULL*. (4)_____.

Date of Interview: *07 May 2018*.

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

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

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

Claim(s) discussed: *22 and 27*.

Identification of prior art discussed: *of the record*.

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

Discussed new claim limitations in claims 22 and 27, and some mappings based on the prior art used. The examiner also indicated some details needed for the "Excerpts from Patent Owner's Invalidity Contentions regarding U.S. Patent No. 7,639,982…," i.e., Non-Patent Literature Document #14 submitted with the IDS filed May 1st, 2018, such as the date available to the public. Applicant's representative agreed to provide this information later.

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

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

☐ Attachment

/WEI ZHAO/ Primary Examiner, Art Unit 2473	

Summary of Record of Interview Requirements

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

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

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

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

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

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

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

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

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1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
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Examiner to Check for Accuracy

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UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

20350 7590 06/05/2018

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER
ZHAO, WEI

ART UNIT	PAPER NUMBER
2473	

DATE MAILED: 06/05/2018

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

TITLE OF INVENTION: DISTRIBUTED ANTENNA SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0	$0	$500	09/05/2018

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

PTOL-85 (Rev. 02/11)

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)

20350 7590 06/05/2018
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

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.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

TITLE OF INVENTION: DISTRIBUTED ANTENNA SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0	$0	$500	09/05/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
ZHAO, WEI	2473	370-328000

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

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

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

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

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

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

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

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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20350 7590 06/05/2018

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1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

EXAMINER	
ZHAO, WEI	

ART UNIT	PAPER NUMBER
2473	

DATE MAILED: 06/05/2018

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

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

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

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

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

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

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

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

Applicant-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN B. CATMULL*. (4)_____.

Date of Interview: *29 May 2018*.

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

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

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

Claim(s) discussed: *2 and 9*.

Identification of prior art discussed: _____.

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

The examiner reached out to the Applicant's representative; discussed allowable subject matter and the examiner made a suggestion on some claim limitations.
See the examiner's amendment for details.

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

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/WEI ZHAO/ Primary Examiner, Art Unit 2473	

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- Name of examiner
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- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
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3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
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   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
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Notice of Allowability	Application No. 15/223,819	Applicant(s) STAPLETON ET AL.	
	Examiner WEI ZHAO	Art Unit 2473	AIA (First Inventor to File) Status No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *5/4/2018*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *2-31*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

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

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

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

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

/WEI ZHAO/
Primary Examiner, Art Unit 2473

DETAILED ACTION

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

Response to Amendment

2. Acknowledgment is made of Applicant's submission of claim amendments with the request for continued examination on May 4, 2018. Claims 22-31 are new; claims 2-31 are pending. This communication is considered fully responsive and sets forth below.

Information Disclosure Statement

3. The information disclosure statement (IDS) submitted on May 1, 2018 was filed after the mailing date of the previous office action. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Examiner's Amendment

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

Authorization for this examiner's amendment was given in a telephone interview with KELVIN B. CATMULL on May 29, 2018. Claims 2, 9, 10, 11 and 12 have been amended as follows:

2. (Currently Amended) A host unit for use in the transport of wireless communications, comprising:

at least one interface to communicatively couple the host unit to at least one signal source;

at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit;

wherein the host unit is configured to receive [[capable of receiving]]a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is configured to send [[capable of sending]]digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit; and

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals.

9. (Currently Amended) The host unit of claim 2, wherein the host unit is configured to packetize [[capable of packetizing]]each digital representation of a downlink channel signal.

10. (Currently Amended) The host unit of claim 2, wherein the host unit is configured to packetize [[capable of packetizing]]each digital representation of a downlink channel signal in compliance with the Common Public Radio Interface (CPRI) standard.

11. (Currently Amended) A system for transporting wireless communications, comprising:

a host unit;

a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source;

wherein the host unit is configured to receive [[capable of receiving]]a plurality of downlink channel signals from the at least one signal source;

wherein the host unit is configured to send [[capable of sending]]digital representations of the plurality of downlink channel signals to the plurality of remote units;

wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit;

wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit;

wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals; and

wherein the host unit is configured to receive [[capable of receiving]]digital signals from each of the plurality of remote units.

12. (Currently Amended) The system of claim 11, wherein the host unit is configured to packetize [[capable of packetizing]]each digital representation of a downlink channel signal.

Allowable Subject Matter

5. Claims 2-31 are allowed. The following is the reason for examiner's statement of allowance:

The closest prior art on record, Sulzberger et al. (US 2005/0152695) and Boldi et al. (US 8,855,489) are generally directed to various aspects of the radio base station with multiple radio frequency heads; and the communications method between a main station and processing nodes includes interconnecting the main station and the nodes in an optical path defining adjacent nodes and non-adjacent nodes.

However, in consideration of the Applicant's submission of claim amendments with the remarks on May 4, 2018, the authorization of the examiner's amendment, and further search, no prior art reference or a combination of prior art references disclose or suggest the combination of limitations specified in the independent claims including:

"the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit;" and "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals," in claim 1.

Claim 11 includes similar limitations.

"transmitting from the host unit, at a second point in time, digital representations of a second set of downlink channel signals to the first remote unit, the second set of downlink channel signals for transmission at the antenna of the first remote unit;" and "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals," in claim 16.

"the digital representation of the first portion includes destination information identifying the first remote unit and the digital representation of the second portion includes destination information identifying the second remote unit, the first portion being different than the second portion;" and "wherein the host unit is configured to receive a digital representation of at least one uplink signal from each of the plurality of remote units," in claim 22.

"the host unit is configured to transmit a digital representation of a first portion of the plurality of carriers to the first remote unit and a digital representation of a second portion of the plurality of carriers to the second remote unit, the first portion being different than the second portion;" and "wherein the host unit is configured to receive a digital representation of at least one uplink signal from each of the plurality of remote units," in claim 27.

Dependent claims 2-10, 12-15, 17-21, 23-26, and 28-31 are also allowable for incorporating the features recited in the independent claims.

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

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to WEI ZHAO whose telephone number is (571)270-5672. The examiner can normally be reached on Monday-Friday, 7:30am-4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, KWANG B. YAO can be reached on 571-272-3182. 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.

/Wei Zhao/
Primary Examiner
Art Unit 2473

Applicant-Initiated Interview Summary	**Application No.** 15/223,819	**Applicant(s)** STAPLETON ET AL.	
	Examiner WEI ZHAO	**Art Unit** 2473	

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

(1) *WEI ZHAO*. (3)_____.

(2) *KELVIN B. CATMULL*. (4)_____.

Date of Interview: *29 May 2018*.

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

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

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

Claim(s) discussed: *2 and 9*.

Identification of prior art discussed: _____.

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

The examiner reached out to the Applicant's representative; discussed allowable subject matter and the examiner made a suggestion on some claim limitations.
See the examiner's amendment for details.

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

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

☐ Attachment

/WEI ZHAO/ Primary Examiner, Art Unit 2473	

Summary of Record of Interview Requirements

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

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

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

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

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

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

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

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

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

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

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

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

Examiner to Check for Accuracy

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

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

CPC- SEARCHED		
Symbol	**Date**	**Examiner**
H04W 40/02, 72/04; H04B 7/022	5/25/2017, 5/26, 9/22, 1/23/2018, 5/25/2018	wz

CPC COMBINATION SETS - SEARCHED		
Symbol	**Date**	**Examiner**

US CLASSIFICATION SEARCHED			
Class	**Subclass**	**Date**	**Examiner**

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

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
searched in usocr, fprs, pgpub, uspat, ip.com, and ieee xplore	5/25/2017, 5/26, 9/22, 1/23/2018, 5/25	wz
fmid search	5/25/2017, 9/22, 1/23/2018	wz
odp search in palm resource center	5/25/2017	wz
updated text search	9/22/2017, 1/23/2018, 5/25/2018	wz

INTERFERENCE SEARCH	

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H04W	72/04	5/26/2017, 1/23/2018, 5/25	wz

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1415	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:15
L2	4	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) same host and (different) with (DL or (downlink$1)) with channel$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:17
L3	5	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) same host and (different) with (DL or (downlink$1)) with (channel$1 or signal$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:18
L4	28	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (DL or (downlink$1)) with (channel$1 or signal$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:19
L5	3	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (DL or (downlink$1)) with (channel$1 or signal$1) and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:19
L6	0	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) wi with (channel$1 or signal$1) and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:20
L7	8	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04W40/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:20
L8	8	(DL or (downlink$1)) with channel$1	US-PGPUB;	ADJ	OFF	2018/05/29

		same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04W40/02$.cpc.	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			09:21
L9	12	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04W72/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:22
L10	12	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:22
L11	24	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04B7/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:22
L12	8	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04B7/$02.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:23
L13	24	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04B7/$022.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:23
L14	24	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04B7/022.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/29 09:24
S4859	33	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 13:46
S4860	25	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (possible or usable or available) with carrier$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	OFF	2018/05/22 13:48

			IBM_TDB			
S4861	13	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 14:36
S4862	8	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and (RRC or (radio with resource$1 with control$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 14:38
S4863	8	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and (RRC or (radio with resource$1 with control$4)) with (information or signal$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 14:39
S4864	6	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and (RRC or (radio with resource$1 with control$4)) with (information or signal$3) and schedul$3 with (UE or user$1 or (user$1 with (equipment or device)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 14:48
S4865	2	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and (RRC or (radio with resource$1 with control$4)) with (information or signal$3) and schedul$3 with (UE or user$1 or (user$1 with (equipment or device))) and index$3 with (transmission or transmit$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 16:53
S4869	2	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and (RRC or (radio with resource$1 with control$4)) with (information or signal$3) and carrier$s with (simultaneous$2 or ("same time"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 18:07
S4870	11	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and H04W72/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/22 18:38
S4872	5	obtain$3 with (information or signal$3)	US-PGPUB;	ADJ	OFF	2018/05/23

		with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and (RRC or (radio with resource$1 with control$4)) with (information or signal$3) and contention	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			18:04
S4873	3	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 same contention and (RRC or (radio with resource$1 with control$4)) with (information or signal$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/23 18:05
S4874	5	(information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 same contention and (RRC or (radio with resource$1 with control$4)) with (information or signal$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/23 18:07
S4875	5	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with (possible or usable or available) with carrier$1 and H04W72/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:19
S4876	7	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and (determin$3 or identify$3) with carrier$1 and H04W72/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:20
S4877	8	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with unlicensed with spectrum and H04W72/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:21
S4878	9	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 same unlicensed with spectrum and H04W72/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:22
S4879	25	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 same spectrum and H04W72/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:22
S4880	23	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with	US-PGPUB; USPAT;	ADJ	OFF	2018/05/24 14:22

		resource$1 same spectrum and H04W72/12$.cpc.	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S4881	7	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 same spectrum and H04W72/121$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:23
S4882	4	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 same spectrum and H04W72/1215$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:23
S4883	129	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 same spectrum and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:23
S4884	75	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 same spectrum and H04W72/045$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:23
S4885	75	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 same spectrum and H04W72/0453$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:24
S4886	46	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/0453$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:24
S4887	13	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W72/0453$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:24
S4889	15	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W16/1$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:25

S4890	13	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W16/14$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/24 14:25
S4893	13	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W72/045$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/25 07:19
S4894	20	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W72/04$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/05/25 07:19

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L15	8	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04B7/022.cpc.	USPAT	ADJ	OFF	2018/05/29 09:49
L16	11	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04w72/$$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/29 09:50
L18	7	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04w40/$$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/29 09:53
L21	3	(DL or (downlink$1)) with channel$1 same remote with (unit$1 or device$1 or equipment) and host with (unit$1 or device$1 or equipment) and (different) with (channel$1 or signal$1) and H04B7/02$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/29 09:54
S4891	2	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W16/14$.cpc.	USPAT	ADJ	OFF	2018/05/24 14:26
S4895	10	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W16/14$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 05:57
S4896	15	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W72/$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 05:58
S4897	4	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1	US-PGPUB;	ADJ	OFF	2018/05/25 05:58

		with spectrum and H04W72/1$.cpc.	USPAT			
S4898	17	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/12$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 05:59
S4899	4	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/121$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 05:59
S4900	36	(information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/121$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 05:59
S4901	31	(information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/1215$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 06:00
S4902	695	(information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/04$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 06:00
S4903	70	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/04$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 06:00
S4905	38	obtain$3 with (information or signal$3) with carrier$1 and carrier$1 with resource$1 with spectrum and H04W72/0453$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 06:01
S4906	5	obtain$3 with (information or signal$3) with carrier$1 same carrier$1 with resource$1 with spectrum and H04W72/0453$.cpc.	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 06:01
S4907	1	"20170111913"	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 06:01
S4908	1	"20160227578"	US-PGPUB; USPAT	ADJ	OFF	2018/05/25 06:25

5/29/2018 9:57:08 AM
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Receipt date: 05/01/2018

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-6,804,540	B1	10-12-2004	Shepherd et al.	
	2.	US-8,842,649	B2	09-23-2014	Liu et al.	
	3.	US-8,532,242	B2	09-10-2013	Fischer et al.	

U.S. PATENT APPLICATION PUBLICATIONS

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
	4.	2010133942	WO	A1	11-25-20110	Teko Telcom S P A		
	5.	1774094	CN	A	05-17-2006	Huawei Tech Co Ltd.		
	6.	201307942	CN	Y	09-09-2009	Comba Telecom Systems China LTD		
	7.	101621806	CN	A	01-06-2010	Comba Telecom Systems(China) Ltd.		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	8.	Petition for Inter Partes Review of U.S. Patent No. 9,531,473 Under 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 41.100 ET SEQ., filed February 2, 2018, 95 pages.	
	9.	ACAMPORA, Anthony, "Declaration of Dr. Anthony Acampora" in support of Inter Partes Review of U.S. Patent No. 9,531,473, Feb 2, 2018, 190 pages.	
	10.	"Comprehensive Dictionary of Electrical Engineering",1999, CRC Press & IEEE Press, 4 pages.	
	11.	"Computer Dictionary. The Comprehensive Standard for Business, School, Library and Home", 1991, Microsoft Press, ISBN 1-55615-231-0, 6 pages.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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

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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

	12.	"Wiley Electrical and Electronics Engineering Dictionary", 2004, Wiley & Sons, Inc., 7 pages.	
	13.	"McGraw-Hill Dictionary of Scientific and Technical Terms", (5th ed.), 1994, McGraw-Hill, Inc., ISBN 0-07-042333-4, 6 pages.	
	14.	Excerpts from Patent Owner's Invalidity Contentions regarding U.S. Patent No. 7,639,982 served in related matter CommScope Technologies LLC v. Dali Wireless, Inc., Case No. 3:16-cv-00477-B (N.D. Tex.) ("Patent Owner's Invalidity Contentions Ex. C"), 410 pages. Feb. 2, 2018	
	15.	HORAK, Ray, "Telecommunications and Data Communications Handbook", 2007, Wiley & Sons, Inc., 55 pages.	
	16.	SPURGEON, Charles E., "Ethernet, The Definitive Guide", 2000, O'reilly & Assoc., Inc., 112 pages.	
	17.	"Dali Wireless, Inc.'s claim construction brief", in: CommScope Technologies LLC v. Dali Wireless, Inc., Case No. 3:16-cv-00477-B (N.D. Tex.), June 30, 2017, 36 pages.	
	18.	"Dali Wireless, Inc.'s responsive claim construction brief", in: CommScope Technologies LLC v. Dali Wireless, Inc., Case No. 3:16-cv-00477-B (N.D. Tex.), August 18, 2017, 30 pages.	
	19.	Office Action for Chinese Patent Application No. 201610011597.9, mailed March 29, 2018, 5 pages	

EXAMINER SIGNATURE			
Examiner Signature /WEI ZHAO/		Date Considered 05/08/2018	

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

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

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

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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Kelvin B. Catmull/	Date (YYYY-MM-DD)	2018-05-01
Name/Print	Kelvin B. Catmull	Registration Number	57,535

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

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

CPC								
Symbol							**Type**	**Version**
H04W		40	/	02			F	2013-01-01
H03F		1	/	3247			I	2013-01-01
H03F		3	/	24			I	2013-01-01
H03F		2200	/	336			A	2013-01-01
H03F		2200	/	57			A	2013-01-01
H03F		2201	/	3224			A	2013-01-01
H03F		2201	/	3233			A	2013-01-01
H04L		25	/	03343			I	2013-01-01
H04L		27	/	362			I	2013-01-01
H04W		24	/	02			I	2013-01-01
H04B		1	/	0475			I	2013-01-01
H04W		24	/	04			I	2013-01-01
H04W		40	/	00			I	2013-01-01
H04L		27	/	2618			I	2013-01-01
H04L		2025	/	03414			A	2013-01-01
H04W		72	/	0453			I	2013-01-01
H04B		2001	/	0425			A	2013-01-01
H04B		7	/	022			I	2013-01-01
H04W		72	/	04			I	2013-01-01

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	30	
/WEI ZHAO/ Primary Examiner.Art Unit 2473	05/29/2018	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No. 20180507

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		H	0	4	W	40 / 02 (2009.01.01)						
CROSS REFERENCE(S)												
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	30	
/WEI ZHAO/ Primary Examiner.Art Unit 2473	05/29/2018	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No. 20180507

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15223819	STAPLETON ET AL.
	Examiner	**Art Unit**
	WEI ZHAO	2473

☒ 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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	30	
/WEI ZHAO/ Primary Examiner.Art Unit 2473	05/29/2018	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No. 20180507

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on August 8, 2018.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-1017552-102440US
Client Ref. No.: DW-1024-4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Shawn Patrick Stapleton
Application No.: 15/223,819
Filed: Jul 29, 2016
For: DISTRIBUTED ANTENNA SYSTEM
Customer No.: 20350

Confirmation No.: 3273
Examiner: Wei Zhao
Technology Center/Art Unit: 2473

STATEMENT OF SUBSTANCE OF INTERVIEW

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

Commissioner:

The undersigned thanks Examiner Zhao for the helpful telephone interviews conducted on May 7, 2018 and May 29, 2018. During the May 7, 2018 interview, the IDS filed May 1, 1028 was discussed. During the May 29, 2018 interview, proposed amendments to the claims were discussed.

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (650) 326-2400 or KCatmull@kilpatricktownsend.com.

Respectfully submitted,

/Kelvin B. Catmull/
Kelvin B. Catmull
Registration No. 57,535

KILPATRICK TOWNSEND & STOCKTON LLP

71029238V.1

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
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(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US	3273

TITLE OF INVENTION: DISTRIBUTED ANTENNA SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0	$0	$500	09/05/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
ZHAO, WEI	2473	370-328000

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

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

1 Kilpatrick Townsend &
2 Stockton LLP
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: Dali Wireless, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Melo Park, California

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

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ☐ A check is enclosed.
- ☒ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 20-1430 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature /Kelvin B. Catmull/ Date August 8, 2008

Typed or printed name Kelvin Catmull Registration No. 57,535

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Patent Application Fee Transmittal				
Application Number:	15223819			
Filing Date:	29-Jul-2016			
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM			
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton			
Filer:	Kelvin B. Catmull/Brian Kanter			
Attorney Docket Number:	091172-1017552-102440US			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

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

Electronic Acknowledgement Receipt	
EFS ID:	33415755
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Kelvin B. Catmull
Filer Authorized By:	
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	08-AUG-2018
Filing Date:	29-JUL-2016
Time Stamp:	19:28:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$500
RAM confirmation Number	080918INTEFSW19300500
Deposit Account	201430
Authorized User	IP eFiling
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant summary of interview with examiner	102440US_Intervsum.pdf	71728 ed50a84733f7e1eb864815a35ad99c1024c04f5c	no	1
Warnings:					
Information:					
2	Issue Fee Payment (PTO-85B)	102440US_IFT.pdf	88800 23bee13d3df2f90757f1db01485710209e1db0c6	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30458 0048fe484154df2515c1a29c9626128346714b0b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	190986		

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.

Receipt date: 05/22/2017

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	15/223,819
Filing Date	July 29, 2016
First Named Inventor	Shawn Patrick Stapleton
Art Unit	2473
Examiner Name	Wei Zhao
Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-8,583,100	B2	11-12-2013	Koziy et al.	
	2.	US-8,346,160	B2	01-01-2013	Kummetz	
	3.	US-8,032,148	B2	10-04-2011	Hettstedt et al.	
	4.	US-8,010,099	B2	08-30-2011	Ma et al.	
	5.	US-7,650,112	B2	01-19-2010	Utsumi et al.	
	6.	US-7,639,982	B2	12-29-2009	Wala	
	7.	US-7,339,897	B2	03-04-2008	Larsson et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	8.	US-2012/0127938	A1	05-24-2012	Lv et al.	
this should be US 20127/0057572	9.	~~US-2012/2057572~~	A1	03-08-2012	Evans et al.	
	10.	US-2011/0135308	A1	~~06-09-2010~~ 06/2011	Tarlazzi et al.	
	11.	US-2010/0278530	A1	11-04-2010	Kummetz et al.	
	12.	US-2010/0177759	A1	07-15-2010	Fischer et al.	
	13.	US-2010/0157901	A1	06-24-2010	Sanderovitz et al.	
	14.	US-2010/0002661	A1	01-07-2010	Schmidt et al.	
	15.	US-2009/0286484	A1	11-19-2009	Phung et al.	
	16.	US-2009/0252136	A1	10-08-2009	Mahany et al.	
	17.	US-2008/0107014	A1	~~05-08-2008~~ 05/2008	Huang et al.	
	18.	US-2007/0066234	A1	03-22-2007	Lastinger et al.	
	19.	US-2002/0187809	A1	12-12-2002	Mani et al.	

/W.Z/

Change(s) applied to document,
/J.E./
2/13/2018

FOREIGN PATENT DOCUMENTS

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2475
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

Change(s) applied to document, /J.E./ 2/13/2018

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-4,775,795		10/1988 ~~07-05-1998~~	~~Page~~ Biehl et al.	
	2.	US-4,999,831		03-12-1991	Grace	
	3.	US-5,457,557	A	10-10-1995	Zarem et al.	
	4.	US-5,579,341	A	11-26-1996	Smith et al.	
	5.	US-5,619,202	A	04-08-1997	Wilson et al.	
	6.	US-5,621,730	A	04-15-1997	Kelley	
	7.	US-5,627,879	A	05-06-1997	Russell et al.	
	8.	US-5,644,622	A	07-01-1997	Russell et al.	
	9.	US-5,748,683	A	05-05-1998	Smith et al.	
	10.	US-5,818,883	A	10-06-1998	Smith et al.	
	11.	US-5,852,651	A	12-22-1998	Fischer et al.	
	12.	US-6,005,506	A	12-21-1999	Bazarjani et al.	
	13.	US-6,005,884	A	12-21-1999	Cook et al.	
	14.	US-6,014,366	A	01-11-2000	Ichiyoshi	
	15.	US-6,112,086	A	08-29-2000	Wala	
	16.	US-6,253,094	B1	06-26-2001	Schmutz	
	17.	US-6,356,369	B1	03-12-2002	Farhan et al.	
	18.	US-6,373,611	B1	01-16-2002	Farhan et al.	
	19.	US-6,594,496	B2	07-15-2003	Schwartz	
	20.	US-6,697,603	B1	02-24-2004	Lovinggood et al.	
	21.	US-6,704,545	B1	03-09-2004	Wala	
	22.	US-6,785,558	B1	08-31-2004	Stratford et al.	
	23.	US-6,826,164	B2	11-30-2004	Mani et al.	
	24.	US-6,831,901	B2	12-14-2004	Millar	
	25.	US-6,836,660	B1	12-28-2004	Wala	
	26.	US-7,257,328	B2	08-14-2007	Levinson et al.	
	27.	US-7,286,507	B1	10-23-2007	Oh et al.	
	28.	US-7,610,460	B2	10-27-2009	Wala	
	29.	US-7,787,854	B2	08-31-2010	Conyers et al.	
	30.	US-8,010,116	B2	08-30-2011	Scheinert	
	31.	US-8,346,091	B2	01-01-2013	Kummetz et al.	
	32.	US-8,446,530	B2	05-21-2013	Bellers	
	33.	US-8,737,454	B2	05-27-2014	Wala et al.	
	34.	US-8,958,789	B2	02-17-2015	Bauman et al.	
	35.	US-9,531,473	B2	12-27-2016	Lemson et al.	

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	36.	US-2005/0157675	A1	07-21-2005	Feder et al.	
	37.	US-2008/0119198	A1	05-22-2008	Hettstedt et al.	
	38.	US-2010/0128676	A1	05-27-2010	Wu et al.	
	39.	US-2006/0094470	A1	05-04-2006	Wake et al.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15/223,819
	Filing Date	July 29, 2016
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2473
	Examiner Name	Wei Zhao
	Attorney Docket Number	091172-1017552-102440US

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1.	US-6,804,540	B1	10-12-2004	Shepherd et al.	
	2.	US-8,842,649	B2	09-23-2014	Liu et al.	
	3.	US-8,532,242	B2	09-10-2013	Fischer et al.	

U.S. PATENT APPLICATION PUBLICATIONS

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
Change(s) applied to document. /J.H/ 8/22/2018	4.	2010133942	WO	A1	~~11-25-20110~~ 11/2010	Teko Telcom S P A		
	5.	1774094	CN	A	05-17-2006	Huawei Tech Co Ltd.		
	6.	201307942	CN	Y	09-09-2009	Comba Telecom Systems China LTD		
	7.	101621806	CN	A	01-06-2010	Comba Telecom Systems(China) Ltd.		

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	8.	Petition for Inter Partes Review of U.S. Patent No. 9,531,473 Under 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 41.100 ET SEQ., filed February 2, 2018, 95 pages.	
	9.	ACAMPORA, Anthony, "Declaration of Dr. Anthony Acampora" in support of Inter Partes Review of U.S. Patent No. 9,531,473, Feb 2, 2018, 190 pages.	
	10.	"Comprehensive Dictionary of Electrical Engineering",1999, CRC Press & IEEE Press, 4 pages.	
	11.	"Computer Dictionary. The Comprehensive Standard for Business, School, Library and Home", 1991, Microsoft Press, ISBN 1-55615-231-0, 6 pages.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /W.Z/

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/223,819	09/18/2018	10080178	091172-1017552-102440US	3273

20350 7590 08/29/2018

KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309
UNITED STATES OF AMERICA

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

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

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

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

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

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

Dali Wireless, Inc., Menlo Park, CA;
Shawn Patrick Stapleton, Burnaby, CANADA;
Paul Lemson, Woodinvile, WA;
Bin Lin, Burnaby, CANADA;
Albert S. Lee, San Mateo, CA;

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IR103 (Rev. 10/09)

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

PTO/AIA/82A (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

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

Application Number	15/223,819
Filing Date	07-29-2016
First Named Inventor	Shawn Patrick Stapleton
Title	DISTRIBUTED ANTENNA SYSTEM
Art Unit	2473
Examiner Name	ZHAO, WEI
Attorney Docket Number	091172-1017552-102440US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Jennifer Spaith/	Date (Optional)	
Name	Jennifer Spaith	Registration Number	51,916
Title (if Applicant is a juristic entity)	Patent Practitioner		
Applicant Name (if Applicant is a juristic entity)	DALI WIRELESS, INC.		

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

☑ *Total of 1 forms are submitted.

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

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

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

PTO/AIA/82B (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

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

Application Number	Filing Date

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

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 27076

OR

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

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

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

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

DALI WIRELESS, INC.

☐ Inventor or Joint Inventor (title not required below)

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

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

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

SIGNATURE of Applicant for Patent

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

Signature		Date (Optional)	
Name	Albert Lee		
Title	CEO		

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

☑ Total of 1 forms are submitted.

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

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Electronic Acknowledgement Receipt	
EFS ID:	36492144
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Jennifer Lane Spaith/Angela Staschke
Filer Authorized By:	Jennifer Lane Spaith
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	03-JUL-2019
Filing Date:	29-JUL-2016
Time Stamp:	12:59:06
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	POA_15223819_3273_P282730US06.pdf	642312 37621dc52d15aefff73f59e241628b08121e18c7	no	2
Warnings:					

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing	
Information:	
Total Files Size (in bytes):	642312

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 NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

POWER OF ATTORNEY NOTICE



20350
KILPATRICK TOWNSEND & STOCKTON LLP
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

Date Mailed: 07/09/2019

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/03/2019.

- The Power of Attorney to you in this application has been revoked by the applicant. 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**.

/afessehaye/

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
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

POA ACCEPTANCE LETTER

27076
DORSEY & WHITNEY LLP - Seattle
INTELLECTUAL PROPERTY DEPARTMENT
Columbia Center
701 Fifth Avenue, Suite 6100
Seattle, WA 98104-7043

OC000000109461357

Date Mailed: 07/09/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/03/2019.

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

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

/afessehaye/

PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
Stylesheet Version v1.2

EPAS ID: PAT5633990

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	SECURITY INTEREST

CONVEYING PARTY DATA

Name	Execution Date
DALI WIRELESS, INC.	06/18/2019

RECEIVING PARTY DATA

Name:	DALI RESEARCH (NORTHWIND) LLC
Street Address:	156 WEST 56TH STREET
Internal Address:	9TH FLOOR
City:	NEW YORK
State/Country:	NEW YORK
Postal Code:	10019

PROPERTY NUMBERS Total: 143

Property Type	Number
Application Number:	15251293
Application Number:	13960346
Application Number:	15682431
Application Number:	16059434
Application Number:	10137556
Application Number:	11262079
Application Number:	11799239
Application Number:	11961969
Application Number:	12021241
Application Number:	13211243
Application Number:	13211247
Application Number:	13301224
Application Number:	13404679
Application Number:	13619538
Application Number:	13724157
Application Number:	13887133
Application Number:	13913207
Application Number:	14095891
Application Number:	14169719

Property Type	Number
Application Number:	14245190
Application Number:	14260145
Application Number:	14480285
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Application Number:	14691152
Application Number:	14788567
Application Number:	14800515
Application Number:	14949405
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Application Number:	15205820
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Application Number:	14743789
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Application Number:	12603419
Application Number:	13553967
Application Number:	14087682
Application Number:	14885890

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Application Number:	12928934
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Application Number:	14248597
Application Number:	14754908
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Application Number:	12928943
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Application Number:	14335647
Application Number:	14703579
Application Number:	13211236
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Application Number:	14333277
Application Number:	14831626
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Application Number:	14480267
Application Number:	14918371
Application Number:	16279535
Application Number:	13686036
Application Number:	14225673
Application Number:	14960177
Application Number:	13670162
Application Number:	13670290
Application Number:	15857356
Application Number:	13671203
Application Number:	13754702

Property Type	Number
Application Number:	14678779
Application Number:	15445467
Application Number:	16039182
Application Number:	13753288
Application Number:	13777185
Application Number:	15383121
Application Number:	16054678
Application Number:	13894309
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Application Number:	15912859
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Application Number:	15676631
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Application Number:	14987093
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Application Number:	16240433
Application Number:	14168328
Application Number:	15582776
Application Number:	16205567
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Application Number:	15279136
Application Number:	14183297
Application Number:	14189044
Application Number:	15907153
Application Number:	14199617
Application Number:	15917342
Application Number:	14257209
Application Number:	15819279

Property Type	Number
Application Number:	14590447
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Application Number:	16360980
Application Number:	14639418
Application Number:	15090402
Application Number:	15820299
Application Number:	15203015
Application Number:	15358060
Application Number:	15594323

CORRESPONDENCE DATA

Fax Number: (212)586-5095

Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.

Phone: 2125865800
Email: DFRIEDMAN@CTSWLAW.COM
Correspondent Name: DANIEL J. FRIEDMAN
Address Line 1: 420 LEXINGTON AVENUE
Address Line 2: SUITE 2400
Address Line 4: NEW YORK, NEW YORK 10170

NAME OF SUBMITTER:	DANIEL J. FRIEDMAN
SIGNATURE:	/Daniel J. Friedman/
DATE SIGNED:	07/24/2019
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 42
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PATENT SECURITY AGREEMENT

This Patent Security Agreement, dated as of June 18, 2019 (this "Agreement"), made by Dali Wireless, Inc., a Delaware corporation ("Grantor"), in favor of Dali Research (Northwind) LLC, a Delaware limited liability company (together with its successors and assigns, "Grantee"). Reference is made to that certain Prepaid Forward Purchase Agreement between Buyer and Seller, dated as of the date hereof (as it may be amended from time to time, the "Purchase Agreement").

RECITALS

WHEREAS, the Grantor has an ownership interest in certain Patents set forth on Exhibit A hereto (the "Patents"); and

WHEREAS, the Grantor and Grantee are parties to that certain Security Agreement, of even date herewith (as from time to time amended or supplemented, the "Security Document"); and

WHEREAS, pursuant to the Security Document, Grantor has granted to Grantee a security interest in certain of its assets, including, without limitation, the Patents, to secure the performance of Grantor's obligations under the Security Document and related agreements; and

WHEREAS, it is a condition precedent to Grantee's entry into the Security Document and related agreements that the Grantor execute and deliver this Agreement to Grantee; and

WHEREAS, the Grantor and Grantee by this instrument seek to confirm and make a record of the grant of the security interest in the Patents and the assignment of the Patents upon the occurrence of an Event of Default (as defined below) in accordance with the terms of this Agreement; and

WHEREAS, capitalized terms used and not defined herein have the meanings given to them in the Security Document.

NOW, THEREFORE, for good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, the Grantor hereby agrees, confirms and acknowledges as follows:

1. As collateral security for the payment and performance of the Obligations, Grantor hereby grants and conveys to Grantee a first priority continuing security interest in and lien upon all Patents now owned and hereafter acquired by Grantor and the Proceeds and products thereof. The Grantor does hereby acknowledge and confirm that the Patents, the goodwill associated therewith, and the Proceeds and products thereof constitute Collateral pledged by Grantor to Grantee pursuant to the Security Document.

2. The Grantor further acknowledges and confirms that the rights and remedies of Grantee with respect to the Patents are more fully set forth in the Security Document, the terms and provisions of which are incorporated herein by reference.

3. The Grantor hereby irrevocably constitutes and appoints Grantee, with full power of substitution, as its true and lawful attorney-in-fact, with full irrevocable power and authority in its place and stead and in its name or otherwise, from time to time in Grantee's sole discretion, at Grantee's sole cost and expense, to take any and all action and to execute and deliver any and all documents and instruments which Grantee may deem reasonably necessary or advisable to (a) accomplish the purposes of perfecting, continuing and preserving, a continuing first priority security interest in the Patents and the goodwill associated therewith in favor of Grantee, and (b) effect a transfer of the Patents and the goodwill associated therewith to Grantee or to Grantee's designees without further consent or authorization of the Grantor upon the occurrence of an Event of Default (as defined in the Security Document) (an "Event of Default"). In furtherance and not in limitation of the foregoing, if an Event of Default has occurred and is continuing, the Grantee is hereby authorized file with the United States Patent and Trademark Office or with such other governmental authorities, the assignment in the form substantially similar to that of Exhibit 1 attached to this Agreement, together with such other instruments and documents as Grantee may deem necessary or appropriate to effectuate the foregoing.

4. Grantee is hereby authorized to file or record this Agreement or any other instrument or documents in such public offices and with such governmental authorities, including the United States Patent and Trademark Office, as Grantee may determine from time to time for the purpose of evidencing the foregoing grant of security.

[REMAINDER OF PAGE INTENTIONALLY LEFT BLANK AND SIGNATURES ON NEXT PAGE]

IN WITNESS WHEREOF, this Patent Security Agreement has been executed and delivered as of the day and year first above written.

GRANTOR

DALI WIRELESS, INC.

By:_____

Name: Albert Lee

Title: CEO

ACCEPTED AND AGREED:

GRANTEE:

DALI RESEARCH (NORTHWIND) LLC

By_____

Title: Authorized Person

EXHIBIT 1

ASSIGNMENT OF PATENTS

This **ASSIGNMENT OF PATENTS** (this "Assignment"), dated as of _____ __, 20__, made by **Dali Wireless, Inc.**, a Delaware corporation ("Assignor"), in favor of **Dali Research (Northwind) LLC**, a Delaware limited liability company (together with its successors and assigns, "Grantee" or "Assignee") and the Assignee as set forth below. For good and valuable consideration, the receipt and adequacy of are hereby acknowledged, Assignor hereby assigns to Grantee the Patents set forth on Exhibit A hereto (the "Patents") as follows:

1. Assignment of Patents. Assignor hereby assigns, transfers, and conveys to _____, a _____ with offices at _____ (the "Assignee") all of Assignor's right, title and interest in and to the Patents together with the goodwill associated therewith and the right to sue for past infringement of the Patents.

3. Filing and Recordation. Assignee is hereby authorized to file or record this Assignment or any other instrument in such public offices and with such governmental authorities, including the United States Patent and Trademark Office, as Assignee may determine from time to time for the purpose of evidencing the foregoing assignment.

IN WITNESS WHEREOF, Assignor has executed this Assignment of Patents as of the date first above written.

ASSIGNOR:

DALI WIRELESS, INC.

By:_____

Name:_____

Title:_____

TITLE	COUNTRY	APPLN. NO.	FILING DATE	PUB NO.	PUB DATE	PATENT NO.	ISSUE DATE	STATUS
SYSTEM AND METHOD FOR DIGITAL MEMORIZED PREDISTORTION FOR WIRELESS COMMUNICATION	United States of America	10/137,556	5/1/02	US 2003-0207680 A1	11/6/03	6,985,704	1/10/06	Issued
SYSTEM AND METHOD FOR DIGITAL MEMORIZED PREDISTORTION FOR WIRELESS COMMUNICATION	United States of America	11/262,079	10/27/05	US 2006-0046665 A1	3/2/06	8,326,238	12/4/12	Issued
SYSTEM AND METHOD FOR DIGITAL MEMORIZED PREDISTORTION FOR WIRELESS COMMUNICATION	United States of America	13/619,538	9/14/12	US-2013-0243124-A1		8,731,495	5/20/14	Issued
SYSTEM AND METHOD FOR DIGITAL MEMORIZED PREDISTORTION FOR WIRELESS COMMUNICATION	United States of America	14/245,190	4/4/14	US-2014-0306762-A1		9,031,521	5/12/15	Issued
SYSTEM AND METHOD FOR DIGITAL MEMORIZED PREDISTORTION FOR WIRELESS COMMUNICATION	United States of America	14/684,678	4/13/15	US-2015-0326349-A1		9,374,196	6/21/16	Issued
SYSTEM AND METHOD FOR DIGITAL MEMORIZED PREDISTORTION FOR WIRELESS COMMUNICATION	United States of America	16/230,750	12/21/18					Pending
HIGH EFFICIENCY LINEARIZATION POWER AMPLIFIER FOR WIRELESS COMMUNICATION	China	200780023875.1	4/30/07	101479956	7/31/13	ZL200780023875.1	7/31/13	Issued
HIGH EFFICIENCY LINEARIZATION POWER AMPLIFIER FOR WIRELESS COMMUNICATION	United States of America	11/799,239	4/30/07	US 2007/0241812 A1		8,064,850	11/22/11	Issued
HIGH EFFICIENCY LINEARIZATION POWER AMPLIFIER FOR WIRELESS COMMUNICATION	United States of America	13/301,224	11/21/11	US-2012-0135695-A1	5/31/12	8,620,234	12/31/13	Issued
HIGH EFFICIENCY LINEARIZATION POWER AMPLIFIER FOR WIRELESS COMMUNICATION	United States of America	14/095,891	12/3/13	US-2014-0179248-A1		9,054,758	6/9/15	Issued
HIGH EFFICIENCY LINEARIZATION POWER AMPLIFIER FOR WIRELESS COMMUNICATION	United States of America	14/691,152	4/20/15	US-2015-0333710-A1		9,742,446	8/22/17	Issued

HIGH EFFICIENCY LINEARIZATION POWER AMPLIFIER FOR WIRELESS COMMUNICATION	United States of America	15/682,431	8/21/17	US-2018-0097530-A1		10,305,521	5/28/19	Issued
HIGH EFFICIENCY LINEARIZATION POWER AMPLIFIER FOR WIRELESS COMMUNICATION	United States of America	16/388,680	4/18/19					Pending
POWER AMPLIFIER PREDISTORTION METHODS AND APPARATUS	United States of America	11/962,025	12/20/07			8,472,897	6/25/13	Issued
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	China	200880003130.3	1/28/08	101606315	12/16/09	ZL200880003130.3	7/2/14	Issued
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	Macao	J/001490	1/28/08		1/2/15	J/001490	11/13/14	Issued
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	United States of America	12/021,241	1/28/08	US 2008-0174365 A1	7/24/08	8,380,143	2/19/13	Issued
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	China	201410199319.1	1/28/08	CN 103997301 A	9/28/18	ZL 201410199319.1	9/28/18	Issued
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	Hong Kong	14109438.5	9/18/14	1196186A	12/5/14			Published
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	Macao	J/001456	7/2/14					Pending
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	United States of America	13/724,157	12/21/12	US-2013-0147550-A1		9,077,297	7/7/15	Issued
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	United States of America	14/788,567	6/30/15	US-2016-0036394-A1		10,097,142	10/9/18	Issued
POWER AMPLIFIER TIME-DELAY INVARIANT PREDISTORTION METHODS AND APPARATUS	United States of America	16/118,329	8/30/18					Pending
ANALOG POWER AMPLIFIER PREDISTORTION METHODS AND APPARATUS	United States of America	12/203,064	9/2/08	US-2009-0085658-A1		8,693,962	4/8/14	Issued

POWER AMPLIFIER PREDISTORTION METHODS AND APPARATUS USING ENVELOPE AND PHASE DETECTOR	United States of America	12/203,076	9/2/08	US-2009-0096521-A1	4/16/09	8,224,266	7/17/12	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	China	200780051434.2	12/20/07	102017553	10/15/14	ZL200780051434.2	10/15/14	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDE-BAND COMMUNICATION SYSTEMS	India	4344/CHENP/2009	12/20/07			283900	6/5/17	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	Japan	2009-543544	12/20/07	2010-518660	7/17/13	5236661	4/5/13	Issued
METHOD AND SYSTEM FOR BASED AND PREDISTORITION LEANARIZATION IN MULTI-CHANNEL WIDE-BAND COMMUNICATION SYSTEMS	Macao	J/001620	12/20/07			J/001620	3/10/15	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	11/961,969	12/20/07	US 2008/0152037 A1		8,149,950	4/3/12	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	China	201410462933.2	12/20/07	CN 104202279 A				Published
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	European Patent Office	18187871.1	12/20/07	3416340				Published

METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	Hong Kong	15105454.1	12/20/07	1205382A	12/11/15			Published
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	13/404,679	2/24/12	US-2012-0147993-A1	6/14/12	8,509,347	8/13/13	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	13/887,133	5/3/13	US-2013-0315291-A1		8,855,234	10/7/14	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	14/480,285	9/8/14	US-2015-0092830-A1		9,246,731	1/26/16	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	14/991,264	1/8/16	US-2016-0269210-A1		9,913,194	3/6/18	Issued
METHOD AND SYSTEM FOR BASEBAND PREDISTORTION LINEARIZATION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	15/875,936	1/19/18	US-2018-0279197-A1				Published
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	China	200880021049.8	4/23/08	101720528	6/2/10	ZL200880021049.8	3/19/14	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	Germany	08746721.3	4/23/08	2143209		60 2008 056 496.7	8/15/18	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	European Patent Office	08746721.3	4/23/08	2143209	8/15/18	2143209	8/15/18	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	France	08746721.3	4/23/08	2143209		2143209	8/15/18	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	United Kingdom	08746721.3	4/23/08	2143209		2143209	8/15/18	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	India	7544/DELNP/2009	4/23/08	28/2010				Published

DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	Japan	2010-506483	4/23/08	2010-525758	7/22/10	5591106	8/8/14	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	Republic of Korea	10-2009-7024361	4/23/08	10-2010-0017270	3/24/15	10-1503548	3/11/15	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	Macao	J/001446	4/23/08		9/29/14	J/001446	8/25/14	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	Netherlands	08746721.3	4/23/08	2143209		2143209	8/15/18	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	United States of America	12/108,502	4/23/08	US-2008-0265996-A1		8,811,917	8/19/14	Issued
METHOD FOR UPDATING COEFFICENTS OF A PREDISTORTION CIRCUIT AND ADAPTATION CIRCUIT	Republic of Korea	10-2014-7021366	4/23/08		12/22/16	10-1688710	12/15/16	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	United States of America	14/271,881	5/7/14	US-2014-0327481-A1		9,768,739	9/19/17	Issued
DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM	United States of America	15/684,580	8/23/17	US-2018-0102747-A1				Published
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	China	200880021149.0	4/23/08	102089966	2/3/16	ZL 2008800211490	2/3/16	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	Germany	08829011.9	4/23/08	2145385		60 2008 057 483.0	10/17/18	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	European Patent Office	08829011.9	4/23/08	2145385	10/17/18	2145385	10/17/18	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	France	08829011.9	4/23/08	2145385		2145385	10/17/18	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	United Kingdom	08829011.9	4/23/08	2145385		2145385	10/17/18	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	India	7514/DELNP/2009	4/23/08	27/2010	9/10/18	300878	9/10/18	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	Japan	2010-504909	4/23/08	2010-530148	4/16/14	5474764	2/14/14	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	Republic of Korea	10-2009-7024268	4/23/08	10-2010-0017214	1/20/15	10-1484796	1/14/15	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	Macao	J/002140	4/23/08		9/13/16	J/002140	8/9/16	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	Netherlands	08829011.9	4/23/08	2145385		2145385	10/17/18	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER	United States of America	12/108,507	4/23/08	US 2008-0284509 A1	11/20/08	7,688,135	3/30/10	Issued
BASEBAND-DERIVED RF DIGITAL PREDISTORTION	China	200880126324.2	12/8/08	102150361	11/9/16	ZL 2008801263242	11/9/16	Issued

BASEBAND-DERIVED RF DIGITAL PREDISTORTION	European Patent Office	08873193.0	12/8/08	2248255				Published
BASEBAND-DERIVED RF DIGITAL PREDISTORTION	India	4196/CHENP/2010	12/8/08	01/2011				Published
BASEBAND-DERIVED RF DIGITAL PREDISTORTION	Japan	2010-536550	12/8/08	2011-511493	7/31/13	5250636	4/19/13	Issued
BASEBAND-DERIVED WIDEBAND RF DIGITAL PREDISTORTION SYSTEM	Republic of Korea	10-2010-7015019	12/8/08	10-2010-0108546	10/25/16	10-1669173	10/19/16	Issued
BASEBAND-DERIVED RF DIGITAL PREDISTORTION	Macao	J/002468	12/8/08		5/4/17	J/002468	4/11/17	Issued
BASEBAND-DERIVED RF DIGITAL PREDISTORTION	United States of America	12/330,451	12/8/08	US 2009-0146736 A1		8,213,884	7/3/12	Issued
BASEBAND-DERIVED RF DIGITAL PREDISTORTION	United States of America	13/481,389	5/25/12	US-2012-0230382-A1	9/13/12	8,401,499	3/19/13	Issued
BASEBAND-DERIVED RF DIGITAL PREDISTORTION	United States of America	13/776,163	2/25/13	US-2013-0214861-A1		8,548,403	10/1/13	Issued
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	China	201080025887.X	4/26/10	CN 102460385 A	5/16/12	ZL201080025887X	3/2/16	Issued
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	European Patent Office	10767899.7	4/26/10	2 430 531	3/21/12			Allowed
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	Indonesia	W-00 2012 01448	4/26/10		12/19/17	ID P 000 048 875	12/19/17	Issued
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	India	8527/CHENP/2011	4/26/10	8527/CHENP/2011				Published
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	Republic of Korea	10-2011-7027891	4/26/10			10-1967471	4/3/19	Issued
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	Macao	J/002198	4/26/10		10/17/16	J/002198	9/12/16	Issued
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	United States of America	12/767,669	4/26/10	US 2010-0271957 A1	10/28/10	9,026,067	5/5/15	Issued
REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	Japan	2015-178686	4/26/10					Pending

REMOTELY RECONFIGURABLE POWER AMPLIFIER SYSTEM AND METHOD	Japan	2017-253609	4/26/10					Pending
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER WITH POWER TRACKING	United States of America	12/603,419	10/21/09	US-2010-0176885-A1	7/15/10	8,274,332	9/25/12	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER WITH POWER TRACKING	United States of America	13/553,967	7/20/12	US-2013-0009707-A1	1/10/13	8,618,883	12/31/13	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER WITH POWER TRACKING	United States of America	14/087,682	11/22/13	US-2014-0191805-A1		9,184,703	11/10/15	Issued
N-WAY DOHERTY DISTRIBUTED POWER AMPLIFIER WITH POWER TRACKING	United States of America	14/885,890	10/16/15	US-2016-0173040-A1		10,298,177	5/21/19	Issued
MULTI-BAND WIDEBAND POWER AMPLIFIER DIGITAL PREDISTORTION SYSTEM AND METHOD	China	201080064338.3	12/21/10	CN 102939716A		ZL 201080064338.3	2/3/16	Issued
MULTI-BAND WIDEBAND POWER AMPLIFIER DIGITAL PREDISTORTION SYSTEM AND METHOD	Macao	J/2106	12/21/10			J/002106	7/29/16	Issued
MULTI-BAND WIDEBAND POWER AMPLIFIER DIGITAL PREDISTORITION SYSTEM AND METHOD	United States of America	12/928,934	12/21/10	US-2012-0154038-A1	6/21/12	8,351,877	1/8/13	Issued
DIGITAL PREDISTORTION SYSTEM AND METHOD FOR AMPLIFYING SIGNALS	China	201610003690.5	12/21/10	CN 105634415A	3/8/19	ZL 201610003690.5	3/8/19	Issued
A MULTI-BAND DIGITAL PREDISTORTION SYSTEM AND A METHOD FOR AMPLIFYING SIGNALS	Hong Kong	16112532.2	12/21/10	1224439A	8/18/17			Published
DIGITAL PREDISTORTION SYSTEM AND METHOD FOR AMPLIFYING SIGNALS	Macao	J/3685	12/21/10					Pending
MULTI-BAND WIDE BAND POWER AMPLIFIER DIGITAL PREDISTORTION SYSTEM	United States of America	13/705,022	12/4/12	US-2013-0094612-A1		8,467,747	6/18/13	Issued

MULTI-BAND WIDE BAND POWER AMPLIFIER DIGITAL PREDISTORTION SYSTEM	United States of America	13/894,987	5/15/13	US-2013-0251066-A1		8,903,337	12/2/14	Issued
MULTI-BAND WIDE BAND POWER AMPLIFIER DIGITAL PREDISTORTION SYSTEM	United States of America	14/553,828	11/25/14	US-2015-0171899-A1		9,379,745	6/28/16	Issued
MULTI-BAND WIDE BAND POWER AMPLIFIER DIGITAL PREDISTORTION SYSTEM	United States of America	15/181,033	6/13/16	US-2017-0047952-A1				Published
REMOTE RADIO HEAD UNIT WITH WIDEBAND POWER AMPLIFIER AND METHOD	China	201080064329.4	12/21/10	CN 102948081A	6/1/16	ZL 201080064329.4	6/1/16	Issued
REMOTE RADIO HEAD UNIT WITH WIDEBAND POWER AMPLIFIER AND METHOD	Macao	J/2296	12/21/10			J/002296	12/14/16	Issued
REMOTE RADIO HEAD UNIT SYSTEM WITH WIDEBAND POWER AMPLIFIER AND METHOD	United States of America	12/928,933	12/21/10	US 2011-0158081 A1		8,730,786	5/20/14	Issued
SYSTEM FOR IMPROVING ISOLATION BETWEEN TRANSMITTERS AND RECEIVERS	Hong Kong	17103802.3	12/21/10	1230352A	12/1/17			Published
REMOTE RADIO HEAD UNIT SYSTEM WITH WIDEBAND POWER AMPLIFIER AND METHOD	United States of America	14/248,597	4/9/14	US-2014-0219174-A1		9,106,453	8/11/15	Issued
REMOTE RADIO HEAD UNIT SYSTEM WITH WIDEBAND POWER AMPLIFIER	United States of America	14/754,908	6/30/15	US-2015-0382363-A1		9,814,053	11/7/17	Issued
REMOTE RADIO HEAD UNIT SYSTEM WITH WIDEBAND POWER AMPLIFIER	United States of America	15/718,469	9/28/17	US-2018-0152947-A1		10,153,789	12/11/18	Issued
REMOTE RADIO HEAD UNIT SYSTEM WITH WIDEBAND POWER AMPLIFIER	United States of America	16/213,103	12/7/18					Pending
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	China	201080064414.0	12/21/10	CN 102948071A		ZL 201080064414.0	6/22/16	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	Germany	10838778.8	12/21/10	2517353	10/31/12	60 2010 032 691.8	4/20/16	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	European Patent Office	10838778.8	12/21/10	2517353	10/31/12	2517353	4/20/16	Issued

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MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	United Kingdom	10838778.8	12/21/10	2517353	10/31/12	2517353	4/20/16	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	Indonesia	W00201202630	12/21/10	2014/04399	5/17/18	IDP000051138	5/17/18	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	India	6164/CHENP/2012	12/21/10	2012CN06164				Published
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	Japan	2012-545469	12/21/10	2013-515423		5761646	6/19/15	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	Republic of Korea	10-2012-7019385	12/21/10			10-1815329	12/28/17	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	Macao	J/2312	12/21/10			J/002312	1/4/17	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	United States of America	12/928,931	12/21/10	US-2011-0156815-A1		8,804,870	8/12/14	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	European Patent Office	16166094.9	12/21/10	3068047				Published
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	Hong Kong	17101974.9	12/21/10	1228604A	11/3/17			Published
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	Indonesia	P00201803072	12/21/10					Pending
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	United States of America	14/337,004	7/21/14	US-2015-0010110-A1		9,866,414	1/9/18	Issued
MODULATION AGNOSTIC DIGITAL HYBRID MODE POWER AMPLIFIER SYSTEM AND METHOD	United States of America	15/827,794	11/30/17	US-2018-0227152-A1				Published
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	China	201080064443.7	12/21/10	CN 102870494A	4/20/16	ZL 201080064443.7	4/20/16	Issued

HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	Germany	10848623.4	12/21/10	2524568	11/21/12	60 2010 036 118.7	8/31/16	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	European Patent Office	10848623.4	12/21/10	2524568	8/31/16	2524568	8/31/16	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	France	10848623.4	12/21/10	2524568	11/21/12	2524568	8/31/16	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	United Kingdom	10848623.4	12/21/10	2524568	11/21/12	2524568	8/31/16	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	Indonesia	W00201202631	12/21/10	2013/00167 A	3/21/16	IDP000040 655	3/21/16	Issued
HIGH EFFICIENCY REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	India	6163/CHENP/2012	12/21/10	2012CN06163				Published
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	Japan	2012-545471	12/21/10	2013-515424		5744910	5/15/15	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM FOR WIRELESS COMMUNICATIONS	Republic of Korea	10-2012-7019387	12/21/10			10-1763970	7/26/17	Issued

HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	Macao	J/2206	12/21/10			J/002206	10/18/16	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	United States of America	12/928,943	12/21/10	US-2012-0155572-A1	6/21/12	8,542,768	9/24/13	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	Germany	16181745.7	12/21/10	3110231		60 2010 050 454.9	5/2/18	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	European Patent Office	16181745.7	12/21/10	3110231	5/2/18	3110231	5/2/18	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	France	16181745.7	12/21/10	3110231		3110231	5/2/18	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	United Kingdom	16181745.7	12/21/10	3110231		3110231	5/2/18	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	Hong Kong	17105876.9	12/21/10	1232372A	1/18/19	1232372B	1/18/19	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	Netherlands	16181745.7	12/21/10	3110231		3110231	5/2/18	Issued

HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	United States of America	14/020,425	9/6/13	US-2014-0079153-A1		8,824,595	9/2/14	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	United States of America	14/335,647	7/18/14	US-2015-0080054-A1		9,048,797	6/2/15	Issued
HIGH EFFICIENCY, REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT SYSTEM AND METHOD FOR WIRELESS COMMUNICATIONS	United States of America	14/703,579	5/4/15	US-2015-0381217-A1		9,948,332	4/17/18	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	China	201180050053.9	8/16/11	CN 103180844 A	10/3/17	ZL 201180050053.9	10/3/17	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	European Patent Office	11818694.9	8/16/11	2606435				Published
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	Indonesia	W00 201300982	8/16/11	2014/01150		IDP000048511	11/9/17	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	India	1764/CHENP/2013	8/16/11					Published
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	Japan	2013-524941	8/16/11	2013-541255		5911149	4/8/16	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2013-7006774	8/16/11			10-1662879	9/28/16	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	Macao	J/2833	8/16/11			J/002833	2/15/18	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	United States of America	13/211,236	8/16/11	US-2012-0069880-A1		8,848,766	9/30/14	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	China	201710791641.7	8/16/11	CN 107682021A				Published

REMOTELY RECONFIGURABLE REMOTE RADIO HEAD UNIT	Hong Kong	18109794.9	8/16/11	1250427A	12/14/18			Published
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2016-7026899	8/16/11			10-1835254	2/27/18	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	United States of America	14/479,875	9/8/14	US-2015-0055593-A1		9,826,508	11/21/17	Issued
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	United States of America	15/786,396	10/17/17	US-2018-0184404-A1				Allowed
NEUTRAL HOST ARCHITECTURE FOR A DISTRIBUTED ANTENNA SYSTEM	United States of America	16/406,252	5/8/19					Pending
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	China	201180050052.4	8/16/11	CN 103597807A		ZL 201180050052.4	9/30/15	Issued
REMOTELY CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	European Patent Office	11818695.6	8/16/11	2606571				Published
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Hong Kong	14106888.6	8/16/11	1193522A	8/12/16	HK1193522	8/12/16	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Indonesia	W00 201300983	8/16/11	2015/05508				Published
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	India	1763/CHENP/2013	8/16/11					Published
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Japan	2013-524942	8/16/11	2014-500635		5859538	12/25/15	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Republic of Korea	10-2013-7006776	8/16/11			10-1610447	4/1/16	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Macao	J/1934	8/16/11			J/001934	3/23/16	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	United States of America	13/211,243	8/16/11	US-2012-0039320-A1		8,682,338	3/25/14	Issued

SYSTEM FOR TRANSMITTING SIGNALS AND DISTRIBUTED ANTENNA SYSTEM	China	201510502030.7	8/16/11	CN 105208083A	9/21/18	ZL 201510502030.7	9/21/18	Issued
SYSTEM FOR TRANSMITTING SIGNALS AND DISTRIBUTED ANTENNA SYSTEM	Hong Kong	16105628.1	8/16/11	1217583A	1/13/17			Published
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Japan	2018-124665	8/16/11					Pending
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Macao	J/3488	8/16/11					Pending
REMOTELY RECONFIGUREABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	United States of America	14/169,719	1/31/14	US-2014-0286247-A1		9,419,714	8/16/16	Issued
A METHOD OF OPERATING A DISTRIBUTED ANTENNA SYSTEM AND A METHOD OF COMMUNICATING IN THE SYSTEM	China	201510531485.1	8/16/11	CN 105141513A	12/14/18	ZL 201510531485.1	12/14/18	Issued
METHOD FOR OPERATING A DISTRIBUTED ANTENNA SYSTEM AND METHOD OF COMMUNICATING IN THE SYSTEM	Hong Kong	16105230.1	8/16/11	1217385A	1/6/17			Published
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Japan	2015-245373	8/16/11			6144327	5/19/17	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Republic of Korea	10-2015-7024302	8/16/11			10-1829517	2/8/18	Issued
A METHOD OF OPERATING A DISTRIBUTED ANTENNA SYSTEM AND A METHOD OF COMMUNICATING IN THE SYSTEM	Macao	J/3540	8/16/11					Pending
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	United States of America	14/949,405	11/23/15	US-2016-0080082-A1		9,531,473	12/27/16	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Japan	2017-094314	8/16/11		7/25/18	6364109	7/6/18	Issued

REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	Republic of Korea	10-2018-7003797	8/16/11	20180017234				Published
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	United States of America	15/205,820	7/8/16	US-2017-0070897-A1		9,820,171	11/14/17	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	United States of America	15/391,408	12/27/16	US-2017-0238318-A1		10,159,074	12/18/18	Issued
REMOTELY RECONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHODS	United States of America	16/175,520	10/30/18					Pending
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	China	201180050066.6	8/16/11	CN 103201958A	1/18/17	ZL 201180050066.6	1/18/17	Issued
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	European Patent Office	11818697.2	8/16/11	2606576				Published
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Indonesia	W00 201300670	8/16/11					Pending
DAISY CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	India	1856/CHENP/2013	8/16/11					Published
DAISY CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Japan	2013-525983	8/16/11	2013-541875		6005646	9/16/16	Issued
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIDUTED ANTENNA SYSTEM	Republic of Korea	10-2013-7006775	8/16/11			10-1874655	6/28/18	Issued
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Macao	J/2551	8/16/11			J/002551	6/9/17	Issued
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	United States of America	13/211,247	8/16/11	US-2012-0039254-A1		8,737,300	5/27/14	Issued
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	United States of America	13/913,207	6/7/13	US-2013-0272202-A1		9,148,324	9/29/15	Issued
DAISY-CHAINED RING OF REMOTE UNITS	China	201611139142.1	8/16/11	CN 106921549A				Published

DAISY-CHAINED RING OF REMOTE UNITS	Hong Kong	17112719.6	8/16/11	1238815A	5/4/18			Published
DAISY-CHAINED RING OF REMOTE UNITS	Macao							Unfiled
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	United States of America	14/260,145	4/23/14	US-2014-0313884-A1		9,137,078	9/15/15	Issued
A METHOD OF COMMUNICATING IN A DISTRIBUTED ANTENNA SYSTEM	China	201610011597.9	8/16/11	CN105634585A				Allowed
A METHOD OF COMMUNICATING IN A DISTRIBUTED ANTENNA SYSTEM	Hong Kong	16112531.3	8/16/11	1224444A	8/18/17			Published
A METHOD AND SYSTEM FOR ROUTING AND SWITCHING SIGNALS	Indonesia	P00201801237	8/16/11					Pending
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Japan	2016-139702	8/16/11			6405342	9/21/18	Issued
A METHOD OF COMMUNICATING IN A DISTRIBUTED ANTENNA SYSTEM	Macao							Unfiled
DISTRIBUTED ANTENNA SYSTEM	United States of America	14/800,515	7/15/15	US-2016-0014782-A1		9,419,837	8/16/16	Issued
TRANSPORT OF WIRELESS COMMUNICATIONS	China	201611138820.2	8/16/11	CN 106850735A				Published
WIRELESS COMMUNICATION TRANSMISSION	Hong Kong	17111546.7	8/16/11	1238016A	4/20/18			Published
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Indonesia	P00201703225	8/16/11	2018/00031				Published
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Japan	2016-174930	8/16/11			6463707	1/11/19	Issued
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2018-7018518	8/16/11	20180078335		10-1947975	2/7/19	Issued
TRANSPORT OF WIRELESS COMMUNICATIONS	Macao							Unfiled
DISTRIBUTED ANTENNA SYSTEM	United States of America	15/223,819	7/29/16	US-2017-0055198-A1		10,080,178	9/18/18	Issued

DIGITAL REMOTE UNITS IN A DISTRIBUTED ANTENNA SYSTEM	China	201611138760.4	8/16/11	CN 107018055A				Published
DIGITAL REMOTE UNIT IN DISTRIBUTED ANTENNA SYSTEM	Hong Kong	17113376.8	8/16/11	1239987A	5/11/18			Published
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Japan	2019-000096	8/16/11					Pending
DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2019-7003593	8/16/11	20190015636				Published
DIGITAL REMOTE UNITS IN A DISTRIBUTED ANTENNA SYSTEM	Macao							Unfiled
DISTRIBUTED ANTENNA SYSTEM	United States of America	16/059,434	8/9/18	US-2019-0110239-A1				Allowed
TRANSPORT OF WIRELESS COMMUNICATIONS	China	201611139152.5	8/16/11	CN 107104869A				Published
WIRELESS COMMUNICATION TRANSMISSION	Hong Kong	18100385.3	8/16/11	1241165A	6/1/18			Published
TRANSPORT OF WIRELESS COMMUNICATIONS	Macao							Unfiled
DISTRIBUTED ANTENNA SYSTEM	United States of America	16/410,860	5/13/19					Pending
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	China	201280042828.2	9/4/12	CN 103999436A	8/24/16	ZL 201280042828.2	8/24/16	Issued
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	European Patent Office	12827424.8	9/4/12	2749123				Published
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	Hong Kong	15101013.4	9/4/12	1200622A	10/20/17	HK1200622	10/20/17	Issued
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	Macao	J/2359	9/4/12			J/002359	2/14/17	Issued
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	United States of America	13/602,818	9/4/12	US-2014-0072064-A1		8,817,848	8/26/14	Issued

SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	United States of America	14/333,277	7/16/14	US-2015-0078471-A1		9,148,203	9/29/15	Issued
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR REDUCING UPLINK NOISE	United States of America	14/831,626	8/20/15	US-2015-0358054-A1		9,954,585	4/24/18	Issued
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	China	201280045910.0	9/24/12	CN 103858337A	5/3/17	ZL 201280045910.0	5/3/17	Issued
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	Hong Kong	14109157.4	9/24/12	1195829A	4/27/18	HK1195829	4/27/18	Issued
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	Japan	2014-532074	9/24/12	2014-526863		6080854	1/27/17	Issued
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	Republic of Korea	10-2014-7010583	9/24/12					Allowed
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	Macao	J/1529	9/24/12			J/001529	6/23/17	Issued
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	13/625,760	9/24/12	US-2013-0077713-A1		8,873,674	10/28/14	Issued

SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	14/480,267	9/8/14	US-2014-0376661-A1		9,197,259	11/24/15	Issued
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	14/918,371	10/20/15	US-2016-0191087-A1		10,256,853	4/9/19	Issued
SYSTEM AND METHOD FOR INCREASING BANDWIDTH FOR DIGITAL PREDISTORTION IN MULTI-CHANNEL WIDEBAND COMMUNICATION SYSTEMS	United States of America	16/279,535	2/19/19					Pending
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR BANDWIDTH COMPRESSION AND TRANSPORT OF SIGNALS IN NONCONTIGUOUS FREQUENCY BLOCKS	United States of America	13/686,036	11/27/12	US-2014-0010168-A1		8,724,664	5/13/14	Issued
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR BANDWIDTH COMPRESSION AND TRANSPORT OF SIGNALS IN NONCONTIGUOUS FREQUENCY BLOCKS	United States of America	14/225,673	3/26/14	US-2014-0206282-A1		9,236,897	1/12/16	Issued
SOFTWARE CONFIGURABLE DISTRIBUTED ANTENNA SYSTEM AND METHOD FOR BANDWIDTH COMPRESSION AND TRANSPORT OF SIGNALS IN NONCONTIGUOUS FREQUENCY BLOCKS	United States of America	14/960,177	12/4/15	US-2016-0226784-A1		9,722,939	8/1/17	Issued
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United Arab Emirates	471/2014	11/6/12					Pending
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Australia	2012336027	11/6/12		4/13/17	2012336027	7/28/17	Issued

SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Brazil	BR 11 2014 010895 1	11/6/12					Pending
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	China	201280066105.6	11/6/12	CN 104040368A	8/22/17	ZL 201280066105.6	8/22/17	Issued
RESOURCE ALLOCATION IN A DISTRIBUTED ANTENNA SYSTEM	Germany	12847270.1	11/6/12	EP 2776857 A1		60 2012 047 724.5	6/20/18	Issued
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Eurasian Patent Office	201400556	11/6/12					Pending
RESOURCE ALLOCATION IN A DISTRIBUTED ANTENNA SYSTEM	European Patent Office	12847270.1	11/6/12	EP 2776857 A1	6/20/18	2776857	6/20/18	Issued
RESOURCE ALLOCATION IN A DISTRIBUTED ANTENNA SYSTEM	France	12847270.1	11/6/12	EP 2776857 A1		2776857	6/20/18	Issued
RESOURCE ALLOCATION IN A DISTRIBUTED ANTENNA SYSTEM	United Kingdom	12847270.1	11/6/12	EP 2776857 A1		2776857	6/20/18	Issued
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Hong Kong	15101263.1	11/6/12	1200916A	7/13/18	HK1200916	7/13/18	Issued
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Indonesia	P00 2014 03239	11/6/12	2015/04205				Published
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Israel	232439	11/6/12		4/30/19			Pending
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	India	4237/CHENP/2014	11/6/12					Published
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Japan	2014-540195	11/6/12	2014-534783		6101277	3/3/17	Issued
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2014-7015429	11/6/12					Pending
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Macao	J/2816	11/6/12			J/002816	2/12/18	Issued
RESOURCE ALLOCATION IN A DISTRIBUTED ANTENNA SYSTEM	Netherlands	12847270.1	11/6/12	EP 2776857 A1		2776857	6/20/18	Issued

SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Singapore	11201402105S	11/6/12			11201402105S	7/26/16	Issued
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	13/670,162	11/6/12	US-2013-0114963-A1				Published
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Australia	2017204786	11/6/12					Pending
SOFT HAND-OFF AND ROUTING DATA IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	China	201710619658.4	11/6/12	CN 107529172A				Published
SOFT HAND-OFF IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	European Patent Office	18178591.6	11/6/12	3445078				Published
SOFT HAND-OFF AND ROUTING DATA IN VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Hong Kong	18106058.6	11/6/12	1247019A	9/14/18			Published
VIRTUALIZED WIRELESS NETWORK	United Arab Emirates	472/2014	11/6/12					Pending
VIRTUALIZED WIRELESS NETWORK	Australia	2012336026	11/6/12		7/21/16	2012336026	11/3/16	Issued
VIRTUALIZED WIRELESS NETWORK	Brazil	11 2014 011034 4	11/6/12					Pending
VIRTUALIZED WIRELESS NETWORK	China	201280066289.6	11/6/12	CN 104081795B	12/21/18	ZL 201280066289.6	12/21/18	Issued
VIRTUALIZED WIRELESS NETWORK	Eurasian Patent Office	201400555	11/6/12	201400555				Published
VIRTUALIZED WIRELESS NETWORK	European Patent Office	12848304.7	11/6/12	EP 2777302				Published
VIRTUALIZED WIRELESS NETWORK	Hong Kong	15102186.3	11/6/12	1202012A	9/11/15			Published
VIRTUALIZED WIRELESS NETWORK	Indonesia	P00 2014 03237	11/6/12	2015/03305				Allowed
VIRTUALIZED WIRELESS NETWORK	Israel	232438	11/6/12			232438	7/31/18	Issued
VIRTUALIZED WIRELESS NETWORK	India	4232/CHENP/2014	11/6/12	2014CN04232				Published
VIRTUALIZED WIRELESS NETWORK	Japan	2014-540194	11/6/12	2015-505427		6158818	6/16/17	Issued
VIRTUALIZED WIRELESS NETWORK	Republic of Korea	10-2014-7015432	11/6/12					Pending

VIRTUALIZED WIRELESS NETWORK	Macao	J/1714	11/6/12					Pending
VIRTUALIZED WIRELESS NETWORK	Malaysia	PI 2014001321	11/6/12					Pending
VIRTUALIZED WIRELESS NETWORK	Singapore	11201402104T	11/6/12			11201402104T	2/2/18	Issued
VIRTUALIZED WIRELESS NETWORK	United States of America	13/670,290	11/6/12	US-2013-0128810-A1		10,264,626	4/16/19	Issued
VIRTUALIZED WIRELESS NETWORK	China	201811416669.3	11/6/12					Pending
VIRTUALIZED WIRELESS NETWORK	Japan	2017-113169	11/6/12					Pending
VIRTUALIZED WIRELESS NETWORK	Singapore	10201800761X	11/6/12	10201800761X				Published
VIRTUALIZED WIRELESS MESH NETWORK	United States of America	15/857,356	12/28/17	US-2018-0249532-A1				Published
VIRTUALIZED WIRELESS NETWORK	Australia	2018247240	11/6/12					Pending
VIRTUALIZED WIRELESS NETWORK WITH PILOT BEACONS	United States of America	13/671,203	11/7/12	US-2013-0114486-A1		9,420,628	8/16/16	Issued
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Brazil	BR 11 2014 018841 6	1/31/13					Pending
A SYSTEM FOR ROUTING SIGNALS IN A DISTRIBUTED ANTENNA SYSTEM	China	201380007517.7	1/31/13	CN 104221293A	2/22/17	ZL 201380007517.7	2/22/17	Issued
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	European Patent Office	13744144.0	1/31/13	2 810 373				Published
SYSTEM FOR ROUTING SIGNALS IN A DISTRIBUTED ANTENNA SYSTEM	Hong Kong	15104338.6	1/31/13	1204164A	3/29/18	HK1204164	3/29/18	Issued
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Israel	233785	1/31/13					Pending
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	India	5859/CHENP/2014	1/31/13	2014CN05859				Published
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Japan	2014-554989	1/31/13			6193265	8/18/17	Issued

DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2014-7024349	1/31/13					Pending
A SYSTEM FOR ROUTING SIGNALS IN A DISTRIBUTED ANTENNA SYSTEM	Macao	J/2563	1/31/13			J/002563	6/23/17	Issued
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	13/754,702	1/30/13	US-2014-0037292-A1		9,025,956	5/5/15	Issued
DATA TRANSMISSION IN VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Hong Kong	17113429.5	1/31/13	1239969A	5/11/18			Published
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Japan	2017-154789	1/31/13					Pending
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	14/678,779	4/3/15	US-2015-0326957-A1		9,621,971	4/11/17	Issued
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	15/445,467	2/28/17	US-2017-0303019-A1		10,051,350	8/14/18	Issued
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	16/039,182	7/18/18	US-2019-0082243-A1				Published
FREQUENCY TRANSLATION IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	13/753,288	1/29/13	US-2014-0036770-A1		9,723,612	8/1/17	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	Brazil	BR 11 2014 020305 9	2/19/13					Pending
METHODS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	China	201380009723.1	2/19/13	CN104160725A	5/1/18	ZL 201380009723.1	5/1/18	Issued
EVOLUTIONARY ALOGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	Germany	13749837.4	2/19/13	2815591		60 2013 025 498.2	8/23/17	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	European Patent Office	13749837.4	2/19/13	2815591	8/23/17	2815591	8/23/17	Issued

EVOLUTIONARY ALOGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	France	13749837.4	2/19/13	2815591		2815591	8/23/17	Issued
EVOLUTIONARY ALOGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	United Kingdom	13749837.4	2/19/13	2815591		2815591	8/23/17	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	Hong Kong	15103517.1	2/19/13	1203022A	10/9/15			Published
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	Israel	233975	2/19/13		4/30/18	233975	7/31/18	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	India	6777/DELNP/2014	2/19/13	2014DN06777				Published
DATA TRANSPORT IN A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	Japan	2014-557866	2/19/13			6320939	4/13/18	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2014-7025637	2/19/13					Pending
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	Macao	J/3166	2/19/13			J/003166	10/9/18	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	United States of America	13/770,113	2/19/13	US-2014-0057627-A1		9,148,839	9/29/15	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA	European Patent Office	17185342.7	2/19/13	3258722				Published

EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	United States of America	14/837,850	8/27/15	US-2016-0073313-A1		9,854,494	12/26/17	Issued
EVOLUTIONARY ALGORITHMS FOR GEOGRAPHIC LOAD BALANCING USING A DISTRIBUTED ANTENNA SYSTEM	United States of America	15/782,309	10/12/17	US-2018-0160356-A1				Published
HYBRID DATA TRANSPORT FOR A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	13/777,185	2/26/13	US-2014-0072299-A1		9,537,572	1/3/17	Issued
HYBRID DATA TRANSPORT FOR A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	15/383,121	12/19/16	US-2017-0104538-A1		10,063,319	8/28/18	Issued
HYBRID DATA TRANSPORT FOR A VIRTUALIZED DISTRIBUTED ANTENNA SYSTEM	United States of America	16/054,678	8/3/18	US-2019-0036606-A1				Published
METHOD AND SYSTEM FOR SOFT FREQUENCY REUSE IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	13/894,309	5/14/13	US-2014-0233468-A1		9,197,358	11/24/15	Issued
METHOD AND SYSTEM FOR SOFT FREQUENCY REUSE IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	14/887,922	10/20/15	US-2016-0113014-A1		9,538,536	1/3/17	Issued
METHOD AND SYSTEM FOR SOFT FREQUENCY REUSE IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	15/383,431	12/19/16	US-2017-0230836-A1		9,942,771	4/10/18	Issued
METHOD AND SYSTEM FOR SOFT FREQUENCY REUSE IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	15/912,859	3/6/18	US-2018-0332477-A1				Allowed
METHOD AND SYSTEM FOR SOFT FREQUENCY REUSE IN A DISTRIBUTED ANTENNA SYSTEM	United States of America							Unfiled
SELF-OPTIMIZING DISTRIBUTED ANTENNA SYSTEM USING SOFT FREQUENCY REUSE	United States of America	13/935,157	7/3/13	US-2014-0161057-A1		9,363,768	6/7/16	Issued
SELF-OPTIMIZING DISTRIBUTED ANTENNA SYSTEM USING SOFT FREQUENCY REUSE	United States of America	15/154,073	5/13/16	US-2017-0013568-A1		9,769,766	9/19/17	Issued
SELF-OPTIMIZING DISTRIBUTED ANTENNA SYSTEM USING SOFT FREQUENCY REUSE	United States of America	15/676,631	8/14/17	US-2018-0092045-A1				Allowed

METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS	Brazil	BR 11 2015 001348 1	7/18/13						Pending
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS	China	201380039353.6	7/18/13	CN 104584501A					Allowed
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS	European Patent Office	13823723.5	7/18/13	2875620					Published
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS	Hong Kong	15108803.3	7/18/13	1208291A	2/26/16				Published
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS	Israel	236619	7/18/13		8/30/18	236619		12/1/18	Issued
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS	India	211/CHENP/2015	7/18/13	2015CN00211					Published
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS	Japan	2015-524332	7/18/13	2015-525036					Allowed

METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS		Republic of Korea	10-2015-7004064	7/18/13				Pending
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS		Macao						Unfiled
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS		United States of America	13/945,736	7/18/13	US-2014-0159810-A1	9,225,296	12/29/15	Issued
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS		Israel	259447	7/18/13				Pending
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS		United States of America	14/956,040	12/1/15	US-2016-0344351-A1	10,263,569	4/16/19	Issued
METHOD AND SYSTEM FOR ALIGNING SIGNALS WIDELY SPACED IN FREQUENCY FOR WIDEBAND DIGITAL PREDISTORTION IN WIRELESS COMMUNICATION SYSTEMS		United States of America	16/352,065	3/13/19				Pending
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM		United Arab Emirates	125/2015	7/26/13				Pending
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM		Australia	2013296819	7/26/13		8/31/17	2013296819	12/18/17 Issued

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Brazil	BR 11 2015 001916 1	7/26/13					Pending
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	China	201380040757.7	7/26/13	CN 104956732B	4/30/19	ZL 201380040757.7	4/30/19	Issued
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Eurasian Patent Office	201500184	7/26/13					Pending
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	European Patent Office	13825612.8	7/26/13	2880888				Published
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Hong Kong	16101919.8	7/26/13	1214067A	7/15/16			Published
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Indonesia	P00201500998	7/26/13					Pending
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Israel	236631	7/26/13			236631	12/1/18	Issued
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	India	244/CHENP/2015	7/26/13					Published
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Japan	2015-525473	7/26/13		8/15/18	6373837	7/27/18	Issued
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2015-7004047	7/26/13					Pending
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Macao							Unfiled
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Malaysia	PI 2015000254	7/26/13					Pending
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Singapore	11201500770U	7/26/13			11201500770U	5/22/17	Issued
OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	13/950,160	7/24/13	US-2014-0162664-A1				Published

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	Australia	2017268613	7/26/13					Pending
A SYSTEM FOR DYNAMICALLY ROUTING SIGNALS	China	201910237775.3	7/26/13					Pending
TIME SYNCHRONIZED ROUTING IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	13/960,346	8/6/13	US-2014-0162713-A1		9,439,242	9/6/16	Issued
TIME SYNCHRONIZED ROUTING IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	15/251,293	8/30/16	US-2017-0118734-A1		10,045,314	8/7/18	Issued
TIME SYNCHRONIZED ROUTING IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	16/038,613	7/18/18	US-2019-0082407-A1				Published
POWER AMPLIFIER PROTECTION USING A CYCLIC REDUNDANCY CHECK ON THE DIGITAL TRANSPORT OF DATA	United States of America	14/095,706	12/3/13	US-2014-0223266-A1		9,559,806	1/31/17	Issued
DAS INTEGRATED DIGITAL OFF-AIR REPEATER	United States of America	14/044,668	10/2/13	US-2014-0169263-A1		9,112,549	8/18/15	Issued
DAS INTEGRATED DIGITAL OFF-AIR REPEATER	United States of America	14/743,789	6/18/15	US-2016-0007264-A1		9,622,148	4/11/17	Issued
DAS INTEGRATED DIGITAL OFF-AIR REPEATER	United States of America	16/230,253	12/21/18					Pending
WIDE BANDWIDTH DIGITAL PREDISTORTION SYSTEM WITH REDUCED SAMPLING RATE	United States of America	13/777,194	2/26/13	US-2014-0241461-A1		8,913,689	12/16/14	Issued
WIDE BANDWIDTH DIGITAL PREDISTORTION SYSTEM WITH REDUCED SAMPLING RATE	United States of America	14/552,231	11/24/14	US-2015-0180519-A1		9,258,022	2/9/16	Issued
WIDE BANDWIDTH DIGITAL PREDISTORTION SYSTEM WITH REDUCED SAMPLING RATE	United States of America	14/987,093	1/4/16	US-2016-0261294-A1		9,673,848	6/6/17	Issued
WIDE BANDWIDTH DIGITAL PREDISTORTION SYSTEM WITH REDUCED SAMPLING RATE	United States of America	15/492,902	4/20/17	US-2017-0353199-A1		10,218,392	2/26/19	Issued
WIDE BANDWIDTH DIGITAL PREDISTORTION SYSTEM WITH REDUCED SAMPLING RATE	United States of America	16/240,433	1/4/19					Pending
INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	United States of America	14/168,328	1/30/14	US-2014-0313075-A1		9,671,496	6/6/17	Issued

INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	United States of America	15/582,776	5/1/17	US-2017-0363743-A1		10,180,497	1/15/19	Issued
INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	United States of America	16/205,567	11/30/18					Pending
FEEDBACK BASED INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	United States of America	14/171,600	2/3/14	US-2014-0306841-A1		9,476,984	10/25/16	Issued
FEEDBACK BASED INDOOR LOCALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	United States of America	15/279,136	9/28/16	US-2017-0146662-A1				Allowed
INDOOR LOCALIZATION USING ANALOG OFF-AIR ACCESS UNITS	United States of America	14/183,297	2/18/14	US-2014-0320340-A1				Published
METHOD AND SYSTEM FOR WI-FI DATA TRANSMISSION	United States of America	14/189,044	2/25/14	US-2014-0314061-A1		9,955,361	4/24/18	Issued
METHOD AND SYSTEM FOR WI-FI DATA TRANSMISSION	United States of America	15/907,153	2/27/18	US-2018-0324599-A1				Published
INDOOR TRILATERALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	United States of America	14/199,617	3/6/14	US-2014-0313076-A1		9,958,548	5/1/18	Issued
INDOOR TRILATERALIZATION USING DIGITAL OFF-AIR ACCESS UNITS	United States of America	15/917,342	3/9/18	US-2018-0329068-A1				Published
REAL-TIME LOCATING SYSTEM USING GPS TIME DIFFERENCE OF ARRIVAL WITH DIGITAL OFF-AIR ACCESS UNITS AND REMOTE UNITS	United States of America	14/257,209	4/21/14	US-2014-0340255-A1		9,851,445	12/26/17	Issued
REAL-TIME LOCATING SYSTEM USING GPS TIME DIFFERENCE OF ARRIVAL WITH DIGITAL OFF-AIR ACCESS UNITS AND REMOTE UNITS	United States of America	15/819,279	11/21/17	US-2018-0239025-A1				Published
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Brazil	BR 11 2016 014197 0	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	China	201480069382.1	12/18/14	CN 105830373B	4/23/19	ZL 201480069382.1	4/23/19	Issued
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	European Patent Office	14872389.3	12/18/14	3084992				Published

DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Hong Kong	17100236.5	12/18/14	1226878A				Published
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Indonesia	P00201604728	12/18/14	2017/10943				Published
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Israel	246210	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	India	201617023992	12/18/14					Published
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Japan	2016-541192	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Republic of Korea	10-2016-7019353	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Macao							Unfiled
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Malaysia	PI 2016001132	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Singapore	11201605002Q	12/18/14					Allowed
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	United States of America	14/574,071	12/17/14	US-2015-0207545-A1		9,847,816	12/19/17	Issued
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Australia	2019202190	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	China	201910227542.5	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	Singapore	10201904722T	12/18/14					Pending
DIGITAL TRANSPORT OF DATA OVER DISTRIBUTED ANTENNA NETWORK	United States of America	15/812,018	11/14/17	US-2018-0212650-A1				Allowed

NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Brazil	BR 11 2016 015642 0	1/6/15					Pending
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	China	201580003669.9	1/6/15	CN 105874824A				Published
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	European Patent Office	15733064.8	1/6/15	3092832				Published
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Hong Kong	17100234.7	1/6/15	1226892A				Published
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Indonesia	P00 2016 05228	1/6/15	2017/10346				Published
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Israel	246326	1/6/15					Pending
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	India	201617024698	1/6/15					Published
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Japan	2016-562732	1/6/15					Pending
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Republic of Korea	10-2016-7020351	1/6/15					Pending
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Malaysia	PI 2016001173	1/6/15					Pending
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Singapore	11201605464T	1/6/15					Pending
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	United States of America	14/590,447	1/6/15	US-2015-0303999-A1				Allowed
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Australia	2019202185	1/6/15					Pending
NETWORK SWITCH FOR A DISTRIBUTED ANTENNA NETWORK	Singapore	10201805615W	1/6/15	10201805615W				Published

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DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	United States of America	14/580,585	12/23/14	US-2015-0303998-A1				Published
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Brazil	BR 11 2016 014663 8	12/23/14					Pending
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	China	201480070750.4	12/23/14	CN 105917675A				Published
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	European Patent Office	14874737.1	12/23/14	3087762				Published
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Hong Kong	17100988.5	12/23/14	1227599A				Published
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Indonesia	P00201604818	12/23/14	2017/09815				Published
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Israel	246242	12/23/14					Pending
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	India	201617024316	12/23/14					Published
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Japan	2016-560881	12/23/14					Pending
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2016-7020070	12/23/14					Pending
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Malaysia	PI 2016001159	12/23/14					Pending
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Singapore	11201605115V	12/23/14					Pending
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	United States of America							Unfiled
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Australia	2019202115	12/23/14					Pending
DIGITAL MULTIPLEXER IN A DISTRIBUTED ANTENNA SYSTEM	Singapore	10201805212Y	12/23/14	10201805212Y				Published
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Australia	2015218375	2/13/15					Pending
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Switzerland	15749690.2	2/13/15	3105968		3105968	12/5/18	Issued
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	China	201580008198.0	2/13/15	CN 105993139A				Published

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SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Germany	15749690.2	2/13/15	3105968		602015020944.3	12/5/18	Issued
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	European Patent Office	15749690.2	2/13/15	3105968	12/5/18	3105968	12/5/18	Issued
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Spain	15749690.2	2/13/15	3105968		3105968	12/5/18	Issued
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	France	15749690.2	2/13/15	3105968		3105968	12/5/18	Issued
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	United Kingdom	15749690.2	2/13/15	3105968		3105968	12/5/18	Issued
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Hong Kong	17102313.7	2/13/15	1229081A	11/10/17			Published
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Japan	2016-551758	2/13/15					Pending
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Macao							Unfiled
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	Netherlands	15749690.2	2/13/15	3105968		3105968	12/5/18	Issued
SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	United States of America	14/621,192	2/12/15	US-2015-0304044-A1		10,284,296	5/7/19	Issued

SYSTEM AND METHOD FOR PERFORMANCE OPTIMIZATION IN AND THROUGH A DISTRIBUTED ANTENNA SYSTEM	United States of America	16/360,980	3/21/19					Pending
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	Australia	2015227155	3/5/15					Pending
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	Brazil	BR 11 2016 020285 6	3/5/15					Pending
DISTRIBUTED ANTENNA SYSTEM WITH REMOTE RADIO HEADS	China	201580011639.2	3/5/15	CN 106170932A				Allowed
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	European Patent Office	15758873.2	3/5/15	3114780				Published
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	Hong Kong	17104046.7	3/5/15	1230802A	12/8/17			Published
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	Israel	247415	3/5/15					Pending
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	India	201617029173	3/5/15	201617029173				Published
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	Japan	2016-555465	3/5/15					Pending
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	Republic of Korea	10-2016-7027525	3/5/15					Pending
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	Macao							Unfiled
DISTRIBUTED RADIO SYSTEM WITH REMOTE RADIO HEADS	United States of America	14/639,418	3/5/15	US-2015-0256358-A1				Published
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	Australia	2016244115	4/4/16	2016244115				Published
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	Brazil	BR1120170211440	4/4/16					Pending
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	China	201680030803.9	4/4/16	CN 107850631 A				Published
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	European Patent Office	16774416.8	4/4/16	3278122				Published
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	Hong Kong	18106961.2	4/4/16					Pending

METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	Indonesia	PID201707729	4/4/16	2018/05650				Published
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	India	201717038921	4/4/16	201717038921				Published
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	Japan	2017-551651	4/4/16					Pending
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE TDD ARCHITECTURE	Republic of Korea	10-2017-7032015	4/4/16					Pending
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	Macao							Unfiled
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	Singapore	11201708119W	4/4/16					Pending
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	United States of America	15/090,402	4/4/16	US-2016-0360500-A1		9,854,553	12/26/17	Issued
METHOD AND SYSTEM FOR LINK SYNCHRONIZATION IN AN LTE-TDD ARCHITECTURE	United States of America	15/820,299	11/21/17	US-2018-0227870-A1				Published
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Australia	2016289947	7/6/16	2016289947				Published
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Brazil	BR 11 2018 000161 9	7/6/16					Pending
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	China	201680051423.3	7/6/16	CN 108450059 A				Published
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	European Patent Office	16821901.2	7/6/16	3320369				Published
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Hong Kong	18113025.2	7/6/16					Pending
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Israel	256721	7/6/16					Pending
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	India	201817003865	7/6/16	201817003865				Published
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Japan	2018-500520	7/6/16	2018524929				Published
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Republic of Korea	10-2018-7003658	7/6/16					Pending

DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Macao							Unfiled
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	Singapore	11201800110P	7/6/16					Pending
DISTRIBUTED ANTENNA SYSTEM NETWORK ANALYTICS	United States of America	15/203,015	7/6/16	US-2017-0013585-A1				Published
VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	Australia	2016357315	11/21/16	2016357315				Published
VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	China	2016800795294	11/21/16	CN 108604912 A				Published
VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	European Patent Office	16867324.2	11/21/16	3378167				Published
VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	Hong Kong	18113803.0	11/21/16					Pending
VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	Macao							Unfiled
VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	Singapore	11201804193X	11/21/16					Pending
VIRTUAL RADIO ACCESS NETWORK USING SOFTWARE-DEFINED NETWORK OF REMOTES AND DIGITAL MULTIPLEXING SWITCHES	United States of America	15/358,060	11/21/16	US-2017-0250927-A1				Published

REDUNDANCY IN A PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM	Australia	2017261802	5/12/17					Pending
REDUNDANCY IN A PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM	China	2017800434163	5/12/17					Pending
REDUNDANCY IN A PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM	European Patent Office	17796989.6	5/12/17	3456115				Published
REDUNDANCY IN A PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM	Japan	2018-559301	5/12/17					Pending
REDUNDANCY IN A PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM	Republic of Korea	10-2018-7035997	5/12/17					Pending
REDUNDANCY IN A PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM	Singapore	11201809610Y	5/12/17					Pending
REDUNDANCY IN A PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM	United States of America	15/594,323	5/12/17	US-2017-0366268-A1				Published

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PTO/AIA/80 (07-17)
Approved for use through 03/31/2021. OMB 0651-0035
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

[X] Practitioners associated with Customer Number: 167137

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	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(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

[X] The address associated with Customer Number: 167137

OR

[ ]

Firm or individual name		
Address		
City	State	Zip
Country		
Telephone	Email	

Assignee name and address: Dali Wireless, Inc.
535 Middlefield Road
Menlo Park, CA 94025

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, 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.

Signature	Date December 13, 2019
Name Albert Lee, Ph.D.	Telephone
Title Founder, Chairman and Chief Executive Officer	

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Electronic Acknowledgement Receipt	
EFS ID:	38533323
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	27076
Filer:	Jason Vick/Joanne Vos
Filer Authorized By:	Jason Vick
Attorney Docket Number:	091172-1017552-102440US
Receipt Date:	09-FEB-2020
Filing Date:	29-JUL-2016
Time Stamp:	12:53:59
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		Statement_under_373c_w_POA_10333-22-CON-4.pdf	1629164 53f9ba8dcbfcb2f136f54c94d0ae76345a24256b	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Assignee showing of ownership per 37 CFR 3.73	1	2
	Power of Attorney	3	3
Warnings:			
Information:			
	Total Files Size (in bytes):	1629164	

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

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: DALI WIRELESS, INC.

Application No./Patent No.: 15/223,819 Filed/Issue Date: July 29, 2016

Titled: DISTRIBUTED ANTENNA SYSTEM

DALI WIRELESS, INC., a Corporation

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

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

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

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

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

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

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

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

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

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

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

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

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

1. From: Shawn Patrick Stapleton, Paul Lemson, Bin Lin To: DALI SYSTEMS CO. LTD.

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

   Reel 048834, Frame 0131, or for which a copy thereof is attached.

2. From: Albert S. Lee To: DALI SYSTEMS CO. LTD.

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

   Reel 048834, Frame 0319, or for which a copy thereof is attached.

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

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

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

STATEMENT UNDER 37 CFR 3.73(c)

3. From: DALI SYSTEMS CO. LTD. To: DALI WIRELESS, INC.

The document was recorded in the United States Patent and Trademark Office at
Reel 045126, Frame 0677, or for which a copy thereof is attached.

4. From: _____ To: _____

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

5. From: _____ To: _____

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

6. From: _____ To: _____

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

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

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

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

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

/Jason H. Vick/	February 9, 2020
Signature	Date
Jason H. Vick	45,285
Printed or Typed Name	Title or Registration Number

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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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
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

167137
SHERIDAN ROSS PC
1560 Broadway
Suite 1200
Denver, CO 80202

POA ACCEPTANCE LETTER

OC000000114645336

Date Mailed: 02/12/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/09/2020.

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

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

/qtran/

UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	091172-1017552-102440US

CONFIRMATION NO. 3273

27076
DORSEY & WHITNEY LLP - SEATTLE
INTELLECTUAL PROPERTY DEPARTMENT
COLUMBIA CENTER
701 FIFTH AVENUE, SUITE 6100
SEATTLE, WA 98104-7043

POWER OF ATTORNEY NOTICE

OC000000114645322

Date Mailed: 02/12/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/09/2020.

- The Power of Attorney to you in this application has been revoked by the applicant. 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**.

/qtran/

AO 120 (Rev. 08/10)

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	2/21/2019	for the District of Delaware

PLAINTIFF	DEFENDANT
Dali Wireless, Inc.	CommScope Technologies LLC and CommScope Holding Company, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,045,314 B2	8/7/2018	Dali Wireless, Inc.
2	10,080,178 B2	9/19/2018	Dali Wireless, Inc.
3			
4			
5			

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

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

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

AO 120 (Rev. 08/10)

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	5/22/2019	for the District of Delaware

PLAINTIFF	DEFENDANT
Dali Wireless, Inc.	CommScope Technologies LLC and CommScope Holding Company, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,045,314 B2	8/7/2018	Dali Wireless, Inc.
2	10,080,178 B2	9/19/2018	Dali Wireless, Inc.
3	8,682,338 B2	3/25/2014	Dali Systems Co., Ltd.
4	9,847,816 B2	12/19/2017	Dali Systems Co., Ltd.
5			

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

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

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

AO 120 (Rev. 08/10)

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	2/21/2019	for the District of Delaware

PLAINTIFF	DEFENDANT
Dali Wireless, Inc.	CommScope Technologies LLC and CommScope Holding Company, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,045,314 B2	8/7/2018	Dali Wireless, Inc.
2	10,080,178 B2	9/19/2018	Dali Wireless, Inc.
3			
4			
5			

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

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

See D.I. 5, Notice of Voluntary Dismissal

CLERK	(BY) DEPUTY CLERK	DATE
John A Cerino, Clerk United States District Court 844 N. King Street, Unit 18 Wilmington, DE 19801		5/23/19

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

Trials@uspto.gov
Tel: 571–272–7822

Paper 18
Entered: March 12, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COMMSCOPE TECHNOLOGIES LLC,
Petitioner,

v.

DALI WIRELESS INC.,
Patent Owner.

Case IPR2020-01473
Patent 10,080,178 B2

Before KARL D. EASTHOM, MELISSA A. HAAPALA, and SHARON FENICK, Administrative Patent Judges.

FENICK, Administrative Patent Judge.

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

CommScope Technologies LLC ("Petitioner") filed a Petition to institute an *inter partes* review of claims 1–30 ("challenged claims") of U.S. Patent No. 10,080,178 B2 (Ex. 1001, "the '178 patent"). Paper 1 ("Pet."). Dali Wireless Inc. ("Patent Owner") filed a Preliminary Response. Paper 9 ("Prelim. Resp."). With our authorization (Paper 13), Petitioner filed a Reply relating to our discretion under 35 U.S.C. § 325(a), Paper 15 ("Reply"), and Patent Owner filed a Sur-Reply, Paper 17 ("Sur-Reply"). We have authority under 35 U.S.C. § 6(b)(4) and 35 U.S.C. § 314.

The standard for instituting an *inter partes* review is set forth in 35 U.S.C. § 314(a), which provides that an *inter partes* review may not be instituted "unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition."

Upon consideration of the Petition, Preliminary Response, and additional briefing we decline to exercise discretion to deny institution under 35 U.S.C. § 325(d), and we determine that Petitioner has demonstrated a reasonable likelihood that it would prevail in showing the unpatentability of at least one challenged claim of the '178 patent. Accordingly, for the reasons that follow, we institute *inter partes* review.

I. BACKGROUND

A. Real Parties-in-Interest

As the real parties-in-interest, Petitioner identifies CommScope Technologies LLC, CommScope, Inc. of North Carolina, CommScope, Inc., and CommScope Holding Company, Inc. Pet. iv. Patent Owner identifies only itself as real party-in-interest. Paper 3, 1.

B. Related Proceedings

Petitioner and Patent Owner identify *Dali Wireless, Inc. v. CommScope Technologies LLC*, No. 1:19-cv-00952-MN (D. Del.) ("the related action") as a related action involving the '178 patent.[1] Pet. iv; Paper 3, 1.

C. The '178 Patent

The '178 patent is titled "Distributed Antenna System" and relates to a distributed antenna system (DAS) that "enables a high degree of flexibility to manage, control, enhance, [and] facilitate the usage and performance of a distributed wireless network." Ex. 1001, codes (54), (57). According to one embodiment of the invention, a distributed antenna system includes digital access units (DAUs), which each connect to associated base stations and serve as an interface between these base stations and digital remote units (DRUs). *Id.* at 4:37–41. The distributed antenna system receives downlink data via radio frequency (RF) signals from the base stations. *Id.* at 4:60–62. After down-conversion, digitization, and conversion to baseband, the DAUs provide these received signals to DRUs. *Id.* at 4:63–5:6. Figure 1 of the '178 patent, reproduced below, is a block diagram showing the basic structure and an example downlink transport. *Id.* at 3:55–58.

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[1] According to Petitioner, "[t]he trial date for the district court action is March 2022," after the due date for a Final Written Decision in the instant case. See Pet. 87–88. Patent Owner did not present arguments towards exercising discretion to deny institution under 35 U.S.C. § 314(a). *See Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020) (precedential). Therefore, we do not consider this issue further.

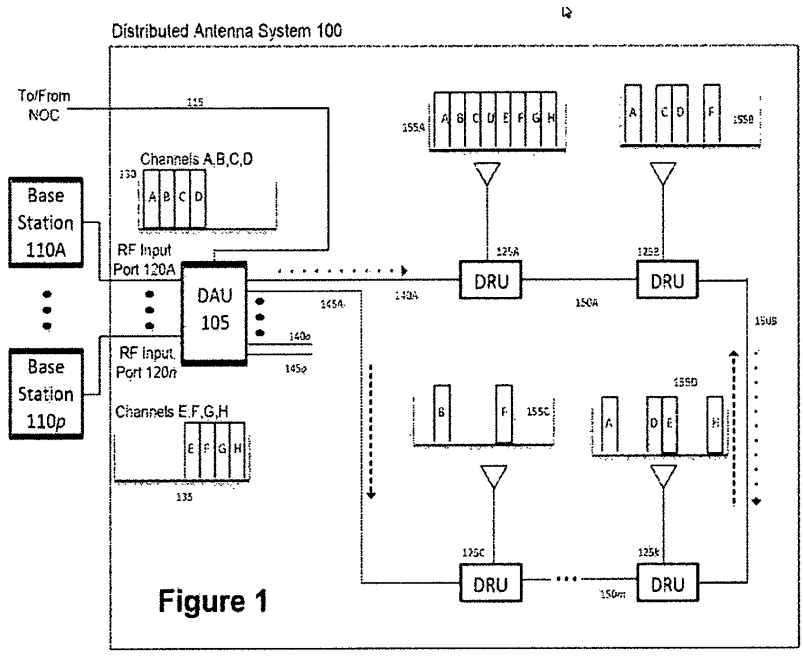


Figure 1 depicts DAU 105 that serves as an interface between associated base stations (110A through 110*p*) and DRUs (125A through 125*k*). *Id.* at 4:38–41, 4:60–62. Some DRUs, e.g., DRU 125B are connected to DAU 105 via a "daisy-chain" connection through its connection 150A to DRU 125A, which is connected directly to DAU 105 through connection 140A. *Id.* at 6:6–7, 6:29–32. As shown in Figure 1, DAU 150 receives composite downlink signal 130, comprising carriers[2] A–D from first base station 110A. *Id.* at 5:59–63. DAU 150 also receives

[2] Elements A–H of Figure 1 are alternatively referred to as "channels" and as "carriers" in the '178 patent. *Compare* Ex. 1001 at 5:17–49, 7:55–7:67, Fig. 1 (describing A–H as channels) *with id.* at 5:62–66, 6:15–25, 6:32–56 (describing A–H as carriers); *see also* Prelim. Resp. 24. We use "carriers" in this section to refer to elements A–H.

composite signal 135, comprising carriers E–H from *p*th base station 110*p*. *Id.* at 5:63–66. Bidirectional optical cables 140A and 145A connect DAU 105 to DRU 125A and 125C, bidirectional optical cables connect the DRUs in a ring configuration. *Id.* at 6:6–15. These connections facilitate networking of DAU105, allowing all carriers A–H to be available to transport data to DRUs 125A–125*k* for downlink. *Id.* at 6:15–18. The antenna ports of the DRUs receive uplink signals and transmit them to the base station via the DAUs. *Id.* at 5:29–42, 10:37–11:22.

Software settings within each DRU are configured in order to control which carrier signals are present in the downlink output signal at the antenna port of the DRU. *Id.* at 6:19–36, 6:43–56. An embedded software control module in a DAU, the DAU Management Control Module, "determin[es] and/or set[s] the appropriate amount of radio resources (such as RF carriers, CDMA codes or TDMA time slots) assigned to a particular DRU or group of DRUs to meet desired capacity and throughput objectives." *Id.* at 11:61–12:6. Another embedded software control module, the DAU monitoring module, "detects which carriers and corresponding time slots for each carrier are active for each DRU [and] provides information to the DAU Management Control Module to help identify when, e.g., a particular downlink carrier is loaded by a percentage greater than a predetermined threshold." *Id.* at 11:61–67, 12:46–54. "If that occurs, the DAU Management Control Module can adaptively modify the system configuration" to deploy additional radio resources for use by a particular DRU needing those resources, and to remove resources from a DRU if it no longer needs the radio resources assigned to it. *Id.* at 12:54–65. This occurs through communication with embedded software control modules in the

DRUs that set individual parameters within the DRU to enable or disable specific radio resources from being transmitted by that DRU. *Id.* at 12:11–33.

Figure 8, reproduced below, illustrates in block diagram form an embodiment of the DAS that includes daisy-chained DAUs. *Id.* at 4:17–19.

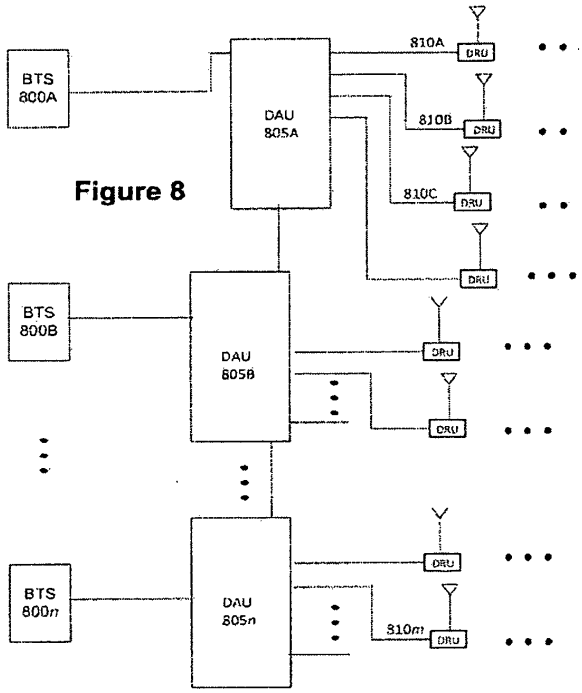


Figure 8

As seen in the DAS of Figure 8 there are multiple DAUs 805A through 805*n*, each connected to one base station. DAUs 805A–805*n* are daisy-chained through connections between the DAUs. *Id.* at 12:36–45. In another embodiment DAUs are connected in a ring configuration. *Id.* at 12:43–45.

D. Illustrative Claim 10

The Petition challenges independent claims 1, 10, 15, 21, and 26, and their dependent claims 2–9, 11–14, 16–20, 22–25, and 27–30. Claim 10, reproduced below with bracketed notations corresponding to those used in the Petition added for reference, is illustrative of the challenged claims at issue:

> 10. [A] A system for transporting wireless communications, comprising:
> [B] a host unit;
> [C] a plurality of remote units, including at least a first remote unit and a second remote unit;
> [D1] wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source;
> [E] wherein the host unit is configured to receive a plurality of downlink channel signals from the at least one signal source;
> [F] wherein the host unit is configured to send digital representations of the plurality of downlink channel signals to the plurality of remote units;
> [G] wherein the host unit is configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, the first set of downlink channel signals for transmission at an antenna of the first remote unit;
> [H] wherein the host unit is configurable to send digital representations of a second set of downlink channel signals to the first remote unit at a second point in time, the second set of downlink channel signals for transmission at the antenna of the first remote unit;
> [I] wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals; and
> [J] wherein the host unit is configured to receive digital signals from each of the plurality of remote units.

Ex. 1001, 15:3–32.

E. The Asserted Grounds

Petitioner challenges claims of the '178 patent as follows (Pet. 1):

Claims Challenged	35 U.S.C. §[3]	References
1–25	102	Wu[4]
1–25	103	Wu
1–25	103	Wu, Sabat-426[5]
8, 11, 19, 21, 23–25	103	Wu, OBSAI RP3[6], OBSAI BTS[7]
8, 9, 11, 19–25	103	Wu, CPRI[8]
26–30	103	Wu, Sabat-552[9]
1–8, 10, 11, 13, 15–19, 21, 23, 24	102	Oh[10]
1–8, 10, 11, 13, 15–19, 21, 23, 24	103	Oh, Wu

Petitioner additionally relies on the declaration of Dr. Anthony Acampora (Ex. 1003).

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[3] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102, 103. Because the '178 patent claims priority to an application filed before the effective date of the applicable AIA amendment, we refer to the pre-AIA version of 35 U.S.C. § 102 and § 103. *See* Ex. 1001, code (63).
[4] Wu et al., US 2010/0128676 A1, pub. May 27, 2010 (Ex. 1005).
[5] Sabat et al., US 2009/0180426 A1, pub. July 16, 2009 (Ex. 1010).
[6] OBSAI Reference Point 3 Specification Version 3.1 (2006) (Ex. 1007)
[7] OBSAI Open Base Station Architecture Initiative - BTS System Reference Document Version 2.0 (2006) (Ex. 1008)
[8] CPRI Specification V 4.0 (2008-06-30) Interface Specification (Ex. 1006).
[9] Sabat Jr. et al., US 6,963,552 B2, iss. Nov. 8, 2005 (Ex. 1011).
[10] Oh et al., US 7,286,507 B1, iss. Oct. 23, 2007 (Ex. 1023).

II. ANALYSIS

A. Discretionary Denial under 35 U.S.C. § 325(d)

Patent Owner requests that we exercise our discretion under 35 U.S.C. § 325(d) to deny the Petition because Wu, Oh, Sabat-426, and CPRI are the same or substantially similar to art that was before the Examiner during prosecution of the '178 patent. Prelim. Resp. 29–37; Sur-Reply. Patent Owner further argues that the Petitioner has not shown how the Office erred in allowing the challenged claims over Wu, Oh, Sabat-425, and CPRI, all of which were cited in Information Disclosure Statements ("IDSs"). Prelim. Resp. 36; Sur-Reply 4–5. Petitioner argues that the record does not show that the Examiner evaluated the references cited in the IDSs, and that the Examiner's failure to evaluate the references, or failure to find that Wu and Oh disclosed or taught the limitations described by the Examiner as missing in the art of record, was error. Pet. 13; Reply.

Because Petitioner sufficiently demonstrates Examiner error, we decline to exercise our discretion under 35 U.S.C. § 325(d) to deny the Petition.

1. Legal Principles

Institution of inter partes review is discretionary. *Harmonic Inc. v. Avid Tech, Inc.*, 815 F.3d 1356, 1367 (Fed. Cir. 2016) (explaining that "the PTO is permitted, but never compelled, to institute an IPR proceeding"). The Patent Office may, for example, deny institution under 35 U.S.C. § 325(d), which provides, in pertinent part, that "[i]n determining whether to institute or order a proceeding under this chapter . . . the Director may take into account whether, and reject the petition or request because, the same or

substantially the same prior art or arguments previously were presented to the Office."

In evaluating whether the same or substantially the same prior art or arguments were previously presented to the Office, the Board has identified several non-exclusive factors for consideration. *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17–18 (PTAB Dec. 15, 2017) (precedential as to § III.C.5, first paragraph) ("the *Becton, Dickinson* factors"). Those factors are as follows:

> (a) the similarities and material differences between the asserted art and the prior art involved during examination;
>
> (b) the cumulative nature of the asserted art and the prior art evaluated during examination;
>
> (c) the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection;
>
> (d) the extent of the overlap between the arguments made during examination and the manner in which Petitioner relies on the prior art or Patent Owner distinguishes the prior art;
>
> (e) whether Petitioner has pointed out sufficiently how the Examiner erred in its evaluation of the asserted prior art; and
>
> (f) the extent to which additional evidence and facts presented in the Petition warrant reconsideration of the prior art or arguments.

Id.; *see also* Patent Trial and Appeal Board Consolidated Trial Practice Guide (Nov. 2019)[11] 62–63.

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

As explained in *Advanced Bionics, LLC v. Med-El Electromedizinishe Geräte GmbH*, IPR2019-01469, Paper 6 at 8 (PTAB Feb. 13, 2020) ("*Advanced Bionics*") (precedential), we further apply the following two-step framework in determining whether discretionary denial under § 325(d) is appropriate:

> (1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and
>
> (2) if either condition of [the] first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.

Becton, Dickinson Factors (a), (b), and (d) relate to the first step, and *Becton, Dickinson* Factors (c), (e), and (f) relate to the second step. *Id.*

Only if the same or substantially the same art or arguments were previously presented to the Office do we then consider whether petitioner has demonstrated error. *Advanced Bionics*, at 8–10. "If the petitioner fails to show that the Office erred, the Director may exercise his discretion not to institute inter partes review." *Id.* at 8–9 ("If a condition in the first part of the framework [i.e., substantially same art or arguments] is satisfied and the petitioner fails to make a showing of material error, the Director generally will exercise discretion not to institute inter partes review."). "At bottom, this [§ 325(d)] framework reflects a commitment to defer to previous Office evaluations of the evidence of record unless material error is shown." *Id.* at 9. An "example of a material error" could be "misapprehending or overlooking specific teachings of the relevant prior art where those teachings impact patentability of the challenged claims." *Id.* at 8 n.9.

2. Analysis

Under the first step of the *Advanced Bionics* framework, we must determine whether the same or substantially the same prior art was previously presented to the Office. *Advanced Bionics*, at 8. Patent Owner observes that Wu, Oh, Sabat-426, and CPRI were before the Examiner in an Information Disclosure Statement ("IDS"). Prelim Resp. 30; Sur-Reply 2; Ex. 1002, 548–554 (May 12, 2017 IDS, *see* p. 550–551, Cite Nos. 27, 38, 40, 55).

Wu and Oh are described by Petitioner as its "[p]rimary [r]eferences" in this IPR. Pet. 5–11; *see also* Prelim. Resp. 30. Petitioner concedes that "[s]ome of the references, including Wu and Oh" were before the Examiner. Reply 1. Petitioner, however, asserts that there was no discussion or mention of Wu and Oh on the record by the Examiner or applicant, and "no evidence the [E]xaminer *evaluated* the specific features of the references as identified and applied in the petition." *Id.*

In summary, the parties do not dispute that Wu, Oh, Sabat-426, and CPRI were before the Examiner in the IDS. Prelim. Resp. 30; Reply 1; Sur-Reply 2. Thus, these references were "previously presented to the Office." *See Advanced Bionics*, at 7–8 ("Previously presented art includes . . . art provided to the Office by an applicant, such as on an Information Disclosure Statement (IDS), in the prosecution history of the challenged patent."). Because Wu and Oh, along with Sabat-426 and CPRI, were previously presented to the Office, we proceed to the second step of the *Advanced Bionics* framework.

Under the second step of the *Advanced Bionics* framework, we must determine whether Petitioner has demonstrated Examiner error in a manner

material to the patentability of the challenged claims. *Advanced Bionics*, at 10. *Becton, Dickinson* Factors (c), (e), and (f) inform our analysis at this step. *Id.* at 8.

As to *Becton, Dickinson* Factor (c), the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection, the record is not sufficiently clear that the Examiner meaningfully considered the relevant disclosures of the asserted prior art references in the Petition or substantially similar references. Whether the prior art was the basis for a rejection is significant to this analysis. *Compare Boragen, Inc. v. Syngenta Participations AG*, IPR2020-00124, Paper 16 at 7–8 (PTAB May 5, 2020) (denying institution under § 325(d) where the primary reference and a secondary reference in the petition were the basis for five obviousness rejections during the prosecution of the patent at issue), *with DraftKings Inc. v. Interactive Games LLC*, IPR2020-01107, Paper 10 at 16 (PTAB Jan. 6, 2021) (declining to deny institution under § 325(d) where the primary reference in the petition was not the basis of a rejection and disclosed the limitations upon which the Examiner relied to allow the patent).

Here, Petitioner asserts that Wu and Oh were not substantively evaluated by the Examiner during prosecution of the '178 patent. Pet. 13; Reply 1. Moreover, Petitioner argues that Examiner error is "evident in the reasons for allowance, where the examiner concludes none of the references discloses a host unit configurable to change the number of channel signals it sends to a remote unit." Reply 3–4. Because, Petitioner argues, Wu and Oh disclose systems with this type of host unit, the Examiner's conclusion was clear error. *Id.* at 4–5.

Patent Owner argues that evaluation by the Examiner is shown in the Examiner's statement in an office action that he considered the IDS on which Wu and Oh were listed. Prelim. Resp. 30; Sur-Reply 2 (reproducing an annotated portion of Ex. 2002, 500); *see* Ex. 2002, 498–516 (June 5, 2017 Office Action). Patent Owner additionally argues that evaluation is further shown in the Examiner's statement in the Notice of Allowance that "no prior art reference" or "combination of prior art references" discloses or suggests the configurability of the host to change the set and number of downlink channel signals sent to a remote unit at different points in time. Prelim. Resp. 31, 35; Sur-Reply 2 (reproducing in part Ex. 2002, 88); *see* Ex. 2002, 81–89 (Notice of Allowance). Patent Owner argues that Wu and Oh are similar to the art identified by the Examiner as the "closest prior art on record." Sur-Reply at 2–3.

Furthermore, Patent Owner argues that "to ensure patentability, Patent Owner even filed an RCE [Request for Continued Examination] to remove the '178 patent from allowance, and conducted multiple telephone interviews with the Examiner to discuss the prior art" and indicates that it submitted in an IDS both a petition for *inter partes* review of US 9,531,473 B2 ("the '473 patent)[12,13] and the expert declaration of Dr. Acampora relied

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[12] The '473 patent, while also owned by Patent Owner, is not related to the '178 patent; however certain claims bear some similarity to claims of the '178 patent. Prelim. Resp. 11 (co-ownership); Ex. 1003, 15–19 (chart illustrating similarities between claims).

[13] The referenced petition for *inter partes* review of the '473 patent ("the IPR2018-00571 Petition") resulted in institution of *inter partes* review, and, eventually in a final written decision, which has been vacated and remanded in view of *Arthrex, Inc. v. Smith & Nephew, Inc.*, 941 F.3d 1320 (Fed. Cir. 2019) with further proceedings held in administrative abeyance pending

upon in that petition, each discussing Oh and Wu. Prelim. Resp. 11, 35; Ex. 2002, 127–131 ("May 1, 2018 IDS"). Patent Owner represents that "on May 7, 2018, Patent Owner had a telephone conference with the Examiner to specifically discuss the [May 1, 2018 IDS] to ensure that the claims of the '178 patent were patentable in view of the [IPR2018-00]571 petition." Prelim. Resp. 11 (citing Ex. 2002, 69, 107–108).

While Patent Owner now characterizes the purpose of the RCE as being filed to provide additional prior art, we note that the RCE added ten claims and identified the purpose of the amendment as "secur[ing] an appropriate scope of protection." Ex. 2002, 118. The RCE additionally "urged" entry of the amendment noting that "no more than a cursory review of the record is needed." *Id.* The Examiner's interview summary of the May 7, 2018 interview does not contain any indication that Oh, Wu, the IPR2018-00571 petition, or the expert declaration were discussed. Ex. 2002, 108 (describing the substance of the interview as relating to new claim limitations in two claims and date information needed regarding a different item on the May 1, 2018 IDS).

Under this factor, the record is not sufficiently clear as to the extent the relevant disclosures of the asserted prior art was meaningfully considered during examination. Although the IDS indicates that Wu and Oh were considered as noted above, Petitioner provides persuasive argument

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Supreme Court review of the *Arthrex* decision. *CommScope Technologies LLC v. Dali Wireless Inc.*, IPR2018-00571, Paper 1 (Petition, filed Feb. 2, 2018), Paper 26 (PTAB Aug. 14, 2018) (Institution Decision), Paper 53 (PTAB Aug. 12, 2019) (Final Written Decision), Paper 59 (PTAB May 4, 2020) (General Order in Cases Remanded Under *Arthrex, Inc. v. Smith & Nephew, Inc.*, 941 F.3d 1320 (Fed. Cir. 2019)).

indicating that the Examiner overlooked or did not appreciate the materiality of the teachings of Wu and Oh in relation to the allowed claims. Additionally, the obvious materiality of Wu and Oh, discussed *infra*, and the absence of their use as a basis for rejection, suggests that the Examiner misapprehended or overlooked the relevant disclosures of these references.

As to *Becton, Dickinson* Factor (e), whether Petitioner has pointed out sufficiently how the Examiner erred in its evaluation of the asserted prior art, Petitioner provides persuasive evidence of Examiner error. The Examiner allowed the claims of the '178 patent because of limitations relating to the configurability of the host that Petitioner argues are disclosed by Wu and Oh in several grounds in the Petition. Reply 4 (citing Ex. 1005 ¶ 46; Ex. 1023 9:44–10:9, 14:16–17). Patent Owner acknowledges that this feature was cited in the reasons for allowance. Prelim. Resp. 31, 35; Sur-Reply 2. Patent Owner further argues (as addressed further below, Section II.E) that Wu does not anticipate the host unit as described in the claims. Sur-Reply 5. However, the Petition relies not only on anticipation by Wu but obviousness over Wu, alone or in combination with other art. *See* Pet. 41–49.

Given the fact that the Examiner did not expressly rely on Wu and Oh in rejecting the claims during prosecution or in the Examiner's explanation of the reasons for allowance, and given the description and explanation provided by Wu and Oh as discussed *infra*, we find that the Examiner erred by either overlooking, or failing to appreciate, the materiality of the disclosures of Wu and Oh.

Finally, as to *Becton, Dickinson* Factor (f), the extent to which additional evidence and facts presented in the Petition warrant reconsideration of prior art or arguments, Petitioner addresses the asserted

references in detail as discussed in our analysis below, II.E–J. Petitioner argues that the final decision issued in IPR2018-00571 is evidence that the claims merit reconsideration. Reply 5. Patent Owner notes that this decision has been vacated (pursuant to *Arthrex*). *See* Sur-Reply 5; *supra* notes 13, 14.

Considering *Becton, Dickinson* Factors (c), (e), and (f) together, we conclude that Petitioner sufficiently demonstrates Examiner error based on the grounds in its Petition, with support from expert testimony, which shows, in particular, that the Examiner overlooked, or did not appreciate, the materiality of Wu's and Oh's disclosures relating to the configurability of the host unit.

3. Conclusion

For the reasons discussed above, we conclude that the Petition presents facts and evidence that, in this case, sufficiently demonstrate the Examiner erred in a manner material to the patentability of the challenged claims, and we therefore decline to exercise our discretion to deny institution under 35 U.S.C. § 325(d).

B. Principles of Law

It is a petitioner's burden to demonstrate unpatentability in an *inter partes* review. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (citing *Tech. Licensing Corp. v. Videotek, Inc.*, 545 F.3d 1316, 1326–27 (Fed. Cir. 2008)).

To anticipate a claim, a prior art reference must disclose every limitation of the claimed invention, either expressly or inherently. *Blue Calypso, LLC v. Groupon, Inc.*, 815 F.3d 1331, 1341 (Fed. Cir. 2016).

However, this is not an *ipsissimis verbis* test, i.e., identity of terminology is not required. *In re Bond*, 910 F.2d 831, 832 (Fed. Cir. 1990).

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are "such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved based on the following underlying factual determinations: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations.[14] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). "To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). We analyze the asserted grounds with the principles stated above in mind.

C. Level of Ordinary Skill in the Art

Petitioner asserts that the proper level of ordinary skill in the art is a "bachelor's degree in electrical engineering (or equivalent field) with 2-3 years of work experience in wireless communications." Pet. 16 (citing Ex. 1003 ¶¶ 19–21). Patent Owner contends that the proper level of skill given

[14] At this stage, the record contains no allegations or evidence of secondary considerations.

by the Petitioner should include "work experience dealing with wireless devices such as remote units and antennas." Prelim. Resp. 22. Based on the evidence of record at this point, including the types of problems and solutions described in the '178 patent and the asserted prior art, at this stage we agree with and adopt Patent Owner's definition of the level of ordinary skill in the art, although our findings and conclusions would be the same if we applied Petitioner's somewhat broader proposed definition.

D. Claim Construction

In an *inter partes* review, the Board construes each claim "in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b). Under the same standard applied by district courts, claim terms take their plain and ordinary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc). "There are only two exceptions to this general rule: 1) when a patentee sets out a definition and acts as . . . lexicographer, or 2) when the patentee disavows the full scope of a claim term either in the specification or during prosecution." *Thorner v. Sony Comput. Entm't Am. LLC*, 669 F.3d 1362, 1365 (Fed. Cir. 2012).

Petitioner requests that we construe the term "host unit" found in all independent claims, and the term "dynamically change(s)" found in claims 2–6 and 16–18. Pet. 15. Patent Owner provides a discussion and an alternate proposal for each term. Prelim. Resp. 22–28.

1. "host unit"

Petitioner contends that "host unit" should be construed as "unit that transports and controls communications between remote units and the signal source." Pet. 15 (citing Ex. 1003 ¶ 30). Patent Owner disagrees with Petitioner's construction and instead contends that the proper construction is "a digital access unit that manages communications between an operator network and one or more remote radio units." *See* Prelim. Resp. 23–25.

Our decision with respect to the prior art's disclosures or teachings with respect to "host unit" would not be affected by the claim construction of this term. In view of our analysis below, we do not see a need for construction of this term for the purposes of institution. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) ("[W]e need only construe terms 'that are in controversy, and only to the extent necessary to resolve the controversy'. . . ." (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

2. "dynamically change" or "dynamically changes"

With respect to "dynamically change" or "dynamically changes," as found, for example, in claim 2 ("wherein the host unit is configurable to dynamically change" from sending the representations of the first set of downlink channel signals to sending representations of the second set) it is Petitioner proposes "automatically change" or "change instantly in response to conditions as they occur." Pet. 15–16 (citing Ex. 1003 ¶¶ 26–29). Patent Owner addresses and objects to each proposed construction. Patent Owner disagrees with either construction and instead proposes that "dynamically change" should be construed as "adaptively change." *See* Prelim. Resp. 26–28.

Our decision with respect to the prior art's disclosures or teachings with respect to "dynamically change[s]" would not be affected by the claim construction of this term. Therefore, we do not see a need for construction of this term for the purposes of institution. *See Nidec Motor Corp.*, 868 F.3d at 1017.

E. Asserted Anticipation Based on Wu, Claims 1–25

Petitioner asserts claims 1–25 are anticipated by Wu. Pet. 16–41. Patent Owner addresses these assertions in its Preliminary Response. Prelim. Resp. 21, 54–59.

1. Overview of Wu

Wu is titled "Carrier Channel Distribution System" and describes a system where signals are communicated between base transceiver stations (BTSs) and remote transceiver units (RTUs), providing fine-grained control for this communication, splitting carrier channels and routing only some channels to RTUs according to a routing policy. Ex. 1005, codes (54), (57), ¶¶ 9, 11, 38–44. A BTS receives signals within a plurality of frequency bands, each of which may comprise multiple channels. *Id.* ¶¶ 11, 35, 37, 38. Figure 2 of Wu, reproduced below, is a schematic of a base transceiver station and associated host units.

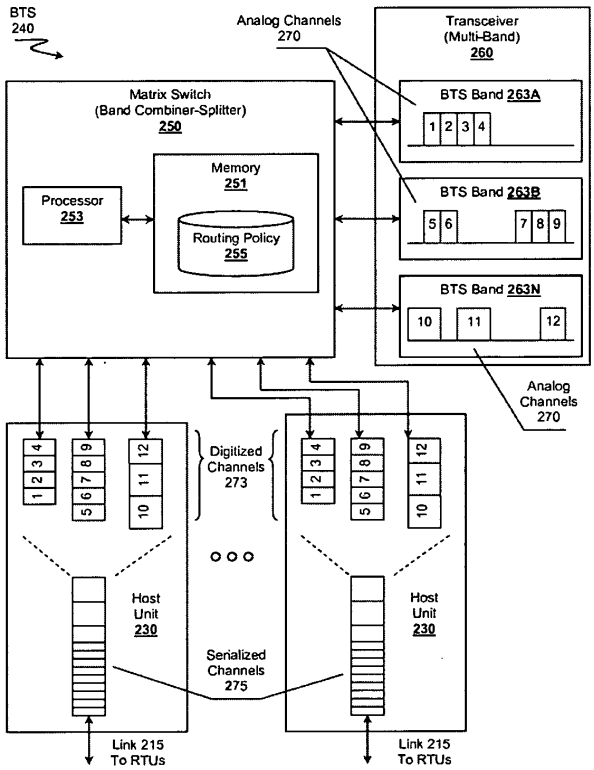


Figure 2

Figure 2 shows base transceiver station (BTS) 240 including transceiver 260, matrix switch 250, and host units 230. *Id.* ¶¶ 15, 34–36. Transceiver 260 receives signals on BTS bands 263A through 263N, and each may include multiple channels 270, e.g., channels 270 labelled 5 through 9 in BTS band 263B. *Id.* ¶¶ 35, 37. Transceiver 260 forwards the received channels 270 to matrix switch 250 that routes them according to Routing Policy 255 to host unit 230, which further distributes them to RTUs over links 215. *Id.* ¶ 38. The system is bi-directional, and carrier channel signals are received by host units 230 from RTUs and forwarded to

transceiver 260 for transmission within bands 263. *Id.* ¶¶ 36, 49. Wu also discloses that some signals may be received at an RTU with another RTU acting as intermediary. *Id.* at Figs. 1, 4, ¶¶ 33, 51.

Policy 255 can be reconfigured in order to change the routing of channels to the various RTUs. *Id.* ¶¶ 48, 49. Channels may be routed, allocated, or distributed, for example, based on anticipated requirements of areas at a certain time of day, or on current traffic load. *Id.* ¶¶ 43, 44. Transmissions between host units and RTUs are disclosed as preferably occurring according to the CPRI Standard. *Id.* ¶¶ 31, 49.

2. Analysis of Anticipation of Claims 10 and 15 by Wu

Petitioner argues that Wu discloses claim 10's "system for transporting wireless communications" in its "better carrier channel transport system." Pet. 19 (quoting Ex. 1005 ¶ 2, 9, citing Ex. 1003 ¶ 38).

With respect to limitation B of claim 10, Petitioner argues that the host unit is disclosed by the combination of matrix switch 250 and units 130 and 230 in Wu. *Id.* at 18, 20 (citing Ex. 1005, Fig. 2 (elements 250, 230); Ex. 1003 ¶ 39). Petitioner argues that the "signal source" of limitations D1 and E is disclosed by Wu's transceiver 260. Id. *at* 20 (citing Ex. 1005, Fig. 2 (element 260); Ex. 1003 ¶ 40). To explain these disclosures, Petitioner presents an annotated version of Wu's Figure 2, reproduced below.

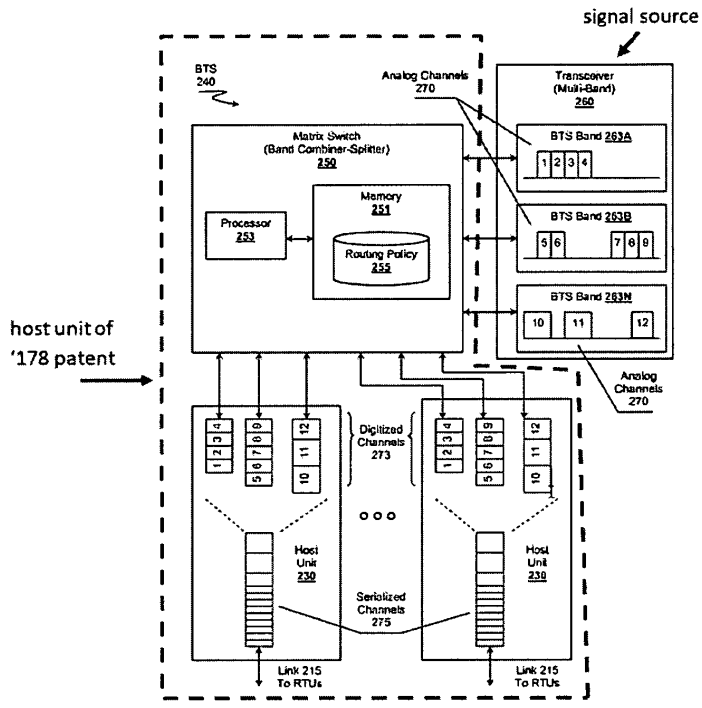


Figure 2

Id. at 18. Figure 2, as annotated by Petitioner, shows a dotted red box enclosing Wu's matrix switch 250 and Wu's host units 230, which Petitioner labels as the host unit. *Id.* Petitioner argues that Wu discloses elements D1 ("wherein the host unit comprises at least one interface to communicatively couple the host unit to at least one signal source") and E ("the host unit is configured to receive a plurality of downlink channel signals from the at least one signal source") through its disclosure that matrix switch 250 communicates with transceiver 260 and receives from transceiver 260 a plurality of downlink channel signals. *Id.* at 22 (citing Ex. 1005, ¶ 38, Fig. 2 (elements 260, 263A, 263B, 263N); Ex. 1003 ¶¶ 42–43).

Petitioner argues that the plurality of remote units of limitation C is disclosed in Wu's remote transceiver units. *Id.* at 21 (citing Ex. 1005, ¶¶ 11, 30, 33, Fig. 1; Ex. 1003 ¶ 41). With respect to the requirements of the claim that the claimed host unit be configured/configurable to send digital representations of the plurality of downlink channel signals to remote transceiver units (limitation E, also limitations F, G, and H), Petitioner contends that Wu discloses this in Wu's discussion of the combination of matrix switch 250 and Wu's host units 230 to provide "fine grained control" in sending send digital representations of signals received from the transceiver 260 "individually or in arbitrary groups" to the remote transceiver units. *Id.* at 22–23 (citing Ex. 1005, ¶¶ 9, 11, 38, 39, 47, 49; Ex. 1003 ¶¶ 44–49).

Petitioner further argues that the other requirements of limitations G and H, and the requirements of limitation I are disclosed in Wu's description of its matrix switch, which provides control over individual carrier channels by routing them, according to a routing policy, including routing channels individually, collectively or "in arbitrary groups" to remote transceiver units for transmission. *Id.* at 22–24 (citing Ex. 1005 ¶¶ 9, 11, 30, 38–47, 49, 54; Ex. 1003 ¶¶ 44–51, 56). Petitioner addresses the host unit's configurability to transmit a first subset of a plurality of downlink signals to a first remote unit and a second subset to a second remote unit (limitations G and H) by referencing Wu's description of changing the number of channels by means of a routing policy that reacts to events and conditions to provide "proper coverage." *Id.* at 23–24 (citing Ex. 1005 ¶¶ 4, 30, 38–47, 49; Ex. 1003 ¶¶ 51, 53). Petitioner cites Wu's specific disclosure of "allocat[ing] more channels" "to increase the bandwidth available" as disclosing limitation I,

which (together with limitations G and H) requires that the number of downlink channel signals sent to a first remote unit is different at a first and second point in time. *Id.* at 24 (citing Ex. 1005 ¶ 46; Ex. 1003 ¶ 54). Petitioner further argues that the transmissions are "for transmission at an antenna" of the remote units (as required by limitations G and H) because Wu discusses the remote transceiver units providing "wireless coverage," which one of ordinary skill would have understood to be provided via the antennas of the remote transceiver units. *Id.* at 24 (citing Ex. 1005 ¶¶ 4, 30; Ex. 1003 ¶ 52).

Lastly, with respect to limitation J of claim 10, Petitioner argues that Wu discloses bi-directional digital communication between the remote transceiver units and Wu's host unit 230. *Id.* at 25 (citing Ex. 1005, Fig. 7-2 (RTU "ADC" elements), ¶ 56 (for uplink, the RTU "mirrors" functionality of unit 230 in downlink)). Petitioner explains how this and related disclosures describe the capability of Wu's host unit to receive at least one uplink signal, thereby disclosing the ability of the host unit (Wu's host unit and matrix switch) to receive digital signals from remote transceiver units. *Id.* (citing Ex. 1005 ¶¶ 36, 49).

Patent Owner argues that Petitioner's grounds based in whole or in part on Wu, excepting the obviousness ground over the combination of Oh and Wu, are flawed because they rely on "an improper box-drawing exercise." Prelim Resp. 38. Patent Owner contends that Petitioner's reliance on "*Wu*'s base station transceiver (BTS) 240 with host units 230," is an improper "combination of disparate components from different units" and "conflicts with both the '178 patent's plain language and [with] settled case law." *Id.* at 38 (citing Pet. 18, 20). Patent Owner argues that "Petitioner's

reliance on the BTS 240 meeting both the 'host unit' and 'signal source' elements is unreasonable and should be rejected." *Id.* at 39.

As discussed above, Petitioner argues that the claimed host unit is disclosed by the described combination of Wu's host units 230 and matrix switch 250. *See* Pet. 18–20. Patent Owner contends that matrix switch 250 is disclosed as part of base transceiver station 240, but that host units 230 are not disclosed as part of base transceiver station 240. Prelim. Resp. 38–40 ("Host units 230 are arranged separately from BTS 240 and do not include a matrix switch 250"). On the current record, we disagree. First, Figure 2's element label 240 appears to apply to all included elements of Figure 2, this is confirmed by the description of the figure in the written portion of the Wu's specification. Ex. 1005, ¶ 15 ("FIG. 2 is a schematic of a possible base transceiver station (BTS) having a matrix switch *and host units*." (emphasis added), Fig. 2; *see also id.* ¶¶ 17, 51, Fig. 4 (depicting host units 430 within base transceiver station 440); *but see id.* Fig. 1 (depicting host units 130 as separate but abutting base transceiver station 140).

Patent Owner cites *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1371 (Fed. Cir. 2008), arguing that the differences Patent Owner asserts exist between Wu's disclosure and the claim means the anticipation ground must fail. *Id.* at 39–40. However, *Net MoneyIN* dealt with a situation in which the prior art reference disclosed "two separate protocols," neither of which included all the claimed elements, but not the combination of those two protocols in one system. *Net MoneyIn*, 545 F.3d at 1371. In that situation *Net MoneyIn* guides us that obviousness is invoked, not anticipation. *Id.* Here, the host units 230 and matrix switch 250 are not

distinct embodiments that cannot be combined in an anticipation ground, rather they work in concert as described in Wu.

After considering Petitioner's arguments, we determine that, given the arrangements of the elements in Wu, Petitioner has a sufficient likelihood of succeeding in showing that Wu's host units 230 with its matrix switch 250 discloses the claimed "host unit" and that Wu's transceiver 260 discloses a signal source. All of Patent Owner's arguments with respect to Petitioner's argument that Wu anticipates claim 10 rely on discussing the capabilities of Wu's host units 230, as opposed to the capabilities of the host units 230 and the matrix switch 250 and are thus not persuasive at this stage of the proceeding. *See* Prelim. Resp. 40–44 (arguing that, because host units 230 are "pass-through" devices, they are not configurable to send different sets of signals at different times), 44–47 (arguing that each Wu host unit relays the same signals to all remote transceiver units connected to it, and therefore cannot send different sets of downlink channel signals to one remote transceiver unit); 47 (arguing that matrix switch 250 in Wu, rather than Wu's host units, is used to allocate the channels sent to different remote transceiver units).

Petitioner refers to its arguments with respect to claim 10 in arguing that Wu anticipates claim 15. Pet. 26–27. Patent Owner does not present separate arguments regarding claim 15.

On this record and taking into account Patent Owner's arguments, Petitioner has shown a reasonable likelihood of demonstrating that claims 10 and 15 are anticipated by Wu.

3. Analysis of Anticipation of Claim 1 By Wu

With respect to each limitation of claim 1, aside from the limitation that the host unit comprises "at least one interface to communicatively couple the host unit to a plurality of remote units, including at least a first remote unit," Petitioner argues that claim 1 is anticipated by Wu for the same reasons given with respect to claim 10, and discussed above. Pet. 26. Petitioner argues that the limitation regarding communicatively coupling the host unit to a plurality of remote units is taught or suggested by the optical interfaces of Wu's host units 230 through which a host unit communicates with remote transceiver units, including, in some exemplary illustrations, to multiple remote transceiver units. *Id.* (citing Ex. 1005 ¶¶ 30, 49–51, Figs. 1, 4; Ex. 1003 ¶¶ 60–61).

Patent Owner does not separately address this argument with respect to claim 1. On this record and taking into account Patent Owner's prior arguments, Petitioner has shown a reasonable likelihood of demonstrating that claim 1 is anticipated by Wu.

4. Analysis of Anticipation of Claim 21 By Wu

With respect to each limitation of claim 21, for all but the last two limitations Petitioner argues that claim 1 is anticipated by Wu for the same or substantially the same reasons given with respect to claim 10, and discussed above. Pet. 35–36.

With respect to the limitation of claim 21 that "the host unit is configured to send a digital representation of any carrier of any downlink signal it receives to any of the plurality of remote units" and that the first and second portion of the plurality of carriers are different (the term labeled "element O" and part of the term labeled "element Q" by Petitioner),

Petitioner argues that Wu's matrix switch operates to route carrier channels individually, and that examples provided in Wu illustrate Wu's capability to provide "fine grained" control over the individual channel signals alone or in arbitrary groups. *Id.* at 36–37.

With respect to the balance of "element Q" of claim 21, which requires that the digital representations of the first and second portions of the plurality of carriers include destination information, Petitioner argues that

> Wu discloses that units 230 use either the CPRI or OBSAI protocols for communicating the digitized carrier channels to the RTUs. As discussed above, both of these standards employ destination addresses for routing signals. The OBSAI standard, for example utilizes a 19 byte message format for communicating with remote RRUs. The first 13 bits of the message defines an address, which includes a node address that identifies a particular RRU (8 bits) and even includes a more specific sub-node address (5 bits) for identifying a particular module within the node. Ex. 1003 ¶130, ¶¶95-98, ¶99, ¶102-107, ¶115-118. The CPRI protocol also discloses the use of destination addresses for more complex networked topologies. Ex. 1003 ¶130, ¶¶82-83, ¶¶87-88; Ex. 1006 at p. 84 (6.3.2. and 6.3.3).

Id. at 38; *see also id.* at 30–31 (describing the teachings of CPRI (Ex. 1006), OBSAI RP3 (Ex. 1007), and OBSAI BTS (Ex. 1008) relating to destination addresses).

With respect to claim 21, in addition to the arguments previously discussed with respect to claims 1, 10, and 15, Patent Owner argues that "[r]ather than pointing to any such teaching in *Wu*, Petitioner cites to the secondary references . . . *CPRI* and *OBSAI*." Prelim. Resp. 48. Petitioner argues that this "incorporation" of CPRI and OBSAI does not support anticipation. *Id.* (citing *Net MoneyIN*, 545 F.3d at 1371). However, on the present record, and for the purposes of institution, we determine that

Petitioner properly employs the CPRI, OBSAI RP3, and OBSAI BTS references as extrinsic evidence of the properties of the CPRI and OBSAI standards specifically referenced in Wu. *See In re Baxter Travenol Labs*, 952 F.2d 388, 390 (Fed. Cir. 1991) (extrinsic evidence may be used to explain what a reference discloses). For this reason, and for the reasons described with reference to claims 1, 10, and 15, on this record and taking into account Patent Owner's prior arguments, Petitioner has shown a reasonable likelihood of demonstrating that claim 21 is anticipated by Wu.

5. Analysis of Anticipation of Claims 2–9, 11–14, 16–20, and 22–25 by Wu

Petitioner also presents a sufficient showing supported by the record with respect to anticipation by Wu of dependent claims 2–9, 11–14, 16–20, and 22–25. *See* Pet. 27–34, 39–41. With respect to these claims and anticipation over Wu, Patent Owner's arguments are addressed above. *See* Prelim. Resp. 38–49.

For the reasons described with reference to claims 1, 10, 15, and 21, on this record and taking into account Patent Owner's prior arguments, Petitioner has shown a reasonable likelihood of demonstrating that claims 2–9, 11–14, 16–20, and 22–25 are anticipated by Wu.

F. Asserted Obviousness Based on Wu or on Wu and Sabat-426, Claims 1–25

Petitioner also asserts claims 1–25 are obvious over Wu alone, or over a combination of Wu and Sabat-426. Pet. 41–42.

1. Overview of Sabat-426

Sabat-426 is titled "Digital Distributed Antenna System" and describes a system that distributes the capacity of a digital base station to solve coverage and capacity requirements. Ex. 1008, codes (54), (57).

Sabat-426 describes a DAS network that distributes downlink signals from a base station to digital distributed radio (DDR) units via a DDR hub. *Id.* ¶¶ 25, 30, 31, 33, 34.

Figure 6 of Sabat-426 is reproduced immediately below:

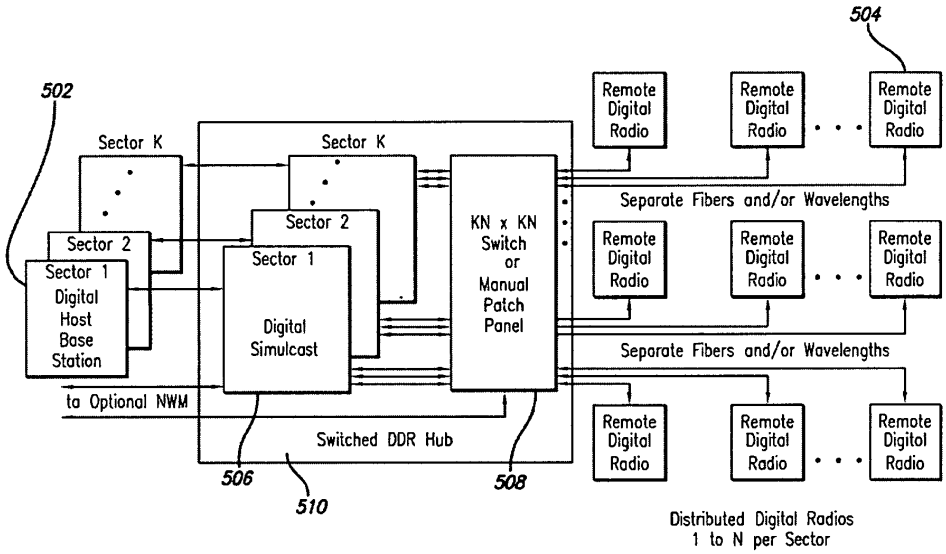


FIG. 6

Figure 6 is a block schematic drawing including a DDR hub, which includes a digital switch to provide capacity reallocation capability to the network. *Id.* ¶ 28. Figure 6 shows base station sectors 502 for sectors 1 through K, transmitting via DDR hub 510 to DDR units 504. *Id.* ¶¶ 27, 28, 43–46.

2. *Analysis of Obviousness of Claims 1–25 over Wu or Wu and Sabat-426*

For obviousness of claims 1–25 over Wu, or over Wu and Sabat-426, Petitioner relies mainly on its arguments with respect to anticipation over Wu, but anticipating Patent Owner's arguments that Wu's matrix switch 250

and host unit 230 would not properly disclose a host unit, Petitioner argues that it would be obvious to one of ordinary skill in the art to "place the functionality" of these units "within a single housing or unit." *Id.* at 41–42 (citing Ex. 1003 ¶ 139). Petitioner additionally argues that Sabat-426 teaches the combination of a programmable switch to allocate capacity to remote antenna units and digital interfaces to those units. *Id.* at 42 (citing Ex. 1010 ¶¶ 31, 32, 37, 46, 47, Fig. 6; Ex. 1003 ¶ 142). Petitioner argues that these modifications would produce a predictable result, and that one of ordinary skill would be motivated to do this to reduce various complexity, cost, and errors. *Id.* (citing Ex. 1003 ¶ 141 (motivation to place the matrix switch and host units of Wu into a single housing), 143 (motivation to combine Wu and Sabat-426)).

Patent Owner argues that Petitioner has failed to present the grounds with particularity, provides minimal analysis, and does not analyze specific claim elements or apply the combination to specific claims. Prelim. Resp. 50. We disagree. Petitioner begins this section of the Petition with the sentence "Patent Owner may argue Wu's matrix switch 250 and units 230 do not form a host 'unit' because they are shown in Figure 2 in different 'boxes.'" Pet. 41. While Patent Owner is correct that our rules require presentation of the grounds with particularity, it is not ambiguous that Petitioner is relying, for the majority of its obviousness analysis, on the arguments with respect to anticipation by Wu, with the exception of the question of whether Wu teaches a host unit in its matrix switch and host units. On the present record, we agree that one of ordinary skill would combine two elements from Wu as a host unit. *See In re Larson*, 340 F.2d 965, 968 (CCPA 1965) ("[U]se of a one piece construction instead of the

structure disclosed in [the prior art] would be merely a matter of obvious engineering choice.").

On the present record and for the purposes of institution, we determine that Petitioner has shown a reasonable likelihood of demonstrating that claims 1–25 are obvious over Wu, or over a combination of Wu and Sabat-426.

G. Asserted Obviousness Based on Wu and "the OBSAI Standard"

Petitioner also asserts claims 8, 11, 19, 21, and 23–25 are obvious over a combination of Wu and "the OBSAI standard." Pet. 43.

Petitioner argues that Wu teaches use of the OBSAI protocol, and that claims 8, 11, 19, 21, and 23–25 are obvious over "Wu plus the OBSAI standard." *Id.*

With respect to this ground, we note that "the OBSAI standard" appears to refer to two documents, OBSAI RP3 (Ex. 1007) and OBSAI BTS (Ex. 1008). Petitioner uses these documents in asserting anticipation by Wu, as previously addressed. *See supra* § II.E.4. Petitioner defines these two documents as the "OBSAI Standard" and states that "[t]he OBSAI Standard (Exs. 1007, 1008) is a well-known open publication publicly available more than one year prior to the '178 patent and therefore, constitute [sic] 102(b) prior art." Pet. 13. Petitioner treats these two documents as one piece of prior art, but does not provide any indication of why, of what the relationship of the two documents is, or of whether they would be combined. As Patent Owner asserts (Prelim. Resp. 51), Petitioner's ground of obviousness over Wu and "the OBSAI Standard" is not asserted with sufficient particularity to explain the proposed combination.

H. Asserted Obviousness Based on Wu and CPRI

Petitioner asserts claims 8, 9, 11, and 19–25 are obvious over a combination of Wu and CPRI. Pet. 43–44.

Petitioner argues that Wu teaches use of the CPRI protocol. *Id.* (citing Ex. 1005 ¶¶ 31, 49, 50; Ex. 1003 ¶ 145). Petitioner references earlier discussions regarding CPRI's teachings regarding packetizing and addressing. *Id.* at 43 ("[A]s addressed above . . . ."); *see id.* 29–30 (citing Ex. 1006, 84; Ex. 1003 ¶¶ 72–92), 39–41 (citing Ex. 1006, 6, 30, 32, 40, 42, 84, Figs. 7, 13E, 14, 15, 16; Ex. 1003 ¶¶ 135, 138).

Patent Owner argues that "Petitioner is . . . silent as to how to apply this combination to the challenged claims." Prelim. Resp. 52. However, it is apparent that Petitioner refers to its earlier analysis for all aspects except the ones specifically pointed out in the first sentence of this ground. Pet. 43 ("These claims [8, 9, 11, 19–25] recite that the host unit is configured either to packetize the downlink signals being sent to the remote units (claims 8-9, 11, 19, 20, 22), or that the host unit includes destination information with the downlink signals (claims 21-25)"). CPRI (Ex. 1006) is a single document that appears, on the present record, to correspond to the CPRI standard discussed in Wu.

On the present record and for the purposes of institution, we determine that Petitioner has shown a reasonable likelihood of demonstrating that claims 8, 9, 11, and 19–25 are obvious over a combination of Wu and CPRI.

I. Asserted Obviousness Based on Wu and Sabat-552, Claims 26–30

Petitioner asserts claims 26–30 are obvious over a combination of Wu and Sabat-552. Pet. 44–49.

1. Overview of Sabat-552

Sabat-552 describes an open access RF signal distribution system supporting wireless voice, data, and other services. Ex. 1011, code (57), 5:6–9. The system is comprised of base stations located at hub sites, with the hubs connected via high speed fiber links to distributed RF access nodes (RANs) distributed throughout a given community, which are used to distribute RF signals and provide wireless service to end customers. *Id.* at 5:6–58, 6:1–23. In one embodiment, hubs are connected via digital cross-connects so a base station located at any hub site can transmit to any RAN. *Id.* at 6:55–59.

2. Analysis of Obviousness of Obviousness of Claims 26–30 over Wu and Sabat-552

For obviousness of claim 26 over Wu and Sabat-552, Petitioner relies for all but two elements on its arguments regarding Wu and similar limitations of claims 1, 10, and 21. Pet. 44–45. With respect to claim 26's recitation of "at least one interface to communicatively couple the host unit to one or more additional host units," (the term labeled "element W" by Petitioner) and of "the host unit [being] configured to send a digital representation of any carrier of any downlink signal it receives to the one or more additional host units" (the term labeled "element X" by Petitioner), Petitioner relies on Sabat-552. *Id.* at 45–47. Petitioner argues that these claim limitations are taught by the combination of Wu's system with Sabat-552's topology in which digital cross connects connect hubs so that a base station at any hub site can have signals transmitted to remote units (RANs) connected to another hub site. *Id.* at 45–46 (citing Ex. 1011, 6:55–61, Fig. 1; Ex. 1003 ¶ 154). Petitioner further argues that one of ordinary skill would have found it obvious to use Sabat-552's interconnections with Wu's matrix

switch and host unit 230, in order to avoid the cost of building additional base stations and distribution networks, and would enable the system to be shared among providers, reducing costs. *Id.* at 46–47 (citing Ex. 1011, 2:48–58, 3:65–4:5; Ex. 1003 ¶¶ 155–156.

In addition to arguments regarding Wu, addressed above, Patent Owner argues that Sabat-552 teaches a centralized routing policy in the disclosure that Sabat-552's Network Management System ("NMS") "distributes individual alarms to the appropriate tenants, and maintains secure transmission for each tenant, whereas each tenant 15 is provided access to only their own respective System, for monitoring and control purposes." Prelim. Resp. 54–55 (quoting Ex. 1011, 9:36–39, citing Ex. 1011, Fig. 1). Therefore, Patent Owner argues, Sabat-552 "does not suggest distributing the functionalities of a routing policy over one or more units." *Id.* at 54.

At this stage of the proceeding, Petitioner shows sufficiently that claim 26 would have been obvious over Wu and Sabat-552. Contrary to Patent Owner's arguments, Sabat-552's tenants are not hubs, but rather "the wireless carrier, Wireless Service Provider (WSP), or other business entity that desires to provide wireless service to end customers." Ex. 1011, 5:55–58. Additionally, the portion of Sabat-552 quoted by Petitioner does not indicate that control is centralized at the NMS, but explicitly states that the tenants have access to their system for control purposes. *Id.* at 9:36–39. Additionally, the host unit of claim 26 (preamble: "A host unit for use in the transport of wireless communications") is recited as containing an interface to a signal source and an interface to a plurality of remote units to which it sends different portions of downlink carrier signals received (the limitations

Patent Owner shorthands as providing "functionalities of a routing policy"). However, the interfaces and configuration of the "one or more additional host units" are not specified in claim 26, and therefore an argument that Sabat-552 does not teach a distributed routing policy, on this record, is not commensurate with the scope of the claim.

Petitioner also presents a sufficient showing supported by the record with respect to obviousness of dependent claims 27–30 over Wu and Sabat-552. *See* Pet. 47–49. With respect to these dependent claims and obviousness over Wu and Sabat-552, Patent Owner does not provide any additional argument.

For the reasons described, on this record and taking into account Patent Owner's arguments, Petitioner has shown a reasonable likelihood of demonstrating that claims 26–30 are obvious over Wu and Sabat-552.

J. Asserted Anticipation Based on Oh, Claims 1–8, 10, 11, 13, 15–19, 21, 23, 24

1. Overview of Oh

Oh is titled "Method and System for Dynamically Routing Between a Radio Access Network and Distributed Antenna System Remote Antenna Units" and describes a DAS system that includes mapping data that correlates network coverage segments (such as cell sectors) with addresses for the remote antenna units, to distribute coverage as desired throughout the DAS. Ex. 1023, codes (54), (57). Oh includes a block diagram of a communications system in its Figure 1, reproduced below.

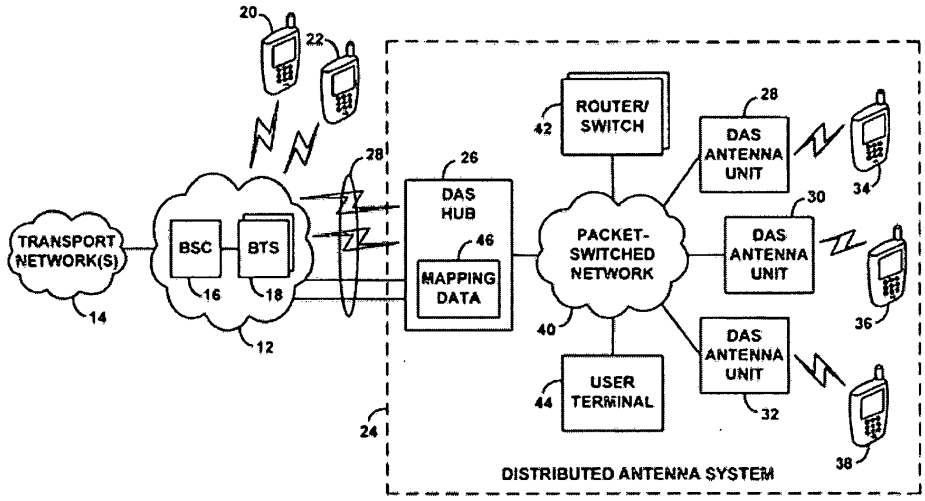


FIG. 1

Figure 1 of Oh illustrates DAS 24 that communicates with radio access network (RAN) 12, which is in RF communication with wireless devices 20 and 22. *Id.* at 4:33–46. RAN 12 defines coverage segments; each coverage segment may be a cell, cell sector, or other coverage area of RAN 12, or a particular carrier frequency or spreading code. *Id.* at 4:47–64. Each coverage segment "constitutes a mechanism in or through which the RAN communicates with client devices that it serves." *Id.* at 4:47–50.

DAS 24 extends coverage of RAN 12. *Id.* at 4:65–5:1. DAS hub 26 in DAS 24 may be connected to RAN 12 via, e.g., an antenna structure receiving signals from RAN 12, or directly via a fiber-optic cable. *Id.* at 5:1–56. DAS hub 26 stores mapping data 46, which correlates RAN coverage segments of RAN 12 with addresses of DAS antenna units 28, 30, 32. *Id.* at 7:35–47. DAS hub 26 uses the mapping data 46 to determine one or more antenna unit addresses to which it should route incoming (downlink)

traffic from RAN 12 to DAS antenna units, and which coverage segments to transmit outgoing data from DAS antenna units to RAN 12. *Id.* at 7:42–53. Packet-switched network 40 is used to communicate between DAS hub 26 and the DAS antenna units. *Id.* at 6:6–22.

2. Analysis of Asserted Anticipation by Oh

Petitioner argues that Oh discloses claim 10's "system for transporting wireless communications" through its description of its DAS. Pet. 51 (citing Ex. 1023 4:65–5:5, 5:57–64; Ex. 1003 ¶¶ 172–176). With respect to limitation B of claim 10 ("a host unit"), Petitioner argues that the host unit is disclosed by Oh's description of its DAS hub. *Id.* (citing Ex. 1023 5:1–3, 7:35–53, 8:25–31; Ex. 1003 ¶¶ 177–180). Petitioner argues that the plurality of remote units of limitation C is disclosed by Oh's description of its DAS antenna units. *Id.* (citing Ex. 1023, 5:57–6:5; Ex. 1003 ¶¶ 181–184). Petitioner argues that the "signal source" of limitations D1 and E is disclosed by Oh's RAN (which includes one or more base stations), which is connected to the DAS hub through the DAS hub's RAN interface, disclosing the interface to communicatively couple the host unit to the signal source. *Id.* at 51–53 (citing Ex. 1023, 2:50–53, 4:33–50, 8:1–11, 10:18–29, Figs. 1, 3 (elements 12, 50); Ex. 1003 ¶¶ 185–196). To explain these disclosures,

Petitioner presents an annotated version of Oh's Figure 1, reproduced below.

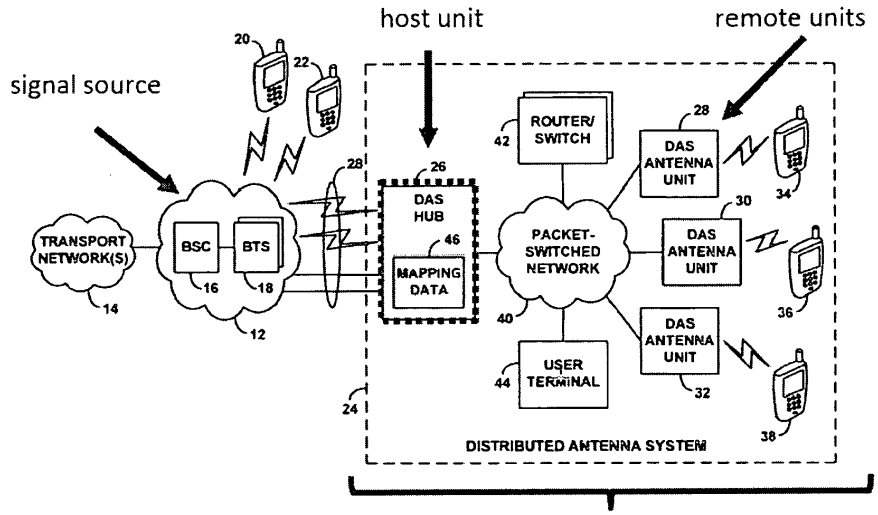


FIG. 1 system transporting wireless communication

Id. at 50. Figure 1, as annotated by Petitioner, shows Oh's DAS hub 26 (identified in red as the host unit), Oh's RAN 12 (identified as the signal source), and Oh's DAS antenna units 28, 30, 32 (identified as the remote units).

With respect to claim 10's "downlink channel signals" (in limitations E through H) a plurality of which are received from the signal source and digital representations of which are sent to the plurality of remote units, Petitioner argues that this is disclosed by Oh's RAN coverage segments, which Oh discloses may be a "cell or sector operating on a *respective RF frequency channel*." *Id.* at 53–54 (citing Ex. 1023, 3:2–5; 4:57–63; Ex. 1003 ¶ 195). Petitioner further argues that "Oh emphasizes [that] its system works with a variety of types and granularities of coverage segments." *Id.* at 55 (citing Ex. 1023, 2:64–3:5, 4:50–64). Petitioner argues that Oh discloses

limitation F in describing that the DAS hub sends signals from the RAN coverage segments to the DAS antenna units, and these signals are sent as IP packets. *Id.* at 56 (citing Ex. 1023, 8:6–11; Ex. 1003 ¶¶ 203–210).

Limitations G, H, and I require the host unit be configurable to send digital representations of a first set of downlink channel signals to the first remote unit at a first point in time, and to send digital representations of a second set at a second point in time, each for transmission at the antenna of the first remote unit, "wherein a number of downlink channel signals in the first set of downlink channel signals is different from a number of downlink channel signals in the second set of downlink channel signals." Ex. 1001, 15:17–30. Petitioner argues that these elements are disclosed by Oh's description of its configurable DAS hub, which includes mapping data that allows different RAN coverage segments to be mapped to different DAS antenna units for transmission via an antenna. Pet. 56–64 (citing Ex. 1023 7:35–53, 8:1–16, 8:47–9:43, Figs. 1–3; Ex. 1003 ¶¶ 211–237). Petitioner contends that Oh emphasizes that the mapping may be altered as desired "to distribute RAN coverage in a desired manner among the DAS antenna units." *Id.* at 59–60 (quoting Ex. 1023, 2:45–49, 3:26–36, 9:44–64; citing Ex. 1003 ¶¶ 238–249). Petitioner argues that Oh's discussion of adding or removing correlations in the mapping data would result in different sets of downlink channel signals being sent to the same DAS antenna units at different points in time, and that these sets can have different numbers of RAN coverage segments, and therefore a different number of downlink channel signals are sent to the DAS antenna units at different times. *Id.* at 59–64 (citing Ex. 1003 ¶¶ 242–248, 250–256.)

Lastly, Petitioner argues that Oh discloses the host unit configured to receive digital signals from each of the plurality of remote units in its disclosure that the DAS hub receives IP packets from the DAS antenna units. *Id.* at 65 (citing Ex. 1023 8:17–31; Ex. 1003 ¶¶ 257–260).

Patent Owner argues that Oh does not disclose the sending of digital representations of sets of downlink channel signals to remote units. Prelim. Resp. 56–59. Patent Owner cites Oh's disclosures that each DAS coverage segment "uses a particular carrier frequency and/or a particular spreading code." *Id.* at 57 (quoting Ex. 1023, 4:54–56). Patent Owner's argument appears to be that each of Oh's coverage segments teaches one carrier frequency and thus not "a set of downlink channel signals," as in claim 10, and that *Oh* does not, therefore, disclose dividing digital representations of downlink channel signals into two sets. *Id.* at 57–58, 59–60.

After considering Petitioner's arguments, we determine that, given the arrangements of the elements in Oh, Petitioner has a sufficient likelihood of succeeding in showing that Oh's DAS hub and mapping data discloses the claimed "host unit" and that Oh's RAN and BTSs disclose a signal source. On the current record and for the purposes of institution, we agree with Petitioner that Oh discloses sending sets of DAS coverage segments alone or in combination to DAS antenna units, and that its description of altering the correlations described by the mapping data discloses the change in number of downlink channel signals sent. *See* Pet. 61–64.

Petitioner argues claim 1 and claim 15 on substantially the same basis. On this record and taking into account Patent Owner's arguments, Petitioner has shown a reasonable likelihood of demonstrating that claims 1, 10, and 15 are anticipated by Oh.

With respect to claim 21, Petitioner relies in part on its arguments with respect to other independent claims, and additionally argues that Oh discloses "the host unit is configured to send a digital representation of any carrier of any downlink signal it receives to any of the plurality of remote units," in its description of flexible mapping in which the "DAS hub is capable of sending any carrier to any desired DAS antenna unit simply by configuring the mapping data such that the RAN coverage segment containing the desired carrier is correlated with the desired DAS antenna unit." Pet. 71–72 (citing Ex. 1023, 3:26–36, 9:44–58; Ex. 1003 ¶¶ 315–317). Petitioner similarly relies on the mapping table to show that a first portion of carriers (those in one RAN coverage segment) may be transmitted to a first remote unit and a second portion (a second RAN coverage segment) to a second remote unit. Pet. 73–74 (citing Ex. 1023, 9:11–20; Ex. 1003 ¶¶ 321–324). Patent Owner makes no additional arguments with respect to claim 21. On this record and taking into account Patent Owner's arguments, Petitioner has shown a reasonable likelihood of demonstrating that claim 21 is anticipated by Oh.

Petitioner also presents a sufficient showing supported by the record with respect to anticipation by Oh of dependent claims 2–9, 11–14, 16–20, and 22–25. *See* Pet. 78–83. With respect to these claims and anticipation over Oh, Patent Owner's arguments are addressed above. *See* Prelim. Resp. 55–61. For the reasons described with reference to claims 1, 10, 15, and 21, on this record and taking into account Patent Owner's prior arguments, Petitioner has shown a reasonable likelihood of demonstrating that claims 2–9, 11–14, 16–20, and 22–25 are anticipated by Oh.

K. Asserted Obviousness Based on Oh and Wu, Claims 1–8, 10, 11, 13, 15–19, 21, 23, 24

Petitioner argues the independent claims are obvious over the combination of Oh and Wu, referencing its argument that Oh anticipates the claims, but additionally arguing that in the proposed combination of Oh and Wu, Wu would provide teachings regarding "fine grained control" over carrier channels in place of Oh's DAS hub which receives and forwards RAN coverage segments. Pet. 83–84. Petitioner argues that one of ordinary skill "would have found it obvious to modify Oh's DAS hub to implement Wu's 'fine grained' control (e.g., using a combiner/splitter)." *Id.* at 84 (citing Ex. 1003 ¶¶ 392–396). Petitioner argues that one of ordinary skill would have done so to allow Wu's "fine grained control" to "further Oh's goal of allowing the routing to be 'changed when desired'" and to improve a known technique to improve a similar device *Id.* at 84–85 (citing Ex. 1023, 9:44–53; Ex. 1003 ¶¶ 393, 396).

Patent Owner argues that one of ordinary skill would not have combined Oh and Wu, due to their disparate teachings regarding what incoming traffic is routed, and because the two references "route traffic in a different manner." Prelim. Resp. 60–61. However, on the present record and for the purposes of institution, we credit Dr. Acampora's testimony and we determine that Petitioner has sufficiently shown that one of ordinary skill would have had reason to implement Wu's teachings in the system of Oh, resulting in a system which routes individual carriers rather than one RAN coverage segment to its remote devices.

Petitioner makes additional arguments with respect to the combination and dependent claims 2–7, 16–18, and 24. Pet. 85–87. Patent Owner presents no additional arguments regarding these claims, and we determine

that Petitioner has presented a sufficient showing supported by the record with respect to obviousness of these claims over Oh and Wu.

III. CONCLUSION

We determine that Petitioner has shown a reasonable likelihood of success in demonstrating that claims 1–25 are anticipated by Wu, obvious over Wu, or obvious over Wu and Sabat-426; that claims 8, 9, 11, and 19–25 are obvious over Wu and CPRI; that claims 26–30 are obvious over Wu and Sabat-552; and that claims 1–8, 10, 11, 13, 15–19, 21, 23, and 24 are anticipated by Oh or obvious over Oh and Wu.

While we do not find a reasonable likelihood of success in demonstrating that claims 8, 11, 19, 21, and 23–25 are obvious over Oh and "the OBSAI standard," *supra* § II.G, "[w]hen instituting *inter partes* review, the Board will authorize the review to proceed on all of the challenged claims and on all grounds of unpatentability asserted for each claim." 37 C.F.R. § 42.108(a).

IV. ORDER

In consideration of the foregoing, it is hereby

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review is instituted for claims 1–30 of the '178 patent on all grounds presented in the Petition;

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

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(12) **INTER PARTES REVIEW CERTIFICATE** (2504th)
United States Patent
Lemson et al.

(10) **Number: US 10,080,178 K1**
(45) **Certificate Issued: Nov. 15, 2021**

(54) **DISTRIBUTED ANTENNA SYSTEM**

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Trial Number:

IPR2020-01473 filed Aug. 14, 2020

Inter Partes Review Certificate for:

Patent No.: **10,080,178**
Issued: **Sep. 18, 2018**
Appl. No.: **15/223,819**
Filed: **Jul. 29, 2016**

The results of IPR2020-01473 are reflected in this inter partes review certificate under 35 U.S.C. 318(b).

AS A RESULT OF THE INTER PARTES REVIEW PROCEEDING, IT HAS BEEN DETERMINED THAT:

Claims **1-30** are cancelled.

* * * * *

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

PTO/AIA/82A (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

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

Application Number	15/223,819
Filing Date	July 29, 2016
First Named Inventor	Shawn Patrick Stapleton
Title	DISTRIBUTED ANTENNA SYSTEM
Art Unit	2473
Examiner Name	ZHAO, WEI
Attorney Docket Number	DALI0004USC4

SIGNATURE of Applicant or Patent Practitioner

Signature	/Sarah Mirza/	Date (Optional)	December 22, 2021
Name	Sarah Mirza	Registration Number	74,866
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

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

☑ *Total of 1 forms are submitted.

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

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

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

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

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

Application Number	Filing Date

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

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 107456

OR

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

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

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

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

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

DALI WIRELESS, INC.

☐ Inventor or Joint Inventor (title not required below)

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

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

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

SIGNATURE of Applicant for Patent

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

Signature	Albert Lee	Date (Optional)	
Name	Albert Lee		
Title	CEO of DALI WIRELESS, INC.		

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

☑ Total of 1 forms are submitted.

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

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

Privacy Act Statement

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

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

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

Electronic Acknowledgement Receipt	
EFS ID:	44585790
Application Number:	15223819
International Application Number:	
Confirmation Number:	3273
Title of Invention:	DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	167137
Filer:	Sarah W. Mirza/Steve Johnson
Filer Authorized By:	Sarah W. Mirza
Attorney Docket Number:	10333-22-CON-4
Receipt Date:	22-DEC-2021
Filing Date:	29-JUL-2016
Time Stamp:	11:24:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	DALI0004USC4_POA.pdf	244360 db10c94657f939fa1825c04a566e0be0f7b81039	no	3

Warnings:

Information:	
Total Files Size (in bytes):	244360

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 NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	DALI0004USC4

CONFIRMATION NO. 3273

107456
Artegis Law Group, LLP
John Carey
7710 Cherry Park Drive Suite T #104
Houston, TX 77095

POA ACCEPTANCE LETTER

OC000000130722547

Date Mailed: 12/29/2021

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/22/2021.

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

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

/yteferra/

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/223,819	07/29/2016	Shawn Patrick Stapleton	10333-22-CON-4

CONFIRMATION NO. 3273

POWER OF ATTORNEY NOTICE

167137
SHERIDAN ROSS PC
1560 Broadway
Suite 1200
Denver, CO 80202

OC000000130722515

Date Mailed: 12/29/2021

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/22/2021.

- The Power of Attorney to you in this application has been revoked by the applicant. 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**.

/yteferra/

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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	REQUEST ID
15/223,819	07/29/2016	Shawn Patrick Stapleton	DALI0004USC4	155225

Acknowledgement of Loss of Entitlement to Entity Status Discount

The entity status change request below filed through Private PAIR on 12/29/2021 has been accepted.

CERTIFICATIONS:

Change of Entity Status:

X Applicant changing to regular undiscounted fee status.

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

This portion must be completed by the signatory or signatories making the entity status change in accordance with 37 CFR 1.4(d)(4).

Signature:	/Sarah Mirza/
Name:	Sarah Mirza
Registration Number:	74866